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Remedial Investigation/Feasibility Study for the Clinch River/Poplar Creek Operable Unit

Volume 1. Main Text

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ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
BEIAS	Biomedical and Environmental Information Analysis Section
BERA	baseline ecological risk assessment
BMAP	Biological Monitoring and Abatement Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CNF	Central Neutralization Facility
COC	contaminants of concern
COE	U.S. Army Corps of Engineers
COPC	contaminants of potential concern
CR/PC	Clinch River/Poplar Creek
CR-ERP	Clinch River Environmental Restoration Program
CRM	Clinch River mile
CRRI	Clinch River Remedial Investigation
DO	dissolved oxygen
DOE	U.S. Department of Energy
ECR	excess cancer risk
EFPC	East Fork Poplar Creek
EPA	U.S. Environmental Protection Agency
EPT	ephemeroptera, plecotera, tricoptera
ER	Environmental Restoration
EROD	ethoxyresorufin-o-deethylase
FDA	Food and Drug Administration
FFA	Federal Facility Agreement
FS	Feasibility Study
HAI	health assessment index
HDPE	high-density polyethylene
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HPRR	Health Physics Research Reactor
HQ	hazard quotient
IRIS	integrated Risk Information System
IWMF	Interim Waste Management Facility
LCL	lower confidence limits
LHS	Latin Hypercube Sampling
LOAEL	lowest observed adverse effect level
LSI	liver-somatic index
MBM	McCoy Branch Embayment mile
MBM	McCoy Branch Embayment mile
MCL	maximum contaminant level
MFO	mixed function oxidase
NCP	National Contingency Plan
NOAEL	no observed adverse effect level
NTS	Nevada Test Site
O&M	operation and maintenance

ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ORREM	Oak Ridge Reservation Environmental Monitoring
OU	operable unit
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PCM	Poplar Creek mile
PLE	product limit estimate
PNL	Pacific Northwest Laboratory
PPE	personal protective equipment
QA	quality assurance
QC	quality control
RAO	remedial action objective
RCF	risk conversion factor
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose
RGO	remedial goal option
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	record of decision
SI	sensitivity index
SWSA	solid waste storage area
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TRE	trivalent rare earths
TRM	Tennessee River mile
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
UCL	upper confidence limit
UV	ultraviolet
VOC	volatile organic contaminants
VSI	visceral-somatic index
WAC	waste acceptance criteria
WBM	Walker Branch Embayment mile
WBR	Watts Bar Reservoir
WBRIPG	Watts Bar Reservoir Interagency Permitting Group
WOC	White Oak Creek

PREFACE

This Remedial Investigation/Feasibility Study Report on the Clinch River/Poplar Creek Operable Unit (DOE/OR/01-1393V1&D1) was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for reporting the results of a site characterization for public review. This work was performed under Work Breakdown Structure 1.4.12.3.1.02.41 (Activity Data Sheet 9302 "Clinch River/Poplar Creek Operable Unit"). This document provides the Environmental Restoration Program with information about the results of investigations performed in Clinch River/Poplar Creek. It includes information on risk assessments that have evaluated long-term impacts to human health and the environment. Information provided in the document forms the basis for the record of decision in the Clinch River/Poplar Creek Operable Unit.

EXECUTIVE SUMMARY

This document is the combined Remedial Investigation/Feasibility Study Report for the Clinch River/Poplar Creek (CR/PC) Operable Unit (OU). The CR/PC OU is located in Anderson and Roane Counties, Tennessee and consists of the Clinch River and several of its embayments in Melton Hill and Watts Bar Reservoirs. These waters have received hazardous substances released over a period of 50 years from the U.S. Department of Energy's Oak Ridge Reservation (ORR), a National Priority List site established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In accordance with CERCLA, a remedial investigation of this OU has been conducted to determine the current nature and extent of any contamination and to assess the resulting risk to human health and the environment. The feasibility study evaluates remedial action alternatives to identify any that are feasible for implementation and that would effectively reduce risk in the OU.

Historical studies had indicated that current problems would likely include ^{137}Cs in sediment of the Clinch River, mercury in sediment and fish of Poplar Creek, and PCBs and pesticides in fish from throughout the OU. Peak releases of mercury and ^{137}Cs are known to have occurred over 35 years ago, and current releases are low. Past releases of PCBs from the ORR are poorly quantified, and any current releases are difficult to quantify because levels are so low.

The current site characterization focused on evaluating contaminants in surface water, sediment, and biota. Contaminants in surface water were all found to be below Ambient Water Quality Criteria throughout the OU. Very few analytes were detected at levels that exceeded concentrations at reference sites. However, through the use of sensitive analytical techniques, a significant increase in mercury levels could be detected in Poplar Creek downstream of East Fork Poplar Creek (EFPC).

Several metals were shown to be elevated in the sediment of McCoy Branch as a result of historical ash disposal to upstream surface water. As expected, ^{137}Cs and mercury were elevated in Clinch River sediments downstream of source streams. Because of their concurrent release histories, peak concentrations of both are roughly coincident, generally being found buried under cleaner sediment in areas of stable sediment deposition. Concentrations of ^{137}Cs and ^{60}Co in near-shore sediments were shown to be low throughout the OU. In Poplar Creek, increased levels of several metals in sediments, including mercury, are found downstream of the mouth of EFPC. Additional metals, uranium, and ^{99}Tc are elevated in sediments downstream of Mitchell Branch, and several more metals are elevated at the coal ash disposal area in lower Poplar Creek. Organic contaminants in sediment consisted primarily of a few relatively ubiquitous environmental pollutants, all of which were found infrequently and at low concentrations. Sediment transport modelling in the Clinch River indicates that, under normal flow conditions, existing ^{137}Cs inventories would decline due to decay. A local storm in the White Oak Creek watershed would result in a temporary increase in contaminated sediment, but normal flows would soon transport these recent deposits downstream. A major regional storm would result in the immediate decline in ^{137}Cs as a result of scour of existing sediment and eventual deposition downstream.

PCBs and the pesticide chlordane were elevated above reference values (Norris Reservoir) in several species of fish throughout the CR/PC OU. Mean levels in all species were below the federal Food and Drug Administration (FDA) action levels (2.0 mg/kg) at all sites. Significant year-to-year and spatial variation in average concentrations were taken to be indicative of multiple sources of these contaminants; moreover, similar levels are known in fish from other East Tennessee reservoirs situated upstream of the ORR. Mercury levels in fish from Poplar Creek were shown to be elevated downstream of EFPC. Mean values were below the FDA action level of 1.0 mg/kg. Uptake of mercury and PCBs at several trophic levels (benthic invertebrates, insectivorous fish, piscivorous fish and wildlife) was documented.

The greatest risk to human health from contaminants in the CR/PC is from the consumption of fish containing PCBs and pesticides. This is the only pathway resulting in a cancer risk greater than 10^{-4}, with two species (catfish and striped/hybrid bass) having average concentrations that result in a greater than 10^{-3} cancer risk. Fish from Poplar Creek contain sufficient mercury to pose a toxic risk to children via the consumption pathway. The state of Tennessee has posted both Poplar Creek and the Clinch River, advising persons to avoid or to limit the consumption of fish taken from these waters. Several radionuclides in sediment would pose an unacceptable risk if dredged and placed on shore so as to allow unrestricted access. Cesium-137 and ^{60}Co each pose an excess cancer risk greater than 10^{-5} via external exposure. If dredge spoil were used for agricultural purposes, modelled concentrations of several contaminants in produce (meat, milk, and vegetables) were predicted to pose an unacceptable risk. Several noncarcinogenic contaminants, primarily metals, posed an unacceptable hazard via direct ingestion of surface water. No unacceptable risks were identified for the swimming or irrigation scenarios.

Significant ecological risks were identified in Poplar Creek, but not the Clinch River. The fish and benthic invertebrate communities in Poplar Creek were both found to be at risk of experiencing a 20% reduction in species richness and abundance. Poplar Creek water was toxic to fish embryos and periodic increases in dissolved metal concentrations reached toxic levels. Fish from Poplar Creek were also in the poorest health as indicated by a suite of biological parameters. Poplar Creek sediment contained several contaminants at concentrations that have been reported toxic by other studies. No significant effects were found for piscivorous or insectivorous wildlife inhabiting Poplar Creek. Cottontail rabbits feeding on vegetation growing on dredge spoil were predicted to be at significant risk from mercury.

A range of remedial options were evaluated and screened in the feasibility study, with three being retained. The no-action alternative must be retained, under CERCLA, for purposes of comparison; however, this alternative is not protective of human health and the environment. Alternative 2, the use of institutional controls and advisories, would be protective of human health but would not address ecological risk. Alternative 3, source containment, would reduce both human health and ecological risks by isolating existing contaminants in sediment thereby reducing the potential for future exposure.

1. INTRODUCTION

1.1 REGULATORY INITIATIVE

This document is the combined Remedial Investigation/Feasibility Study (RI/FS) Report for the Clinch River/Poplar Creek Operable Unit (CR/PC OU), an off-site OU associated with environmental restoration activities at the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR). As a result of past, present, and potential future releases of hazardous substances into the environment, the ORR was placed on the National Priorities List in December 1989 (54 FR 48184). Sites on this list must be investigated for possible remedial action, as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 U.S.C. 9601, *et seq.*). This report documents the findings of the remedial investigation of this OU and the feasibility of potential remedial action alternatives. These studies are authorized by Sect. 117 of CERCLA and were conducted in accordance with the requirements of the National Contingency Plan (40 CFR Part 300).

DOE, the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) have entered into a Federal Facility Agreement (FFA), as authorized by Sect. 120 of CERCLA and Sects. 3008(h) and 6001 of the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 *et seq.*). The purpose of this agreement is to ensure a coordinated and effective response for all environmental restoration activities occurring at the ORR. In addition to other responsibilities, the FFA parties mutually define the OU boundaries, set remediation priorities, establish remedial investigation priorities and strategies, and identify and select remedial actions. A copy of this FFA is available from the DOE Information Resource Center in Oak Ridge, Tennessee.

The CR/PC Remedial Investigation (CRRI) was originally begun under authority of Sect. 3008(v) of RCRA. Although these requirements still apply, CERCLA is the primary regulatory driver because it allows for the consideration of a wider range of contaminants, including radionuclides, polychlorinated biphenyls (PCBs), and contaminants in wastes released before the enactment of RCRA in 1976. The FFA parties intend to meet the RCRA corrective action requirements, as well as any applicable or relevant and appropriate requirements of other environmental law, through the CERCLA process.

1.2 OAK RIDGE RESERVATION ENVIRONMENTAL RESTORATION PROGRAM

The DOE ORR is composed of three major installations—the Oak Ridge National Laboratory (ORNL), the Y-12 Plant, and the K-25 Site (formerly the Oak Ridge Gaseous Diffusion Plant). These facilities were constructed in the early 1940s as research, development, and process facilities in support of the Manhattan Project. Approximately 650 ORR sites have been identified that require environmental evaluation. The remediation of these sites is expected to take two to three decades and cost several billion dollars. The overall strategy in effecting the environmental response has been to partition the ORR into waste area groupings and OUs to facilitate investigation and action. The ORR-wide Environmental Restoration (ER) Program is described in the ORR ER Site Management Plan (DOE 1994).

1.3 CLINCH RIVER ENVIRONMENTAL RESTORATION PROGRAM

The Clinch River Environmental Restoration Program (CR-ERP) was created to investigate the impact of current and past releases of contaminants from the ORR to the off-site surface water environment. The original study area was a single OU, which included Melton Hill Reservoir, the Clinch River arm of Watts Bar Reservoir (WBR), and the WBR downstream of the confluence of the Clinch and Tennessee rivers (Energy Systems 1990). This investigation implemented a phased approach that relied heavily on screening-level risk analysis for estimating the human health and environmental risks resulting from off-site contamination. This phased approach was designed to include (1) an initial screening-level risk assessment to identify areas for which more data were needed; (2) a preliminary (Phase 1) sampling and analysis of water, sediment, and biota from selected sites representative of differing levels of contamination (including upstream reference sites) to determine the range of contaminants present in the off-site environment and also to verify existing data; (3) a focused (Phase 2) sampling and analysis effort directed specifically at supplying additional data for site characterization and human health and ecological risk assessment for specific areas, media, and contaminants of concern; (4) iterative risk assessments, as data became available, to continue focusing of sampling efforts; and (5) the identification and evaluation of potential remedial action alternatives (Energy Systems 1990).

At the public's request, in October 1993, the FFA parties decided that the WBR downstream of the Clinch River should become a distinct OU for the purpose of accelerating the remedial decision in that portion of the reservoir (DOE 1994). The results of the lower WBR RI/FS are discussed by DOE (1995). In keeping with the original phased approach, the remainder of the original OU, consisting of the Clinch River and Poplar Creek downstream of the ORR, was studied in more detail under Phase 2 of the CRRI.

1.4 OBJECTIVES AND SCOPE OF THIS REPORT

The objectives of this report are to (1) describe the current nature and extent of the contamination in the CR/PC system resulting from releases from the ORR (Chap. 3), (2) quantify the current and future risk in the CR/PC system to human health (Chap. 5) and the environment (Chap. 6) resulting from these contaminants, and (3) identify and evaluate remedial action alternatives that are feasible for application in the Clinch River or Poplar Creek (Chaps. 7 and 8). Data collected during Phase 1 and Phase 2 of the CRRI, in conjunction with certain existing data, are used to accomplish each of these objectives.

1.5 SCHEDULE

In conjunction with this RI/FS, DOE is preparing a Proposed Plan that will summarize the findings of the RI/FS and identify a preferred remedial action alternative. A public meeting will be held to present the Plan, and a minimum 30-day comment period will follow. DOE, EPA, and TDEC will jointly select the final remedy after consideration of all public comments. The Proposed Plan is scheduled for release in early 1996.

DOE will document the selection of the final remedy in a formal Record of Decison (ROD), to be signed by EPA and TDEC. This ROD is scheduled for completion in early 1997. If the ROD results in contaminants being left in place at the site, Sect. 121(c) of CERCLA requires review of the remedial decision at least every 5 years to ensure that the selected remedy is protective of human health and the environment. In such an event, DOE may implement a long-term monitoring plan in the Clinch River and Poplar Creek to gather the data necessary to make this determination. If this review indicates that the remedy is not protective of human health and the environment, further remedial action will be required.

2. CHARACTERIZATION OF ENVIRONMENTAL SETTING

2.1 GEOGRAPHY

The area of the Clinch River under investigation is located in eastern Tennessee downstream of the ORR (Fig. 2.1). The OU is large, extending almost 34 miles from the mouth of the Clinch River at Kingston, Tennessee, to the upstream limit of the ORR at Clinch River mile (CRM) 43.7 near the city of Oak Ridge (Fig.2.2 and Plate A). It includes the Poplar Creek embayment of WBR from the creek's mouth at CRM 12.0 upstream to its confluence with East Fork Poplar Creek (EFPC) at Poplar Creek mile (PCM) 5.5.

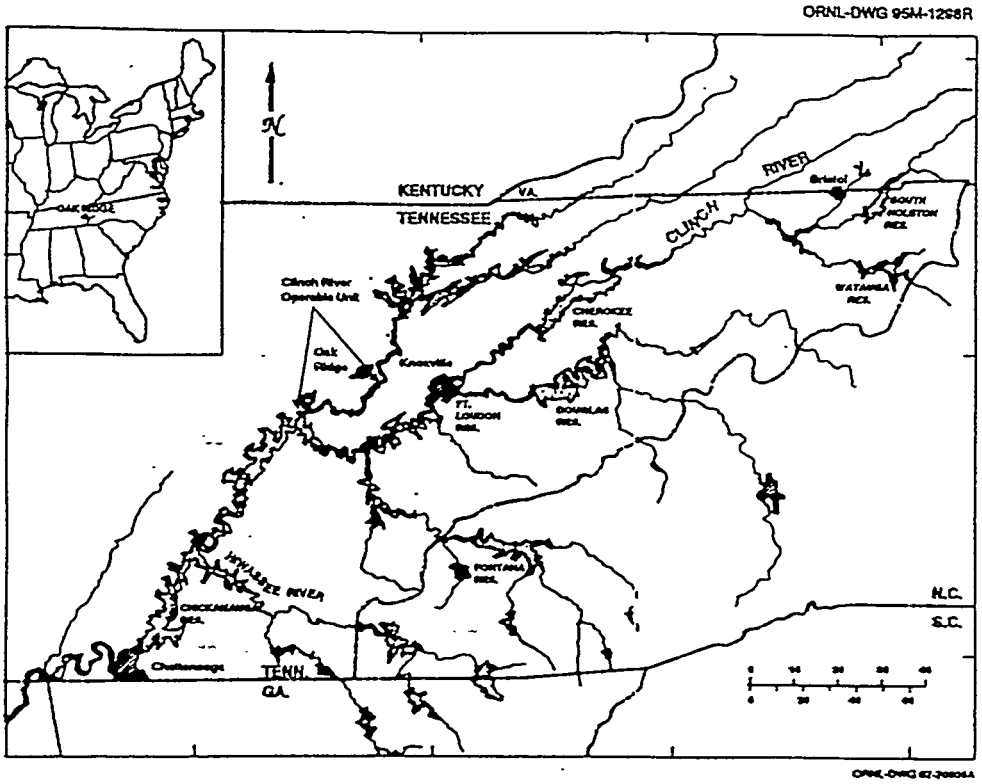

Fig. 2.1. Location of the Clinch River/Poplar Creek Operable Unit in eastern Tennessee.

The ORR is a 34,600-acre tract located within the city limits of Oak Ridge in Anderson and Roane counties. The Clinch River forms the southern and eastern boundaries of the ORR, while Poplar Creek flows directly through the reservation. The Clinch River also forms the boundary between Knox and Anderson counties for a portion of its length in the study area.

The area of the Clinch River under study includes portions of two Tennessee Valley Authority (TVA) reservoirs. Downstream of Melton Hill Dam, located at CRM 23.2, the study area is considered part of the WBR. Upstream of Melton Hill Dam, the study area is in Melton Hill Reservoir.

2.2 DEMOGRAPHY

The ORR lies within the city limits of Oak Ridge (pop. 27,310), but is situated southwest of the residential portion of the city. The largest population center near Oak Ridge is Knoxville (pop. 165,121), located approximately 20 miles to the east. The nearest community downstream of the ORR is Kingston (pop. 4,552), situated at the confluence of the Clinch and Tennessee rivers approximately 9 river miles downstream of the ORR. A total of 115,477 persons live in Anderson and Roane counties. An additional 560,931 persons reside in the 10-county area that borders the above counties. The population distribution within a 50-mile radius of the ORR is depicted in Fig. 2.3. Land use along the Clinch River is primarily agricultural and residential in the valleys and woodland on the ridges (for example, see Fig. 2.18).

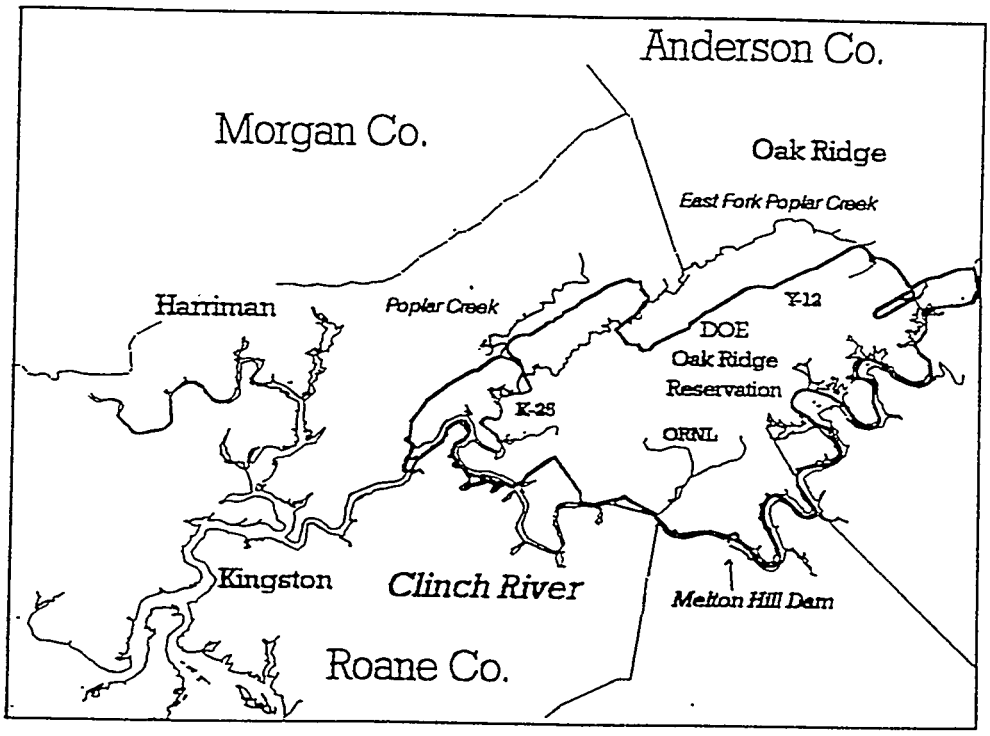

Fig. 2.2. The Clinch River/Poplar Creek Operable Unit, indicating its relation to DOE's Oak Ridge Reservation.

There are currently three potable water intakes on the Clinch River within the study area (Plate A). In Melton Hill Reservoir, the city of Oak Ridge has a municipal intake at CRM 41.5 near Scarboro, and the West Knox County Utility District has an intake at CRM 36.2 near Melton Hill Park. In the WBR, DOE's K-25 Site has a potable water intake at CRM 14.5 at the mouth of Grassy Creek. The municipal intake for the city of Kingston is located on the Tennessee River [Tennessee River mile (TRM) 568.4] immediately upstream of its confluence with the Clinch. Depending on the flow conditions resulting from reservoir operations, effluents from the ORR could reach the intake. Several intakes are located in Melton Hill Reservoir upstream of the ORR, including a pumping station for the West Knox County

Utility District at CRM 46.1, an Anderson County Utility Board intake at CRM 52.5, and municipal intakes for the city of Clinton at CRM 56.9 and 64.8. No domestic intakes are located on Poplar Creek within or downstream of the ORR.

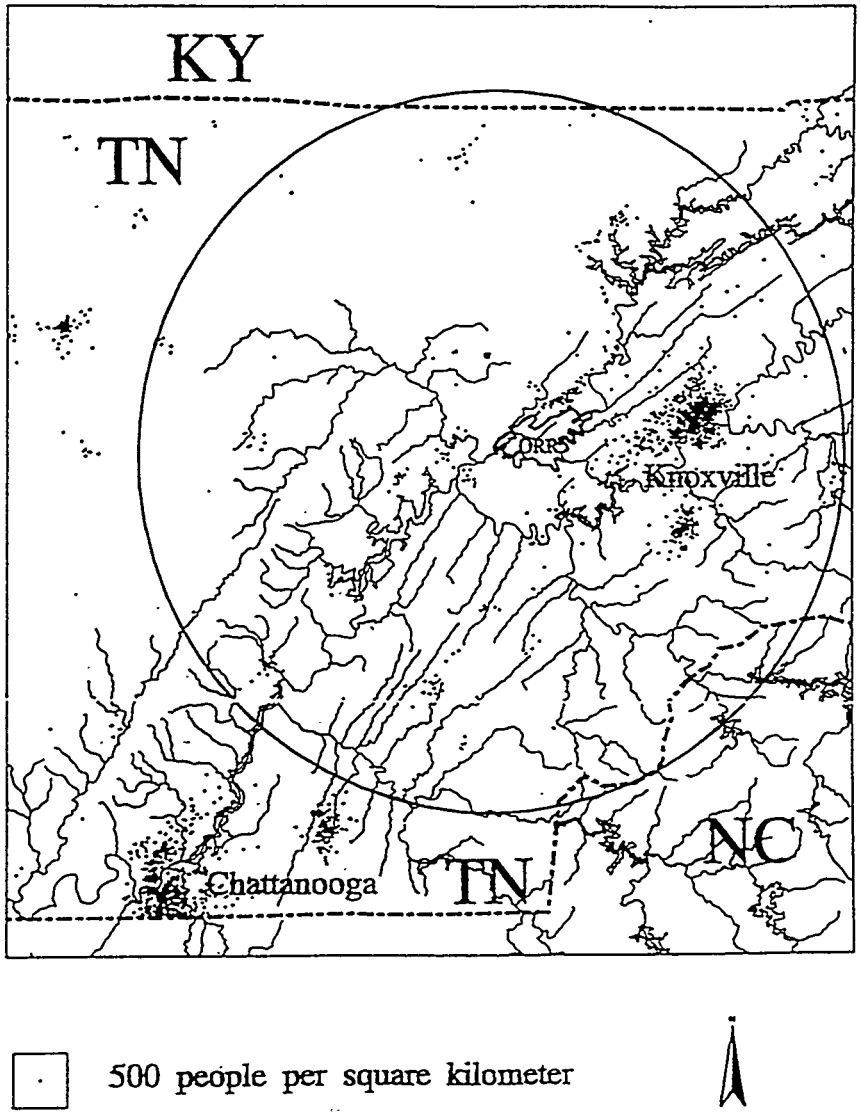

Fig. 2.3. Population density and distribution within 50 miles of the Oak Ridge Reservation.

Popular recreational uses of the Clinch River within the study area include fishing, swimming, skiing, and boating. Public recreational facilities on Melton Hill Reservoir within the study area include Guinn Road Park and Melton Hill Park (Plate A). TVA's Melton Hill Dam Public Use Area provides access to the Clinch River both above and below Melton Hill Dam. In WBR, the only public recreation areas are Kingston City Park and Southwest Point Park at Kingston. The 300-acre Kingston Wildlife Management Area is located across from Kingston at the mouth of the Emory River. The only commercial recreational facility within the study area is a campground on WBR at CRM 17.

In addition to providing domestic water supply and recreational opportunities, the Clinch River provides commercial navigation as far as CRM 66 at the city of Clinton. Other uses of the Clinch River include industrial water supply, wildlife and aquatic habitat, and likely some limited use for irrigation and watering of livestock.

2.3 CLIMATE

The ORR area has a temperate climate with warm, humid summers and cool winters. The climate is moderated by the Cumberland Plateau to the west and the Blue Ridge Mountains to the east. The mean annual temperature is 58°F. The coldest month is usually January, with a mean temperature of 38°F. The hottest month is July, with a mean temperature of 77°F (Energy Systems 1993).

Winds in the area are influenced primarily by the surrounding topography. Prevailing winds are usually southwesterly during the day, moving up the Tennessee River Valley. Nighttime winds generally move down the valley, to the southwest. Strong winds are rare, with wind speeds less than 7.4 mph occurring 75% of the time (Energy Systems 1993).

Precipitation in the area averages between 50 and 55 in. per year. The wettest months are December through March, when slow-moving fronts may result in low-intensity storms of long duration. Another peak occurs in summer, when convective currents create high intensity, short-duration, localized thunderstorms. The driest period is typically autumn, when slow-moving high pressure cells may suppress rain for extended periods. Average annual evapotranspiration is estimated from 32 to 35 in., or 66% of rainfall, leaving an average of 20 to 23 in. available for runoff and infiltration. Evapotranspiration is greatest during the growing season, often exceeding the rate of precipitation, resulting in soil moisture deficits. In winter, precipitation exceeds evapotranspiration, resulting in increased water available for runoff and groundwater recharge (Energy Systems 1993).

Rainfall in 1994 (when data for this RI were being collected) was approximately 65.6 in., considerably above normal. More than half of this total (35.19 in.) fell from January through April and resulted in higher than normal flows during much of the sampling period.

2.4 TOPOGRAPHY, GEOLOGY, AND SOILS

2.4.1 Topography

The ORR and the CR/PC lie in the Ridge and Valley Province (Fig. 2.4). This Province is bordered on the east by the Blue Ridge Province and on the west by the Cumberland Plateau Province. The Ridge and Valley Province extends for 1200 miles from the Canadian St. Lawrence Valley to the Gulf Coastal Plain of Alabama. It is characterized by a succession of northeast trending ridges of various widths. The topography is reflective of the underlying geology, in which ridges are underlain by less soluble cherty limestones, dolomites, and sandy shales, while the valleys are underlain by more soluble limestones, dolomites, and shales. Extensive folding and thrusting throughout the Province has resulted in the characteristic belted pattern of rock formations (Energy Systems 1993).

2.4.2 Geology

The ORR and the CR/PC are underlain by several different geologic formations or groups of formations, all of sedimentary origin (Fig. 2.5). Energy Systems (1993) describes the generalized

stratigraphy as including, in ascending order, the lower Cambrian Rome Formation, the Cambrian Conasauga Group, the Cambrian-Ordovician Knox Group, and the middle Ordovician Chickamauga Group. Younger upper Ordovician to Mississipian rocks are exposed locally in the cores of two synclines north of the White Oak Mountain thrust fault. Although minor carbonate beds are found throughout the Conasauga Group bedrock, the principal carbonate formations on the ORR are the upper Conasauga Group Maynardville Limestone, Chickamauga Group limestones, and the Knox Group. Other formations on the ORR are characterized by silty sandstones, siltstones, limey siltstones, and shales (Energy Systems 1993).

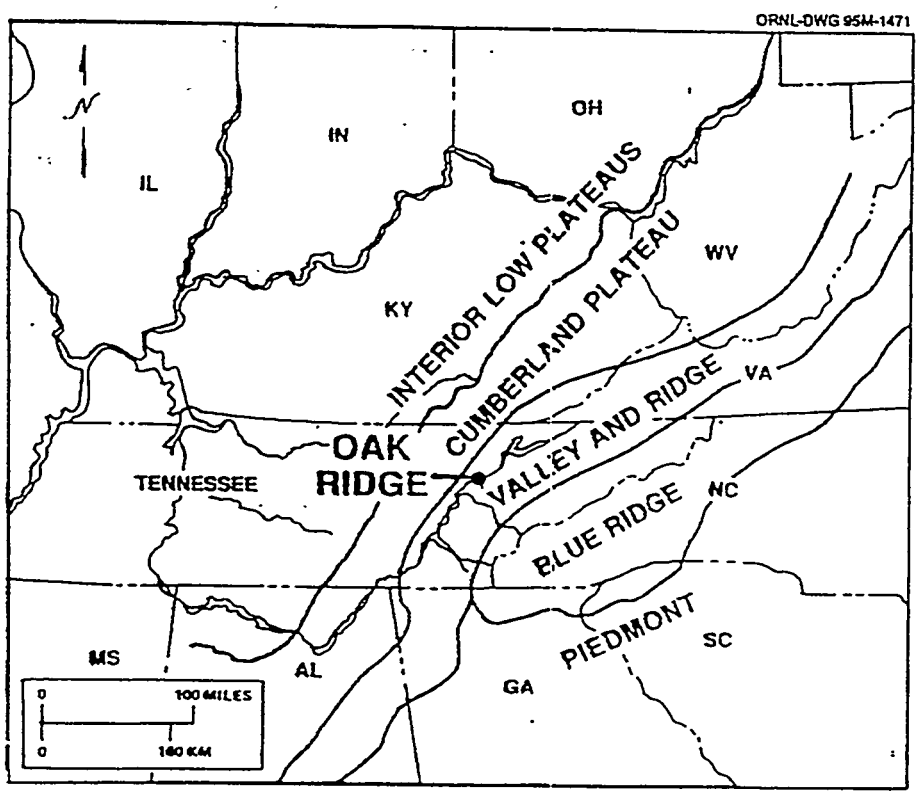

Fig. 2.4. Regional physiographic map depicting the location of the Oak Ridge Reservation and the Clinch River/Poplar Creek Operable Unit in the Valley and Ridge Province (Energy Systems 1993).

The northeast trending ridges of the study area result from a succession of northeast-trending thrust faults that have structurally stacked and replicated the rocks of the geologic units (Fig. 2.6). Most of the prominent ridges are underlain by the Rome or Knox groups, while many of the valleys are underlain by the Chickamauga or Conasauga groups. The major faults in the area were formed during the Permian-Pennsylvanian age and are not active structures (Energy Systems 1993). Competent bedrock in each of these formations is generally overlain by a mantle of *regolith*, a zone of weathered, unconsolidated materials that form in place via chemical and physical weathering of the underlying bedrock. Above the regolith is a relatively thin layer of soil or alluvial sediment.

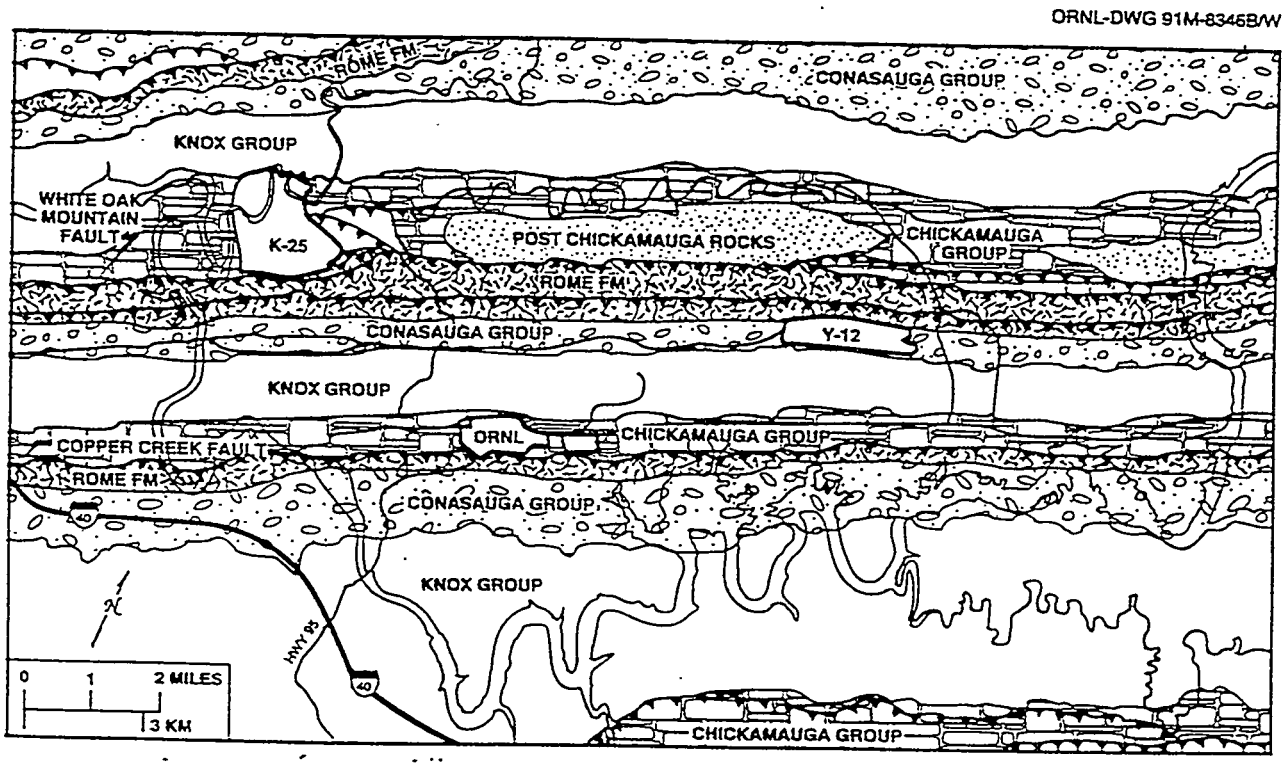

Fig. 2.5. Geologic map of the Oak Ridge Reservation (Energy Systems 1993).

2.4.3 Soils

The land along the Clinch River study area is primarily overlain by residual soils that have weathered in place. The most extensive soils in the study area are the Fullerton, Bodine, Talbott, Colbert, and LeHew soils (USDA 1981). In general, soils can be correlated with the underlying geologic unit that serves as the parent material. The deep, well-drained Fullerton and Bodine soils of Chestnut Ridge, Blackoak Ridge, and Copper Ridge have been derived from the Knox Group, while the shallower, loamier soils of Pine Ridge and Haw Ridge have formed from the Rome Formation. In the valleys underlain by the Chickamauga Limestone, such as Bethel Valley and much of EFPC Valley, the Talbott and Colbert soils, characterized by plastic clay subsoils, predominate. In valleys underlain by the Conasauga shale, such as Bear Creek Valley and Melton Valley, the moderately deep, well-drained Sequoia soils are found. Alluvial soils are also present to a limited extent within the study area, primarily on high river terraces of ancient river floodplains and in narrow tracts along modern streams. The characteristics of any soil are highly localized and can vary widely even within a soil type.

2.4.4 Groundwater

Groundwater conditions on the ORR are summarized here to acquaint the reader with the environmental setting. Groundwater contamination on the ORR is being addressed separately from the CR/PC OU (DOE 1994).

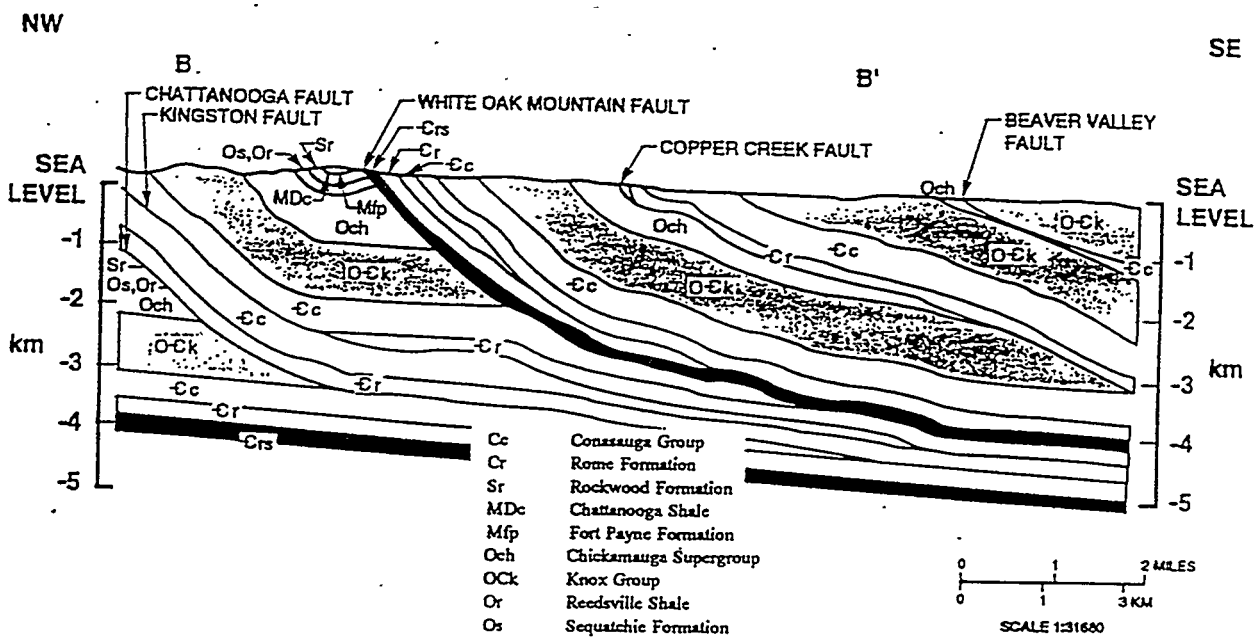

Fig. 2.6. Generalized geologic cross-section of the Oak Ridge Reservation (Energy Systems 1993).

A conceptual model of groundwater occurrence has recently been formulated for the ORR (Solomon et al. 1992, Moore and Toran 1992). The hydrology of the area (Fig. 2.7) can be considered in two broad hydrologic units: (1) the Knox aquifer and (2) the aquitards (Energy Systems 1993). The Knox aquifer consists of the Knox Group and the underlying Maynardville Limestone of the Conasauga Group (Energy Systems 1993), both of which consist of massive carbonate rocks. Although the matrix of this unit exhibits low primary porosity and permeability, flow is controlled by a combination of secondary fractures and solution conduits. Large volumes of water may move relatively long distances in this unit. The Knox aquifer is the primary source of base flow for many streams in the study area. All large springs on the ORR issue from the Knox unit (Energy Systems 1993), and the yield of some wells penetrating the larger solution conduits within this unit yield in excess of 1000 gal/min. The Knox aquifer has been described as the most important aquifer in eastern Tennessee (DeBuchananne and Richardson 1956).

The remaining geologic units underlying the majority of the ORR and Clinch River (the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group) constitute the aquitards (Energy Systems 1993). These units are all of low primary porosity and permeability; secondary permeability is usually much reduced compared to the Knox aquifer. These units are more likely to produce wells of lower yield than the Knox, and base flow to streams is also typically much reduced (Energy Systems 1993).

Within both hydrologic units, three major zones of groundwater occurrence can be identified (Fig. 2.8). The *stormflow zone* is a transient, shallow subsurface zone consisting of the upper 3–6 ft of soil, roughly corresponding to the root zone. The unsaturated *vadose zone* underlies the stormflow zone and consists of the unconsolidated regolith or bedrock. It ranges in thickness from 0 ft near perennial streams, to as much as 50 ft beneath ridges underlain by members of the Rome Formation, to more than 100 ft beneath ridges underlain by the Knox aquifer (Energy Systems 1993). An unconfined *saturated zone* underlies the vadose zone. Its upper boundary constitutes the water table, which may extend into

the regolith and approach the surface near perennial streams. The saturated zone extends down through the bedrock. At depth (generally more than 200 m), the quality of the water changes from freshwater to brine, which is sometimes used to delineate the functional basement of this zone (Energy Systems 1993).

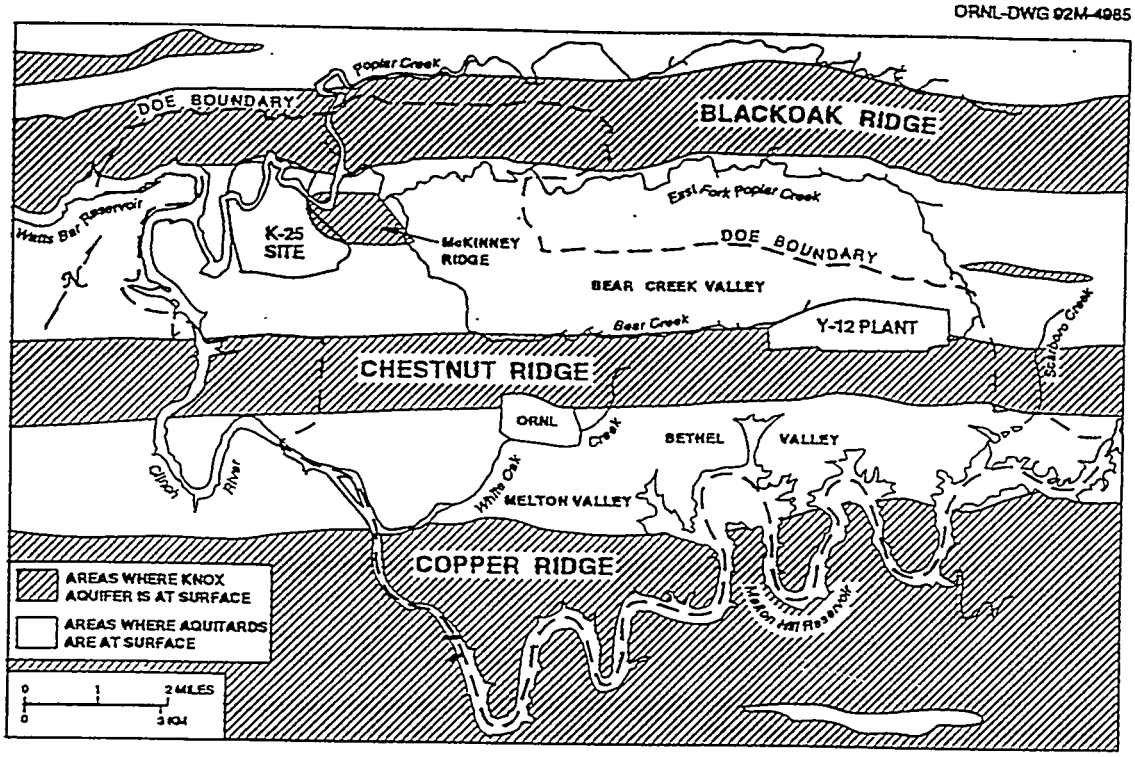

Fig. 2.7. Location of aquitards and the Knox Aquifer on the Oak Ridge Reservation (Energy Systems 1993).

On the ORR, as well as the surrounding region, the majority (95%) of the active subsurface flow is via the shallow stormflow zone to nearby surface streams. The vadose zone transmits water vertically to the saturated zone, necessary for recharge of the saturated zone. Saturated zone flow in the aquitards occurs primarily (95%) in the upper 50 to 100 ft; consequently, flow routes are short, and discharge is to nearby surface streams. In the Knox aquifer, a few solution conduits may be as much as 2 miles long (Energy Systems 1993).

2.5 SURFACE WATER

2.5.1 Physical Characteristics

The Clinch River rises near Tazewell, Virginia, and flows 351.6 miles to the southwest before entering the Tennessee River at Kingston. It drains an area of 4413 mi^2 (Fig. 2.9), primarily within the River and Valley Province. There are two major impoundments on the Clinch River. Norris Reservoir extends from Norris Dam (CRM 79.8) 73 miles upstream on the Clinch River and 53 miles on the Powell River. Norris Reservoir is a deep storage impoundment providing hydropower, flood control, and augmentation of downstream flow during drought conditions. Melton Hill Reservoir, impounded in 1963, extends from Melton Hill Dam at CRM 23.2 upstream 44 miles to Clinton, Tennessee. Melton Hill

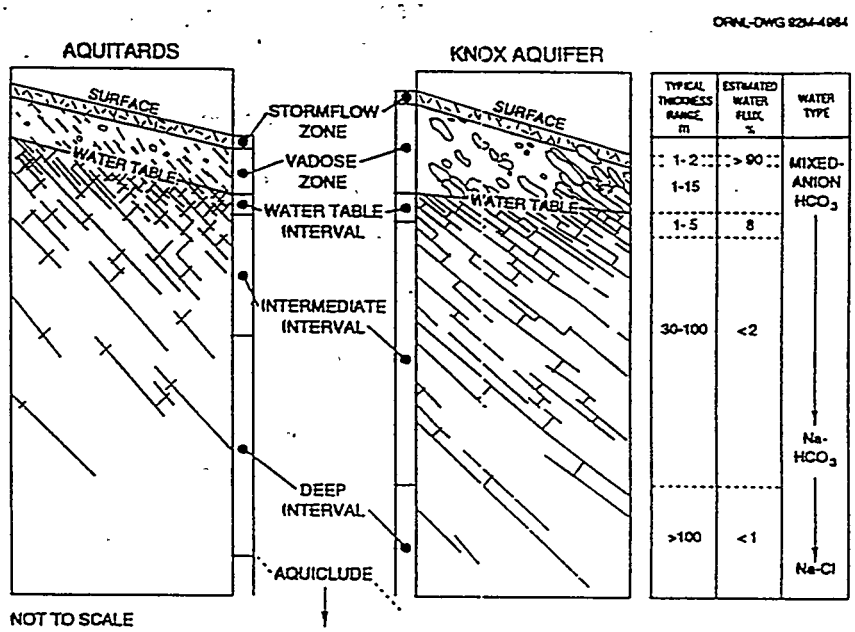

Fig. 2.8. Schematic representation of vertical relationships characteristic of flow zones on the ORR: estimated thickness, water flux, and water type (Energy Systems 1993).

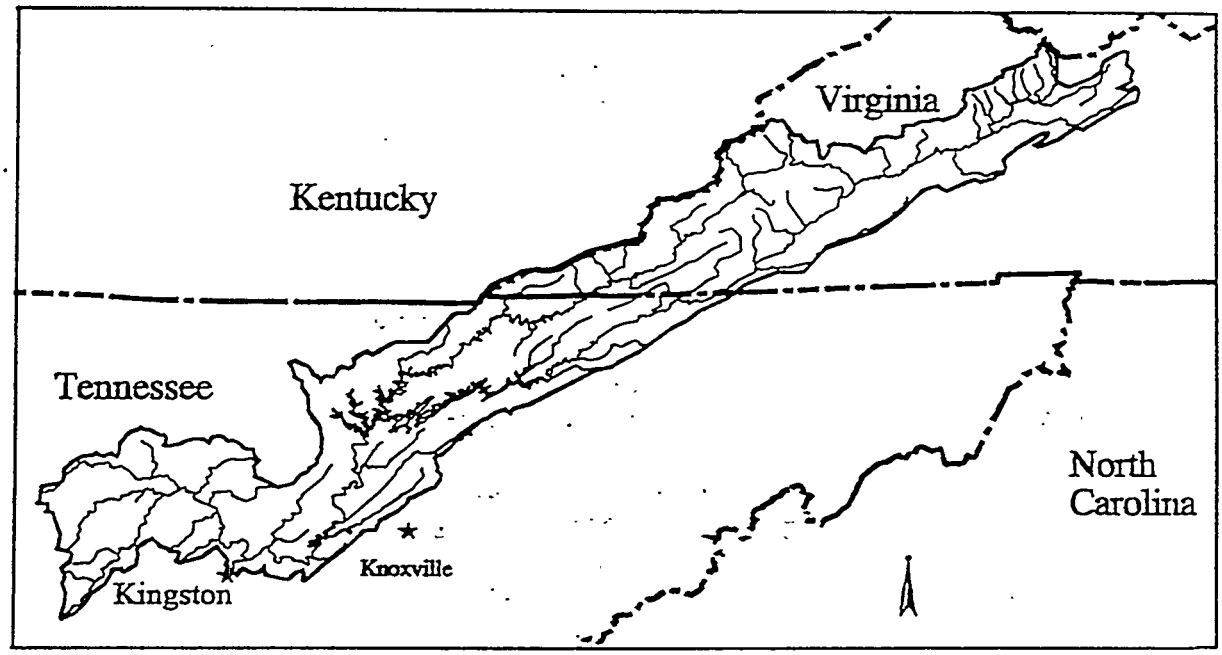

Fig. 2.9. The Clinch River drainage basin—4413 square miles in Virginia and Tennessee.

Reservoir is a smaller, shallower reservoir used primarily for navigation and the generation of hydropower during peak demand periods. Downstream of Melton Hill Dam, the river constitutes an arm of WBR, impounded in 1942 by TVA's Watts Bar Dam on the Tennessee River (TRM 529.9). The CR/PC study area consists of the Clinch River arm of WBR and portions of Melton Hill Reservoir.

The Clinch River arm of WBR extends approximately 23 miles from the mouth of the Clinch River to Melton Hill Dam (Fig. 2.2). It is 2100 surface acres in size and contains approximately 39,000 acre-feet of water at full pool (elevation 741 ft above msl). Average annual discharge at the mouth is approximately 6800 cfs, and the average hydraulic retention time is approximately 3 days. Most of the flow (75%) in this stretch of the river is released from Melton Hill Dam, with an average annual discharge of 4400 cfs. Principal tributaries to the Clinch River arm of WBR are the Emory River, which enters at CRM 4.0, and Poplar Creek, which enters at CRM 12.0. The Emory River discharges approximately 1020 cfs on average, or about 20% of the flow in the Clinch River at Kingston. Most of its 865 mi^2 watershed is located in the Cumberland Plateau. Poplar Creek has a drainage area of 135.9 mi^2 and an average annual flow at its mouth of 228 cfs, or about 4% of the flow at Kingston. The remaining flow comes from minor tributaries, direct precipitation, and groundwater flow.

Poplar Creek and White Oak Creek are the streams of primary interest that have historically transported contaminants from the ORR to the Clinch River arm of WBR. Poplar Creek receives effluents from the Y-12 Plant (via EFPC) and the K-25 Site. Above the ORR, Poplar Creek receives municipal discharges from Oak Ridge (again via EFPC) and Oliver Springs, as well as non-point-source discharges from agricultural and mining activities. White Oak Creek, which enters at CRM 20.8, has its headwaters on the ORR. It drains 6 mi^2 of the ORR, including ORNL, and has an average annual flow of 13.8 cfs.

The Clinch River arm of WBR is primarily riverine through most of its length. More lake-like (lacustrine) conditions, characterized by slowly moving waters, are found downstream of the Emory River, extending up to and including parts of Poplar Creek during summer. Due to reduced surface water velocity, lacustrine areas are subject to thermal and chemical stratification. This reduced flow also leads to the accumulation of organic matter, particle-associated contaminants, and other finer grained materials in the sediments. During colder months, the riverine conditions persist throughout the Clinch River. Since these areas exhibit both riverine and lacustrine conditions, they may best be thought of as transition areas.

The WBR is managed by TVA to provide flood control, navigation, water supply, aquatic habitat, and recreation. During the winter months, the surface of the reservoir is maintained at an elevation of 735 ft above msl to provide flood storage capacity for spring runoff. In mid April, the water level is gradually raised to the summer pool elevation of 741 ft to provide recreational benefits and to improve shoreline aquatic habitat (Fig. 2.10). The relationship between water elevation, surface area, and volume in the Clinch River arm of WBR (excluding Poplar Creek and the Emory River) is depicted in Fig. 2.11.

The flow rate below Melton Hill Dam varies greatly, often hourly, because the primary role of the dam is to generate electricity to meet peak power demands. This practice produces discharges up to 17,500 cfs during peak demand, followed by periods of zero discharge, resulting in rapid changes in surface water elevation in the upper portions the Clinch River (Fig. 2.12).

Melton Hill Reservoir, situated on 44 miles of the Clinch River between Watts Bar and Norris reservoirs, forms the eastern and northern boundaries of the ORR. Melton Hill may be characterized as a "run-of-the-river" reservoir because of its close resemblance to river morphometry, its small surface area (5700 acres), small volume (120,000 acre-feet), and short water-retention time (16 to 17 days)

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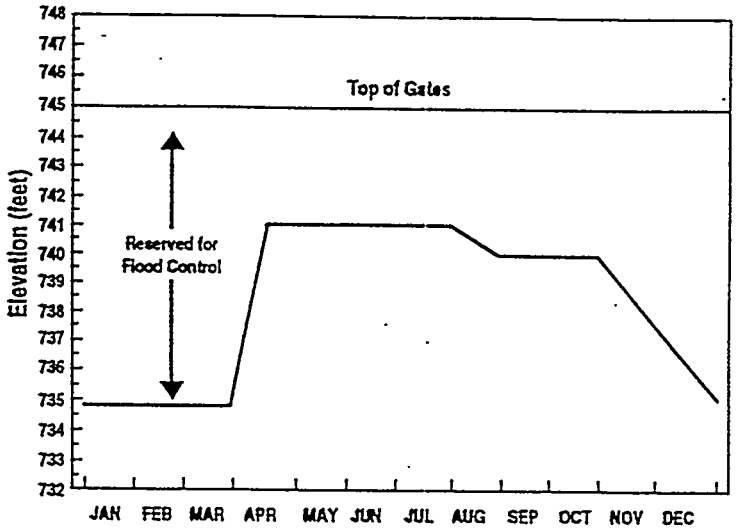
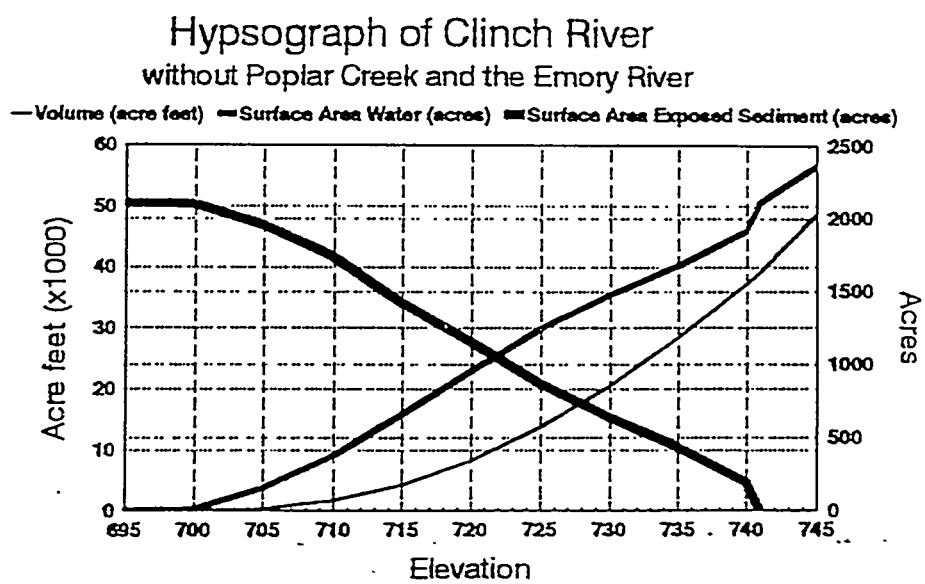


Fig. 2.10. Seasonal water level elevations in Watts Bar Reservoir as maintained by the Tennessee Valley Authority.



	695	700	705	710	715	720	725	730	735	740	741	745
Volume (acre feet)	0.00057	0.02018	0.34203	1.85881	4.18997	8.19478	13.7216	20.4934	28.3957	37.294	39.3488	48.6195
Surface Area Water (acres)	0.5	12.36	160.669	373.018	664.388	852.815	1238.85	1470.62	1672.85	1913.11	2100.7	2369.64
Surface Area Exposed Sediment (acres)	2100.85	2007.35	1869.13	1726.88	1434.33	1167.08	899.75	629.08	436.75	186.69	0	

Fig. 2.11. Relationship between surface water elevation, volume, and exposed sediments in the Clinch River arm of Watts Bar Reservoir.

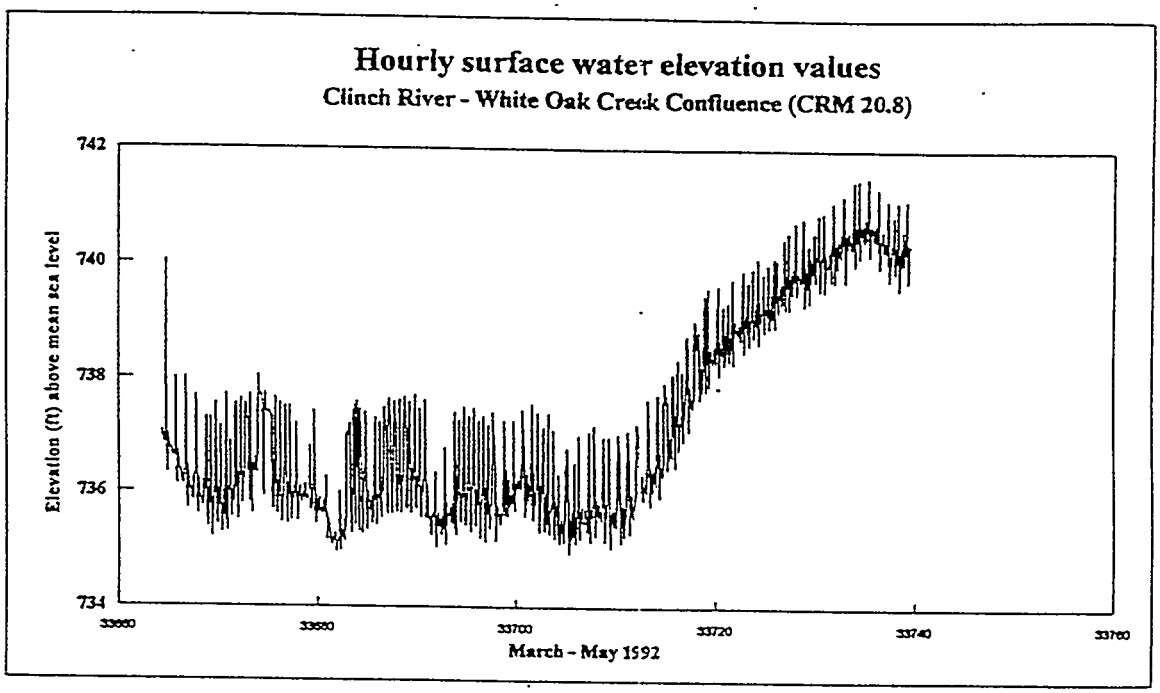


Fig. 2.12. Variation in water level elevations typical of the Clinch River immediately below Melton Hill Dam.

relative to its length (Fehring and Meinert 1993). Full pool in Melton Hill is 795 ft above msl, with intermittent water level fluctuations depending on the system-wide reservoir management needs of the TVA. Unlike Watts Bar, there is no seasonal drawdown of Melton Hill.

Though it is narrow and relatively shallow, Melton Hill Reservoir does exhibit lacustrine qualities for the lower 15 to 18 miles of its length. Transition conditions persist from the Scarboro Creek confluence (CRM 41.1) to the upper end of the Bull Run Steam Plant (CRM 49). The reservoir is exclusively riverine from this point to the end of maintained navigation at CRM 66. This trend from riverine through transition to lacustrine is also observed for the off-channel embayments of the streams that drain the ORR. The situation is most pronounced in the Scarboro and McCoy Branch embayment areas. Both upper and lower embayments exhibit lake-like qualities.

Norris Reservoir, with an average annual discharge of 4200 cfs, contributes 95% of the flow to Melton Hill Reservoir. The remainder comes principally from Bull Run Creek and other minor tributaries. Several small tributaries to Melton Hill originate on the ORR and include Scarboro Creek, McCoy Branch, Walker Branch, and Bearden Creek, all of which originate on the south slope of Chestnut Ridge. The tributaries of principal interest that drain the ORR are Scarboro Creek and McCoy Branch. Wastes from the Y-12 Site were formerly discharged into Kerr Hollow Quarry, which flows via Kerr Hollow Branch to Scarboro Creek, which enters the river at CRM 41.1. Fly ash from the Y-12 steam plant was formerly disposed of in Rogers Quarry, which discharges to McCoy Branch, which flows into the Clinch at CRM 37.3. The average annual discharge of each stream is less than 2 cfs.

2.5.2 Water Quality

Waters of the Clinch River and Poplar Creek are circumneutral, moderately alkaline, and of medium hardness. Water quality parameters measured during this RI are within the ranges for natural surface waters and those historically reported for the Clinch River and Poplar Creek (Table 2.1).

Table 2.1. Minimum, maximum, and mean (in parentheses) values for selected water quality parameters, Clinch River and Poplar Creek[1]

Water Quality Parameter	Clinch River		Poplar Creek	
	Historical Values[2]	CRRI Values	Historical Values[3]	CRRI Values
pH	7-8.6 (7.8)	7.4-8.2 (7.7)	6.4-8.1 (7.5)	5.3-7.9 (7.2)
Conductivity (μmhos/cm)	156-312 (244.3)	131-266 (211)	98-360 (228.7)	92-318 (211)
Alkalinity (mg/L $CaCO_3$)	54-121 (99.8)	55-120 (90.0)	20-150 (76.3)	25-130 (75.0)
Hardness (mg/L Ca)	71-140 (112)	75.3-131 (101.3)	63-146 (116)	2.3-149.5 (95.9)
Dissolved Oxygen (mg/L)	5.2-12.5 (9.1)	6.3-11.2 (8.5)	6.3-13.1 (8.0)	4.7-12.5 (8.1)
Ca (mg/L)	22-40 (33.7)	18.1-35.9 (27)	17-40 (30.2)	0.03-39.3 (25.7)
Mg (mg/L)	3.8-11 (9.3)	5.3-10 (7.5)	5-13 (9.1)	0.01-12.9 (7.4)
SO_4 (mg/L)	7-27 (19.3)	13-25 (17.4)	16-72 (36.5)	16-46 (26.1)
NO_2/NO_3 (mg/L)	0.1-0.7 (0.4)	0.2-0.8 (0.5)	0.5-0.6 (0.53)	0.02-2.7 (0.55)
Fl (mg/L)	0.01-0.2 (0.1)	0.05-0.27 (0.09)	0-3 (0.36)	0.05-0.1 (0.12)
Cl (mg/L)	2-7 (3.8)	2.3-10.2 (3.5)	0.9-4 (2.2)	0.85-55 (5.8)

[1] Comparison of historically recorded values (values from STORET; sample size varies from <10 to >150, depending on parameter) to values measured during the Clinch River Remedial Investigation.
[2] Melton Hill Dam Tailrace, USGS Data.
[3] Poplar Creek above EFPC confluence.

Differences in several water quality parameters may be expected between the waters of the Clinch River and those of Poplar Creek, due to differences in watershed lithologies, land use, and as a result of impoundments on the Clinch River (Fig. 2.13). For example, while principal cations in both streams are calcium and magnesium and the principal anions are carbonate-bicarbonate, sulfate is historically of increased importance in Poplar Creek, ostensibly due to coal mining activities on the Cumberland Plateau (Energy Systems 1993). Averages and ranges for these values observed during the RI are presented in Table 2.1.

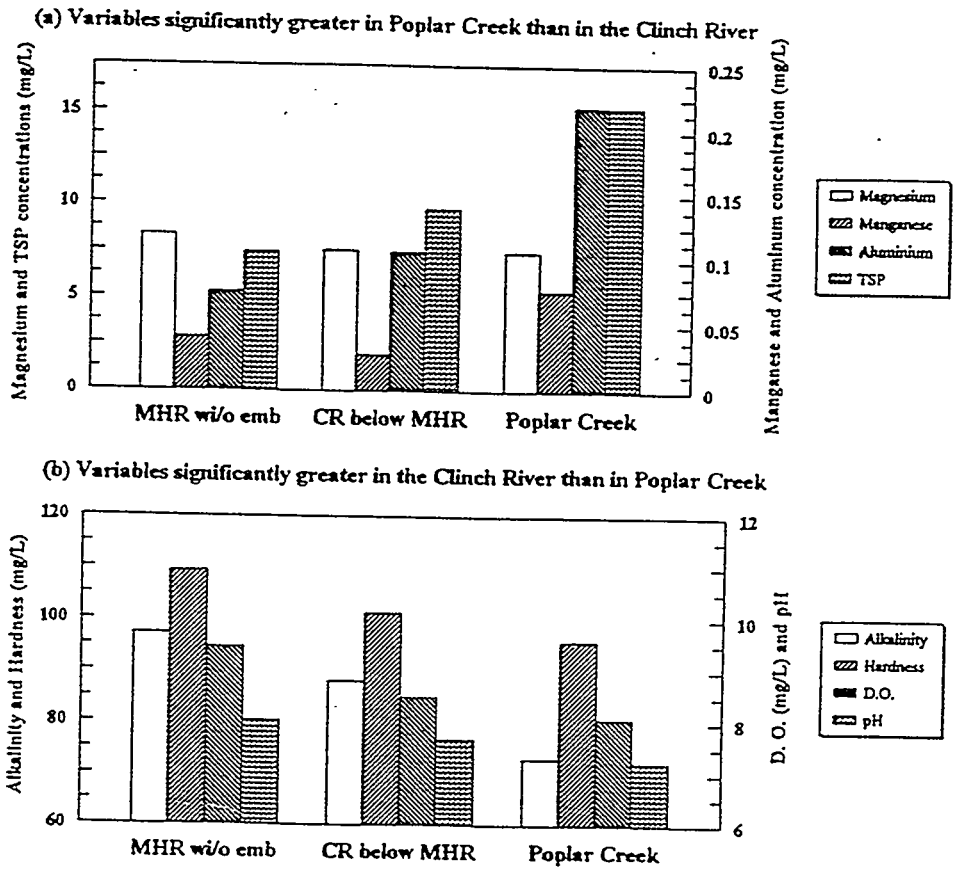


Fig. 2.13. Water quality differences between Clinch River and Poplar Creek.

Several water quality parameters [e.g., temperature, dissolved oxygen (DO), conductivity, alkalinity, total suspended particles, turbidity, hardness] are naturally influenced by season. During this RI, several parameters varied significantly by season but not by location.

Water quality parameters did not vary significantly by location in the Clinch River. Within Poplar Creek, the only parameter that did vary by location was chloride concentration, which was significantly higher ($p < 0.05$) in reach 3.3 below the K-25 Central Neutralization Facility (CNF) outfall. The outfall is currently being extended (via pipeline) to the mouth of Poplar Creek to increase effluent dilution and avoid adverse ecological effects in Poplar Creek that could result from elevated salinity during low flow conditions.

2.6 SEDIMENT

The WBR arm of the Clinch River contains an estimated 2900 acre-ft of sediment, most of which is downstream of Brashear Island (CRM 9.9, Fig. 2.2). TVA silt-range data indicate that before construction of Melton Hill Dam, there was relatively uniform deposition of sediment from the mouth of the river upstream to the current location of the dam. After completion of the dam in 1963, much of the sediment upstream of Poplar Creek had been eroded, and deposition downstream of Brashear Island increased dramatically. It is probable that high-volume, pulsed discharges from Melton Hill Dam

(Sect. 2.4) resulted in the scouring of sediment immediately below the dam and its redeposition downstream of Brashear Island.

Sediment input to the Clinch River is also affected by TVA reservoirs. Norris Reservoir, with a sediment retention factor of 95% (Trimble and Carey 1984), effectively reduces the sediment basin at the mouth of the Clinch River from 4413 mi^2 to 1501 mi^2. Melton Hill Reservoir retains approximately 60% of the sediment entering from upstream and further reduces the local sediment basin to 1070 mi^2. The Emory River and Poplar Creek watersheds comprise 81% and 13%, respectively, of the sediment basin and serve as the primary sediment sources to the Clinch River arm of WBR. Discharges from Melton Hill Dam, while still containing a significant quantity of sediment, carry finer-grained sediment that is less susceptible to deposition in the Clinch River than the coarser-grained sediment carried during periods of high flow by the Emory River and Poplar Creek.

White Oak Creek, although historically a significant source of contaminated sediment, has always been a small contibutor of total sediment to the Clinch River by virtue of its small watershed. Currently, its capacity to transport sediment to the Clinch River is reduced by White Oak Dam and a recently completed sediment retention structure (coffer dam) at its mouth.

The major forces driving sedimentation processes in the Watts Bar arm of the Clinch River are (1) releases from Melton Hill Dam, (2) the operation of WBR, (3) storm events, and (4) the shape of the river bottom. WBR is operated to maintain a summer pool elevation at 741 msl, with weekly a 1-ft variation for mosquito control (Fig. 2.10). During winter drawdown the exposed shoreline is subject to repeated "washing" from boat waves and also by the rapid water level fluctuations resulting from power generation at Melton Hill Dam (Sect. 2.5). The shape of the river bottom also influences sediment deposition patterns. The reservoir bottom can be divided into two areas—the pre-impoundment river channel and the overbank area, or inundated floodplain (Fig. 2.14). The channel portion of the reservoir has historically been thought of as an area where little long-term deposition occurs, functioning as a sediment "pipeline" to the lower reservoir (Struxness et al. 1967). However, the presence of sediments within the channel, particularly in the lower reaches, suggests that this scenario is not entirely accurate. As flow decreases in the lower reaches of the river, sediment accumulation increases. Additionally, the washing of sediment from the near-shore areas effectively winnows sediment from the shallow area into the deep water area. The sinuous shape of the reservoir in the Clinch River arm also influences sediment deposition patterns in cross section, with more sediment accumulating in the straight portions of the Clinch River than in sharp bends. Particle size distribution of sediments also strongly influences where sediments deposit. For instance, coarser sediments (sands) are typically found on the inside of river bends. Large sand spits below Jones Island (CRM 19.8) and Grubb Island (CRM 18.2) are likely depositional areas that pre-date the construction of Melton Hill Dam. The current deposition zone between Brashear Island (CRM 9.9) and Campbells Bend (CRM 11.5) is probably mostly sediment from Poplar Creek. Spatially and temporally varying rainfall and flow conditions obviously affect these generalizations.

A hydro-acoustic survey of the Clinch River and lower portion of Poplar Creek was performed to gather current data regarding sediment type, thickness, and depth to sediment. Approximately 80 miles of survey lines were used in characterizing 20 miles of the river. Because the survey instrumentation required 12 ft of water to operate, the survey was restricted to the channel areas and to those near-shore areas that were safe to navigate.

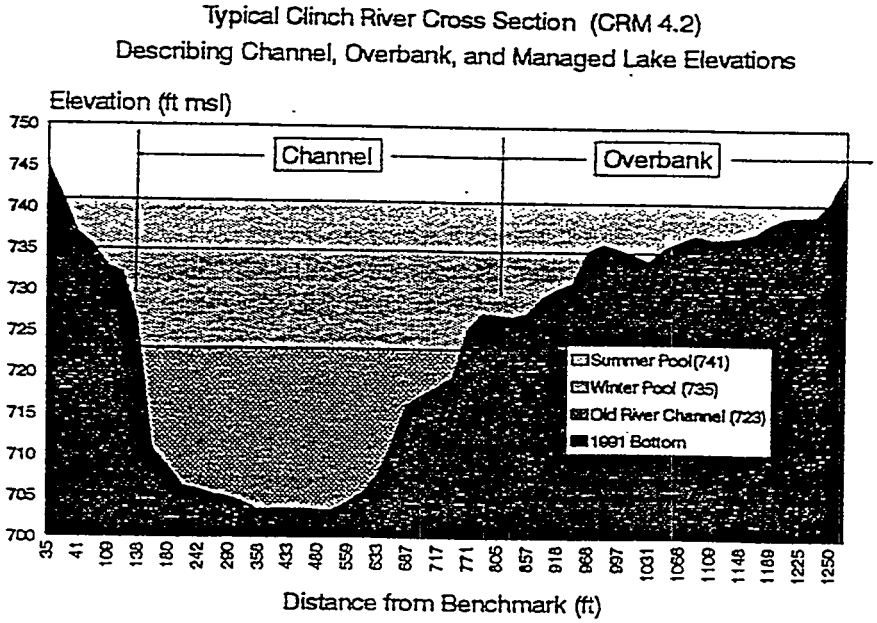


Fig. 2.14. Typical Clinch River cross section (CRM 4.2) depicting the river channel, overbank areas, and managed surface water elevations.

The survey revealed a continuum of sediment densities ranging from 1.1 (slightly denser than water) to greater than 2.5 (rock) (Table 2.2).

Table 2.2. Density ranges for various descriptive sediment type classes (Hamilton 1972)

Density range (g/cm^3 wet)	Sediment description
1.0–1.2	Fluid mud, muds
1.2–1.4	Clays, silty clays
1.4–1.6	Clayey silt, silt
1.6–1.8	Coarse silt, clayey silty sands, very fine sand
> 1.8	Sands (loose or compacted), gravel, moderate to stiff clay, hardpan clay, rock

A map of surface sediment density as interpolated from the survey data is presented in Fig. 2.15. It should be emphasized that this figure represents a possible model of the surface sediment conditions; model data indicate that there are seasonal patterns of erosion and deposition within the Clinch River (Sect. 3.4.6). Because the hydro-acoustic survey was performed during very high flow conditions (water elevation up to 744 ft), it is likely that there was a large amount of soft flocculent and detrital matter rolling along the bottom of the river, increasing proportions of softer sediment types at the time of the survey. Despite this, the softer surface sediment types are scattered in patches along the main channel and are intermixed with denser material. The shoreline area is dominated by denser sediments. Figure 2.16 presents the percentage of each surface sediment density class for two areas within the river: (1) the near-shore area, or that area between winter and summer pool (elevation 735–741 msl), and (2) the area below the winter pool. The near-shore area accounts for 25% of the surface area and is dominated by firmer sediment types. Seventy-five percent of this near-shore area is composed of the densest two categories. The area below the 735 ft winter pool elevation is just the opposite. Only 25%

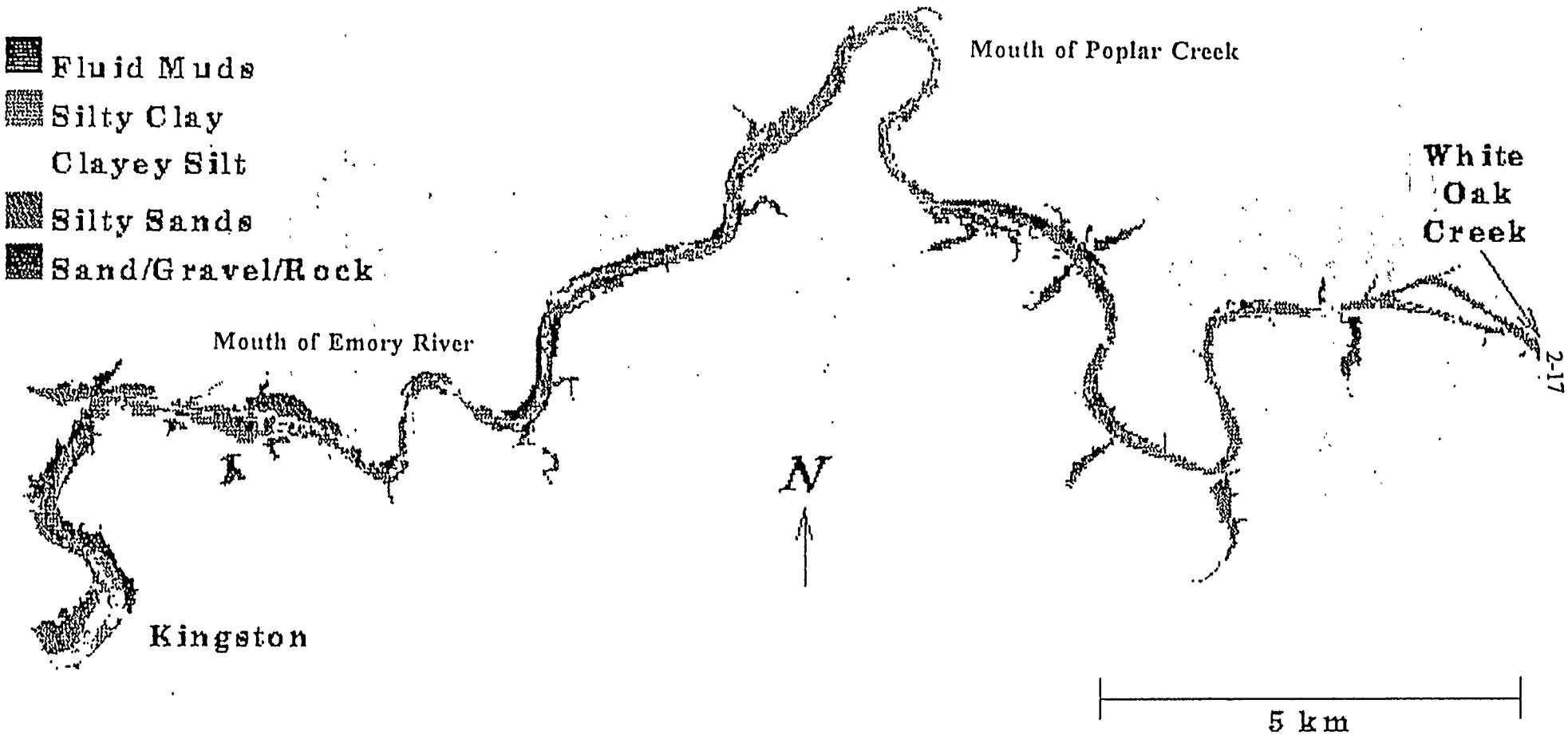


Fig. 2.15. Density of surface sediment in the Clinch River downstream of the Oak Ridge Reservation.

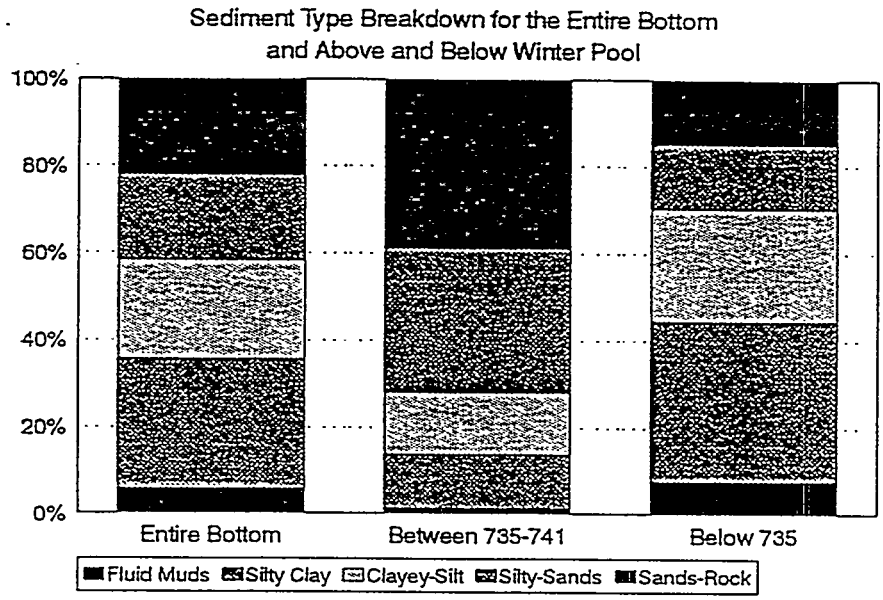


Fig. 2.16. Relative proportions of sediment types in the Clinch River downstream of the Oak Ridge Reservation.

of the sediment falls within the densest two categories, which is not surprising given that the near shore is exposed to wave action for part of the year. This wave action effectively washes fine sediment into deeper water.

Micro-topography also has an influence on deposition pattern. The geologic formations in the area are often exposed and cross the river bottom at various angles. The tilted nature and the varying erosional characteristics of these formations make for a "jagged" bottom where the harder formations stick up and the softer formations are eroded away. This jagged bottom provides numerous locations for sediment deposition because of local low spots and changes in water flow. The result is a highly variable sediment deposition pattern, which is illustrated in the side-scan sonar output from the hydro-acoustic survey (Fig. 2.17). This figure, a plan view of a small section of the river, is a gray-scale representation of river bottom hardness. The dark features are hard rock bottom, and the light features represent softer material. Geologic formations and the associated deposition zone are readily apparent.

Two major construction operations have occurred that affect the distribution of sediments in the Clinch River. (1) In 1952, as part of the construction of the Kingston coal-fired steam plant, an intake channel was dredged in the Emory River, resulting in the removal of approximately 44,000 yd^3 of material. In the same year, a discharge channel was dredged in the Clinch River, and approximately 124,587 yd^3 of material were removed. In the fall of 1955, an underwater dam (weir) was constructed in the Clinch River at CRM 3.9 to facilitate the movement of colder Clinch River water up the Emory River for cooling water supply. The weir was constructed of 17,000 tons of quarry-run limestone rock dumped by barge in a line perpendicular to flow. The dam was constructed to have a crest at the 722 ft msl elevation, which is 13 ft below the winter pool elevation. (2) In 1962, the Clinch River between Grubb Island and Melton Hill Dam was dredged during construction of the dam. An estimated 454,600 yd^3 of material were removed, approximately half of which was sediment and half rock. All dredged material was placed on Grubb and Jones islands and along nearby shorelines.

Side-Scan Sonar output from US Army Corps of Engineers Survey

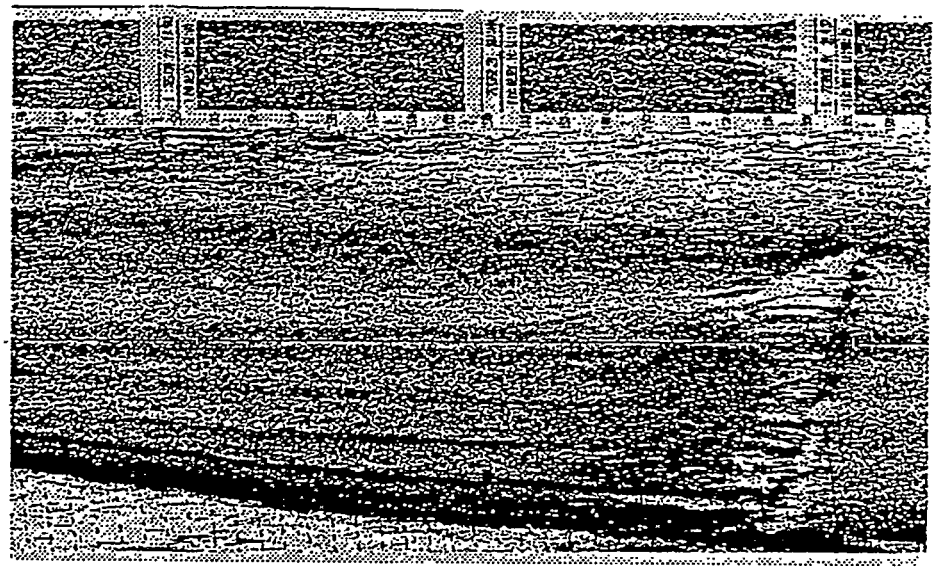


Fig. 2.17. Sonographic image of a portion of the Clinch River bottom. Darker shades represent denser sediments. The structure at the right side of the image is the weir at CRM 3.9 that deflects cooler Clinch River water to TVA's Kingston Steam Plant.

2.7 ECOLOGY

2.7.1 Aquatic Resources

The aquatic ecosystem of the Clinch River and lower Poplar Creek can be summarized by a simplified food web diagram illustrating the principle energy flow pathways and environmental factors that regulate these pathways (Fig. 2.18). The components of this diagram are discussed in the following text.

The Clinch River arm of WBR is a highly elongated riverine impoundment that receives discharges from Melton Hill Reservoir immediately upstream. Varying hydrodynamic regimes such as flow and velocity, temperature fluctuations, and habitat availability, are the main environmental factors that influence and regulate the structure and function of the aquatic food web in the Clinch River and lower Poplar Creek. The combination of cold hypolimnetic discharges, hydropower generation, and the serial arrangement (Norris-Melton Hill to Watts Bar) of these impoundments creates complex hydrodynamic and physicochemical conditions that affect the structure and function of the biological communities in the Clinch River and Poplar Creek systems (Soballe et al. 1992). The ecological structure and functioning of biotic communities in the Clinch River and Poplar Creek are regulated by water residence time, both through direct effects of water renewal on the plankton and other components of the biota, and indirectly through effects on other limnological variables, such as nutrient loading, water depth, turbidity, and mixing regime. The longitudinal ebb and flow of water and the vertical shear created by daily pulsations in reservoir discharges affect material and energy fluxes, plankton dynamics, abundance and distribution of benthic organisms, and nekton ecology. Although lower Poplar Creek can be described as an embayment of upper WBR, it actually exhibits many of the hydrodynamic and physicochemical attributes of estuarine systems, including fluctuations in water level, density gradients, and, in particular, the upstream and downstream movement of water (Loar et al. 1981).

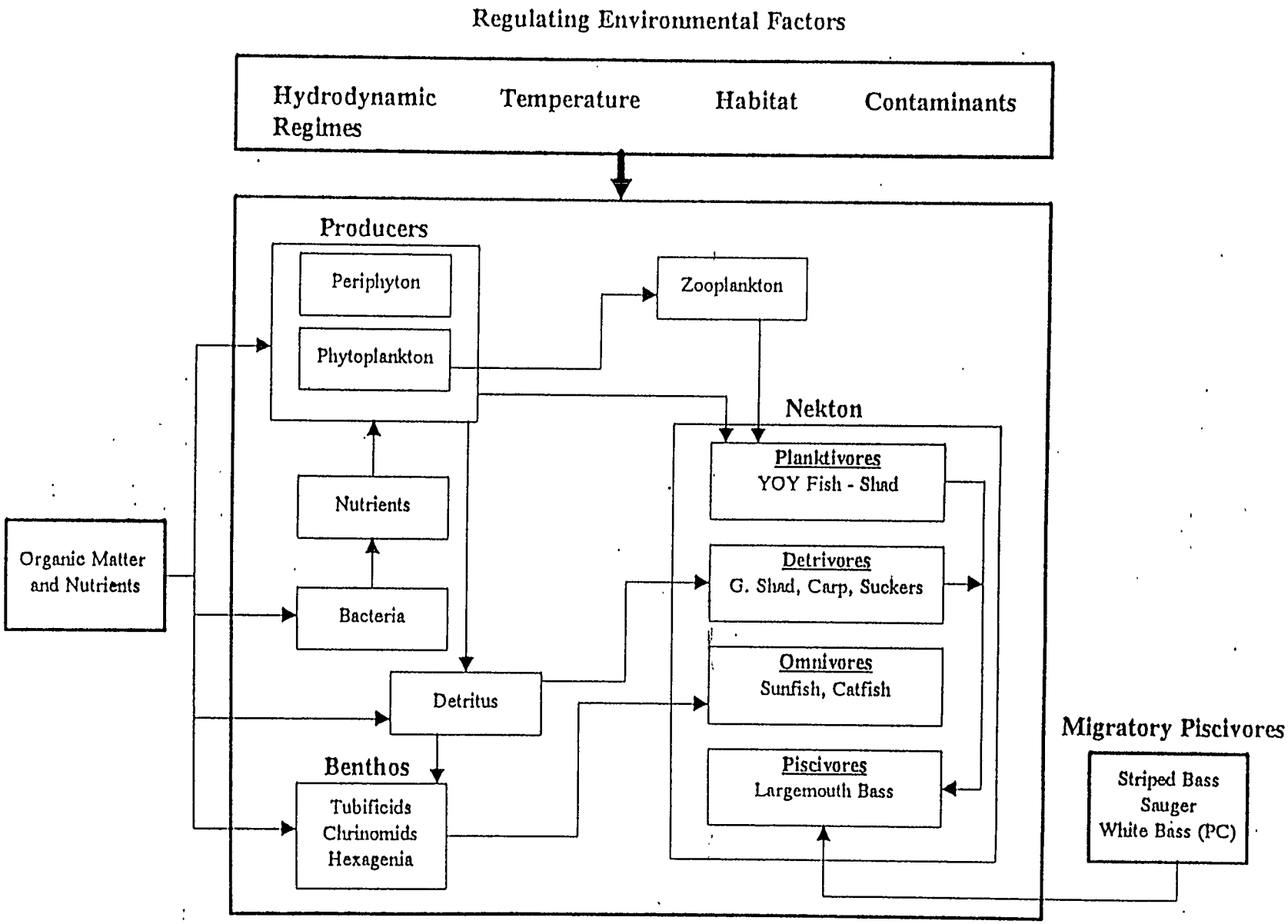


Fig. 2.18. Simplified aquatic ecosystem diagram for the Clinch River and lower Poplar Creek illustrating the principal energy flow pathways and environmental factors that regulate these pathways.

Water residence time influences planktonic communities directly through the effects of water renewal and indirectly by its relationships with other important limnological variables, such as nutrient and light availability, turbidity, and mixing regime (Adams and Hackney 1992). Short residence times generally lower overall system productivity and preclude the establishment of phytoplankton and zooplankton communities. In rapidly flushed systems such as the Clinch, plankton organisms are quickly washed downstream. Therefore, the relative importance of periphyton production to the total autotrophic production within the system is increased. In the Clinch River and Poplar Creek, the food web may depend more on allochthonous material transported from within the watershed and on littoral periphyton production than on phytoplankton production. Even though the lower reaches of Melton Hill Reservoir are primarily lotic in nature, allowing for plankton populations to develop, their contribution to the downstream food chain in the Clinch River is probably minimized because of the hypolimnetic discharge from Melton Hill. Plankton production may also be suppressed in the Clinch River by phosphorus limitation in this system (Elser and Kimmel 1985). In addition, the relative importance of allochthonous material as an energy base to the food web in the Clinch River may be minimized because of the low degree of land-water interconnectivity and the relatively small size of the local watershed (Adams and Hackney 1992). The contribution of macrophyte production to the energy base of the food web is also minimal in these two systems. Even though Eurasian water milfoil is relatively abundant in lower Watts Bar, it is sparse in the Clinch River and has rarely been reported in Poplar Creek. The energy base, therefore, for the food web (both autochthonous and allochthonous) in the Clinch River and Poplar Creek systems is probably relatively low compared to other lotic systems. Reduced energy availability at the lower trophic levels results in relatively low productivity at the higher trophic levels.

The combination of reservoir influences and many other related environmental factors has produced distinct macroinvertebrate communities in Poplar Creek and the Clinch. The benthic community below Melton Hill Dam is composed of the introduced Asiatic clam *(Corbicula)* and species of chironomids and tubificids (Meinert 1991). In addition, a few limited freshwater mussel stocks, possibly including a few specimens of listed endangered species, persist in sections of the Clinch River (TVA 1990). The quality of the benthic community immediately below Melton Hill Dam is depressed, as it is at other inflow zones in the TVA system (Dycus and Meinert 1991). Benthic community quality of the Clinch River below Melton Hill Dam is characterized by TVA as generally poor to fair relative to inflow zones of mainstream Tennessee River reservoirs (Scott 1994). Benthic communities in both systems suffer from a lack of species diversity; ephemeroptera, plecotera, tricoptera (EPT) taxa; long-lived species; and evenness of dominant taxa. Dominant taxa in the upper Clinch River (miles 10–23) are tubificid worms and *Chironomus* sp., while taxa in the lower section of the Clinch River (miles 0–9) are composed primarily of *Chironomidae*, burrowing mayfly *(Hexagenia limbata)*, fingernail clams *(Sphaeriidae)*, and *Tubificidae*. In Poplar Creek, the benthic community quality is also rated as poor to fair. Deficiencies exist in long-lived taxa and EPT taxa. Abundance of benthic organisms is generally less than in the Clinch, with *Tubificidae*, *Chironomidae*, and *Hexagenia* dominating and with very few EPT taxa being reported. The benthic community serves as a partial food supply for benthic detritivores such as gizzard shad, various sucker species, and some omnivorous species such as sunfish and small catfish.

The trophic relations of fish communities in the Clinch River and Poplar Creek are complex and highly dynamic on a temporal scale. Many species of fish are food generalists and their feeding behavior can typically span several trophic levels (e.g., from periphyton grazing to piscivory) and can vary with season and with age. The standing crop and production of the fish communities in these two systems is dependent upon a host of environmental factors, the most important being water residence time, nutrient concentrations, the quality and quantity of food, and habitat availability. As noted earlier, reservoir operational practices (e.g., water level fluctuations, flow regimes) profoundly affect each of these factors, thus influencing the structure and function of fish communities.

The fish community in both the Clinch River and Poplar Creek systems is characterized by relatively low species diversity with representatives of all four main functional feeding groups present. Planktivores include threadfin shad and primarily young-of-the-year fish of most other species. The principal detritivores are gizzard shad, carp, and suckers. Omnivores are dominated by water column feeders such as sunfish, and benthic consumers are primarily catfish. Resident piscivores consist primarily of largemouth bass. In both systems, striped bass and sauger are seasonal migratory species, with white bass using Poplar Creek as a major spawning area during the spring.

Analysis of fish community structure in the Clinch River by the TVA Reservoir Vital Signs Monitoring Program (Hickman et al. 1991) indicates that the dominant trophic group is planktivores/detritivores (shad) comprising 50–60% of the abundance, omnivores (carp, suckers) comprising 10–20%, insectivores (sunfish) comprising 10–15%, and piscivores (black bass, striped bass, and striped bass hybrids) comprising 5–10% of the abundance. The most abundant species in the Clinch River during the fall of 1993 and 1994 were found to be (listed in order of importance) gizzard shad, bluegill minnows, *Cyprinidae*, and largemouth bass. In Poplar Creek during this period, the most dominant species were gizzard and threadfin shad, bluegill, largemouth bass, minnows, yellow bass, and carp (Bevelhimer and Adams, in press). The differences observed in the occurrence and relative abundance of species between Poplar Creek and the Clinch River are due to the seasonal shifts in the distributions of various species as well as the nature and range of habitat (quantity and quality) found in these two areas. Fish communities surveys suggest that there may be a relationship between species diversity and richness with proximity to Poplar Creek. The number of species found in Poplar Creek and the Clinch River immediately downstream of the Poplar Creek mouth ranged from 26 to 28, while the number of species found at other sites in the Watts Bar system ranged from 30 to 37 (Bevelhimer and Adams, in press).

In general, fish communities in the Clinch River are in poorer condition than would be expected of communities in similar tributary streams in the Tennessee Valley (Hickman et al. 1991). Shad (gizzard and threadfin) dominate the fish community in the Clinch River and Poplar Creek. In late winter sauger migrate upstream to spawn in Melton Hill tailwaters, while in late spring and early summer striped bass migrate from other areas of Watts Bar to seek thermal refuges in the cooler waters of the upper Clinch. Poplar Creek, and in particular lower Poplar Creek, appear to be important spring spawning areas for both gizzard shad and white bass.

2.7.2 Terrestrial Resources

This section focuses on the terrestrial environment located adjacent to the Clinch River and Poplar Creek. Two zones will be discussed: (1) the river bank directly above the water level (i.e., supralittoral/epilittoral zone) and (2) a riparian zone that extends 100 m from the shoreline. Both zones will be discussed relative to the vegetation, land use/land cover, wetlands, threatened or endangered plant/animal species, and wildlife present at the site.

The supralittoral/epilittoral zone of the Clinch River and Poplar Creek varies in size, riparian vegetation, and soil type (i.e., sand, clay, gravel). The river banks are predominantly covered with deciduous forests, grasslands, or emergent macrophytes, but some lack vegetative cover entirely. These exposed high vertical banks are prime burrow locations for various birds. The belted kingfisher (*Megaceryle alcyon*), rough-winged swallow (*Stelgidopteryz ruficollis*), and bank swallow (*Riparia riparia*) inhabit the burrows during their breeding seasons. These birds use the burrows from approximately April to June; laying and incubating a clutch of eggs and raising their young in the terminal chamber until they fledge. The burrows found along the banks of the Clinch River were approximately 1.88 m (6 ft 2 in.) from the surface of the water and 0.61 m (2 ft) from the top of the

embankment (Baron and Ashwood, in preparation). Through most of the year (excluding potential migratory habits), belted kingfishers and swallows within the Clinch River or Poplar Creek system have a piscivorous and insectivorous diet, respectively. Many other piscivorous avian species (e.g., great blue heron, black-crowned night heron, osprey) nest within the riparian vegetation or have platform nesting sites (specifically osprey) over the river or creek.

A variety of habitats border the Clinch River and Poplar Creek within the riparian zone. A land use/land cover map (Fig. 2.19) displays habitat types within 100 m of the shoreline. The habitat map was derived from Landsat Thematic Mapper and SPOT satellite images generated in September 1984. The map delineates nine land use/land cover categories: water, urban, agricultural, transitional areas, deciduous forest, mixed forest, evergreen forest, evergreen plantations, and barren land (Table 2.3). The

Table 2.3. The land use/land cover classes used in habitat classification

Land use/land cover	Description
Urban land	Mixture of administrative buildings, laboratories, heavy commercial and industrial buildings, lawns, and clumped shade trees.
Deciduous forest land	Areas of hardwood forest types.
Mixed forest land	Areas of a mixture of hardwoods and pine trees.
Evergreen forest land	Areas dominated by mature pine forest type with trees generally older than 35 years (in 1994), with an uneven canopy.
Evergreen plantation	Areas of pine trees that are row planted, are of uniform age, and are generally younger than 35 years (in 1994).
Agricultural land	Fields of pasture grasses, grassland, row crops, and/or shrubland cover.
Transitional areas	Secondary early successional sites, usually grassland to grassland shrub mix; generally mowed along powerline corridors.
Barren land	Cropped fields, plowed or bare ground areas, or areas where vegetation has been removed, such as construction sites or quarries.

percentage and area (hectares) of various land use and habitat types within each reach are found in Table 2.4. Habitat information was available for approximately 31 miles of the Clinch River, which included reaches 1 and 2, and subreach 4.01 and for all of the Poplar Creek Embayment (reach 3). Although the riparian zone of Poplar Creek is predominantly urban (43.8%), the riparian zone of the Clinch River is predominantly forest (45.5%) and transitional (33.4%).

Some wetlands exist along the Clinch River (subreachs 2.02 and 2.04), Poplar Creek (subreaches 3.04, 3.03, and 3.02), and upper McCoy Branch Embayment (subreach 7.02). These areas are considered wetlands based on the technical criteria of (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland hydrology (U.S. Army Corps of Engineers 1987). Dominant and common plant species found in these areas are listed in Table J1.

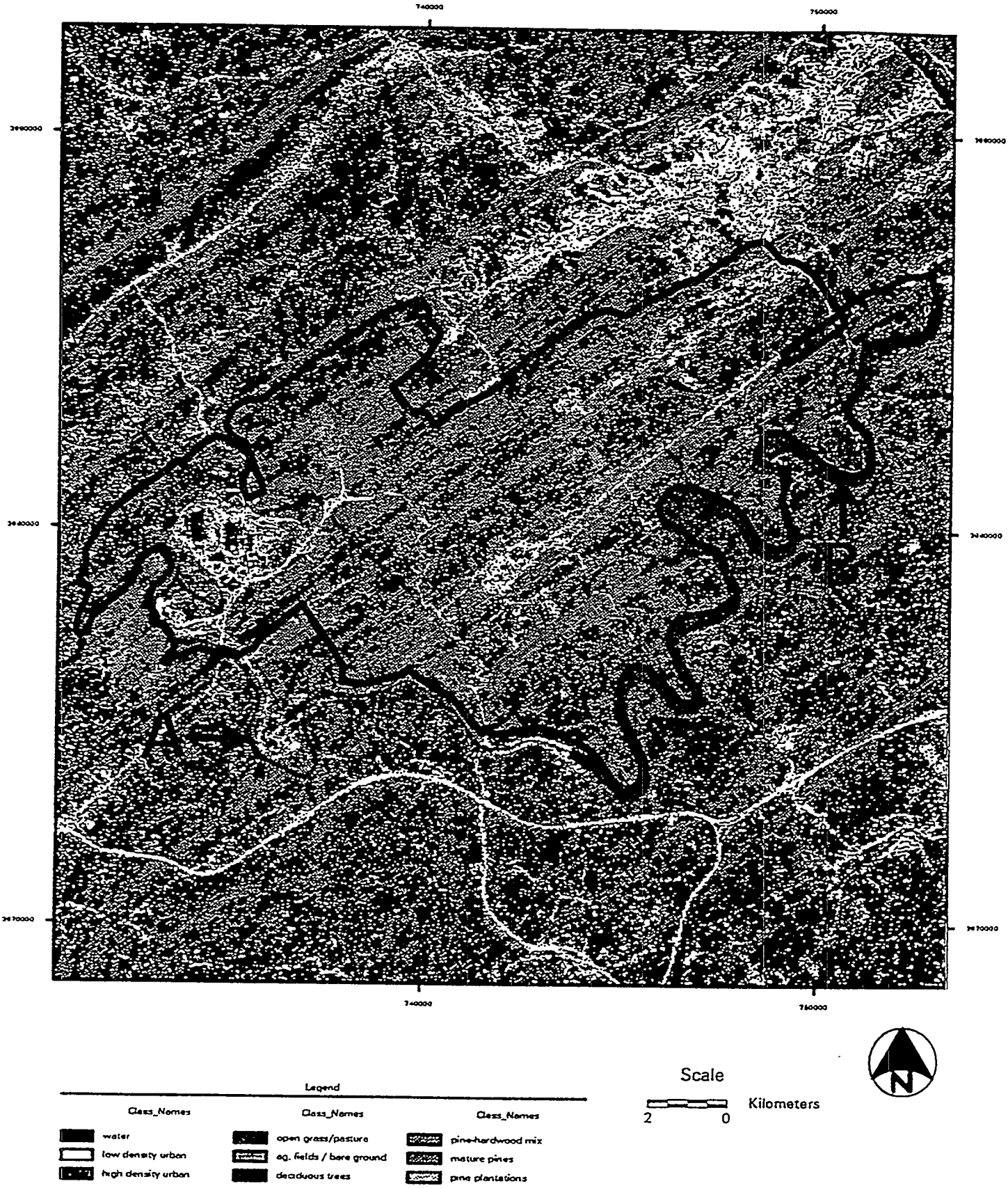


Fig. 2.19. Land use on and immediately surrounding the Oak Ridge Reservation. Site A was being developed at the time for the TVA's Clinch River Breeder Reactor and is not urban land as the legend suggests. Site B is the Freels Bend agricultural station.

Table 2.4. Land use/land cover categories, percentage and area (hectares) of coverage within each Clinch River and Poplar Creek reach (extending 100 meters from shoreline on both sides of river and creek)

Category	Reach 1		Reach 2		Reach 3		Reach 4 (subreach 4.01 only)	
	Percentage	Area (ha)	Percentage	Area (ha)	Percentage	Area (ha)	Percentage	Area (ha)
Urban	9.6%	100.88	15.1%	95.13	43.8%	99.44	8.3%	13.81
Deciduous forest	9.1%	95.44	7.3%	46.00	11.3%	25.56	26.7%	44.63
Mixed forest	32.9%	345.13	23.8%	150.06	5.6%	12.69	23.5%	39.31
Evergreen forest	5.9%	62.25	5.8%	36.63	2.8%	6.38	1.1%	1.88
Evergreen plantation	2.6%	26.75	4.7%	29.70	1.7%	3.81	0.78%	1.31
Agricultural	6.9%	72.44	11.8%	74.69	3.1%	7.00	3.4%	5.63
Transitional areas	32.7%	343.25	31.4%	198.13	31.3%	71.06	36.2%	60.56
Barren	0.27%	2.88	0.21%	1.31	0.39%	0.88	0.07%	0.13

Rare and endangered plant surveys have been performed for most of the ORR. Table J2 identifies all threatened, endangered, and special concern plant species that occur on the ORR, and in some cases they have been specifically located along the Clinch River (Pounds et al. 1993). Specific areas along the Clinch River are designated as Natural Areas and some have been state registered because of the presence of endangered or threatened plant species. These areas along the Clinch River include the Campbell Bend Bluff and Forest (mile ~11.8), Breeder Bluffs (mile 18), Raccoon Creek Golden Seal Area (mile ~19.9–20), Melton Dam Bluffs (mile ~23.6), Tower Shielding Bluffs (mile ~25.2–26), Health Physics Research Reactor (HPRR) Lake Bluffs (mile ~27.2), South Hickory Creek Bend Bluffs (mile ~28.4), North Hickory Creek Bend Bluffs (mile 29), Copper Ridge Outcrop (mile ~31.5), White Cedar Area (mile ~32.6), Bull Bluff (mile 36.9), and Rainy Knob Bluff, Freels Bend (mile ~40.5).

There is only one state-registered natural area along Poplar Creek (Poplar Creek Cliffs) upstream of the confluence with EFPC. Many species that are unusual for the ORR occur in small limestone cliffs near the stream. These species include hemlock (*Tsuga canadensis*), rhododendron (*Rhododendron maximum*), fringe tree (*Chionanthus virginicus*), spider lily (*Hymenocallis fulva*), and mock orange (*Philadelphis hirsutus*). The spreading false-foxglove (*Aureolaria patula*), which is a state-listed and federal-candidate species, occurs here (Pounds et al. 1993).

As would be expected given the diversity of plants and habitat types, the terrestrial environment adjacent to the Clinch River and Poplar Creek supports a wide variety of wildlife species. A list of amphibians, reptiles, birds, and mammals on the ORR has been compiled from various published sources and personal observations (Table J3). This list includes species that have been identified on the ORR as well as some animals that are not confirmed but are present in the Ridge and Valley region. These terrestrial species found on the ORR could use habitat in and adjacent to the riverine system. Table J3 also includes more than 40 species that are listed by either the Tennessee Wildlife Resources Agency (TWRA)or the U.S. Fish and Wildlife Service as threatened, endangered, or in need of management. Each species is identified within a trophic category (i.e., aquatic, arboreal, or ground invertebrate feeder; flying insectivore; herbivore; omnivore; piscivore; predator) indicating potential sources of contaminant exposure from the animal's diet and life history. Several common terrestrial species present along the Clinch River and Poplar Creek systems, which may be exposed to site contaminants, will be addressed in detail in Chap. 6 (Baseline Ecological Risk Assessment). These species include osprey, great blue heron, and mink (piscivorous wildlife; Sect. 6.4); rough-winged swallows, and little brown bats/gray bats (insectivorous wildlife; Sect. 6.5); and cottontail rabbits (herbivorous wildlife; Sect. 6.7).

2.8 SUMMARY OF SITE DESCRIPTION

The overall environmental setting of the ORR and CR/PC OU have been described. Subsequent chapters will characterize the nature and extent of contamination in the OU, assess the resulting risk to human and ecological receptors, and weigh the feasibility of implementing various remedial actions. However, several of the characteristics of the OU are evident from this description which affect the range of remedial options available.

The volume of surface water in the OU is very large. Surface water is also very transient, with short average retention times. Therefore, any remedial action (other than posting of waters) would most likely be effected at the contaminant source, at one or more of the on-site OUs.

The greatest quantity of sediment-associated contaminants will be found where large quantities of sediment occur. In the CR/PC OU (downstream of the primary contaminant sources), this would include the lower reaches of the Poplar Creek embayment and the Clinch River downstream of Poplar Creek.

Even here, relatively little sediment is found in the near-shore and shallow areas, deposition being greatest in the deeper water along the river channel.

There are aquatic and terrestrial biological receptors in the CR/PC OU, some of which would likely be exposed to contaminants that have been released from the ORR. Certain biota may serve as indirect sources of contamination to organisms higher on the food chain. Remediation of these biota would be difficult and alone would not address the ultimate contaminant source.

Finally, humans use the Clinch River and Poplar Creek as a source of drinking water, as a (limited) food source, and for recreation. Such persons would likely be exposed to contaminants that have been released from the ORR.

3. SITE HISTORY AND CURRENT CONDITIONS

This section characterizes the nature and extent of contamination in the CR/PC OU. Section 3.1 provides a more detailed desription of the study area. Background information on ORR site operations and an overview of contaminant releases is provided in Sect.3.2. The nature and extent of contamination is characterized in Sects. 3.3 (water), 3.4 (sediment), and 3.5 (biota). The results are summarized in Sect. 3.6. The quality of the CRRI Phase 2 data is summarized in Appendix G and evaluated in detail by Holladay et al. (1995).

3.1 SITE DESCRIPTION

To facilitate the conduct of the RI, the CR/PC was divided into nine study reaches (Fig. 3.1). The more intensively studied reaches were divided further into a total of 14 subreaches. The boundaries of each reach and subreach are briefly described below. In general, boundaries were established in an effort to distinguish between areas where (1) natural environmental conditions are known to differ or (2) effects are anticipated from plausible contaminant sources.

Reach 10—Norris Reservoir is a negative reference reach on the Clinch and Powell rivers. Norris Dam is located at CRM 79.8, almost 46 miles upstream of the ORR.

Reach 0—Upper Melton Hill Reservoir is a negative reference reach extending from the upstream boundary of the ORR almost 20 miles to CRM 52.

Reach 1—Lower Melton Hill Reservoir is the extent of Melton Hill Reservoir that borders the ORR. This portion of the reservoir extends from Melton Hill Dam at CRM 23.1 to the upstream boundary of the ORR at CRM 43.7. The only known source of contaminants to reach 1 is from the Y-12 Plant via McCoy Branch.

Reach 7—McCoy Branch Embayment is a small embayment of Melton Hill Reservoir that has potentially been affected by the historical disposal of fly ash from the Y-12 Plant into McCoy Branch and Rogers Quarry, upstream. The reach is bisected by a road into two subreaches:

Subreach 7.1—Upper McCoy Branch is the portion of the embayment upstream of the Bull Bluff Road. The potential for impacts is greater in this subreach because the waters are poorly mixed with those of the reservoir, and sediments accumulate here.

Subreach 7.2—Lower McCoy Branch is the part of McCoy Branch Embayment downstream of Bull Bluff Road. The hydraulic connection to upper McCoy Branch Embayment is by culvert.

Reach 8—Walker Branch Embayment is a negative reference reach for the McCoy Branch Embayment. No waste disposal has ever occurred in the Walker Branch watershed.

Reach 2—The upper Clinch River arm of Watts Bar Reservoir is above the mouth of Poplar Creek (CRM 12.0–CRM 23.1). This reach is riverine in nature and has limited sediment accumulation in the main channel. White Oak Creek (WOC), the primary surface water source of contaminants from ORNL, enters the Clinch River in this reach. There are 4 subreaches:

Subreach 2.1—Melton Hill Dam (CRM 23.1) to the mouth of WOC (CRM 20.8) is a very riverine subreach, the characteristics of which are strongly influenced by water releases from Melton Hill Dam. Although upstream of the contaminant sources on WOC, the potential for backflow exists when Melton Hill Dam is not discharging.

Subreach 2.2—The mouth of WOC (CRM 20.8) to the mouth of Pawpaw Creek (CRM 19.0). Contaminants from ORNL would be the least dilute in this subreach of the Clinch River.

Subreach 2.3—The mouth of Pawpaw Creek (CRM 19.0) to the mouth of Grassy Creek (CRM 14.5). This subreach is still riverine, but there is a zone of sediment accumulation at the downstream end of Jones Island. The K-25 potable water intake is at the lower boundary of this subreach.

Subreach 2.4—The mouth of Grassy Creek (CRM 14.5) to the mouth of Poplar Creek (CRM 12.0) is the last subreach upstream of contaminant sources on Poplar Creek.

Reach 3—The Poplar Creek Embayment of Watts Bar Reservoir is ecologically important as a spawning area for several fish species. The surrounding riparian forest supports piscivorous wildlife that feed on the aquatic life of the embayment and the Clinch River. The embayment is an area of sediment accumulation and has historically received contaminants from the Y-12 and K-25 facilities, as well as from the communities of Oak Ridge and Oliver Springs. Backflow from the Clinch River is common. This reach extends from the mouth of the creek upstream 5.5 miles to the mouth of EFPC. There are four subreaches, established primarily on the basis of potential contaminant sources:

Subreach 3.1—The mouth of EFPC (PCM 5.5) to the mouth of Mitchell Branch (PCM 4.6). Any effluents or runoff containing contaminants from the Y-12 Plant or the City of Oak Ridge enter Poplar Creek via EFPC.

Subreach 3.2—The mouth of Mitchell Branch (PCM 4.6) to the K-25 CNF outfall (PCM 3.4). Several K-25 waste outfalls have historically discharged effluents to Mitchell Branch.

Subreach 3.3—The CNF outfall (PCM 3.4) to the Poplar Creek ash disposal area (PCM 1.0). Historically several K-25 sources have discharged wastewaters to this subreach. The K-25 CNF currently discharges to this subreach, but is being extended to allow discharge directly to the Clinch River.

Subreach 3.4— The ash disposal area (PCM 1.0) to the mouth of Poplar Creek. Fly ash from the K-25 steam plant was historically discharged to the creek as a means of disposal. This is a zone of sediment accumulation where particle-associated contaminants might be expected to accumulate.

Reach 4—The lower Clinch River arm of Watts Bar Reservoir extends from the mouth of Poplar Creek (CRM 12.0) downstream to the mouth of the Clinch River (at TRM 567.5). This reach integrates all ORR contaminant sources. Residential land use along the river is greatest in this reach. It is an area of increasingly lacustrine conditions and sediment deposition. There are four subreaches:

Subreach 4.1—The mouth of Poplar Creek (PCM 12.0) to downstream of Brashear Island (CRM 8.5) makes up the Clinch River subreach with the least dilution of contaminants from Poplar Creek. Significant sediment accumulation upstream and immediately downstream of Brashear Island.

Subreach 4.2—Brashear Island (CRM 8.5) to the mouth of the Emory River (CRM 4.4) is a zone of increasingly significant sediment accumulation and shoreline development.

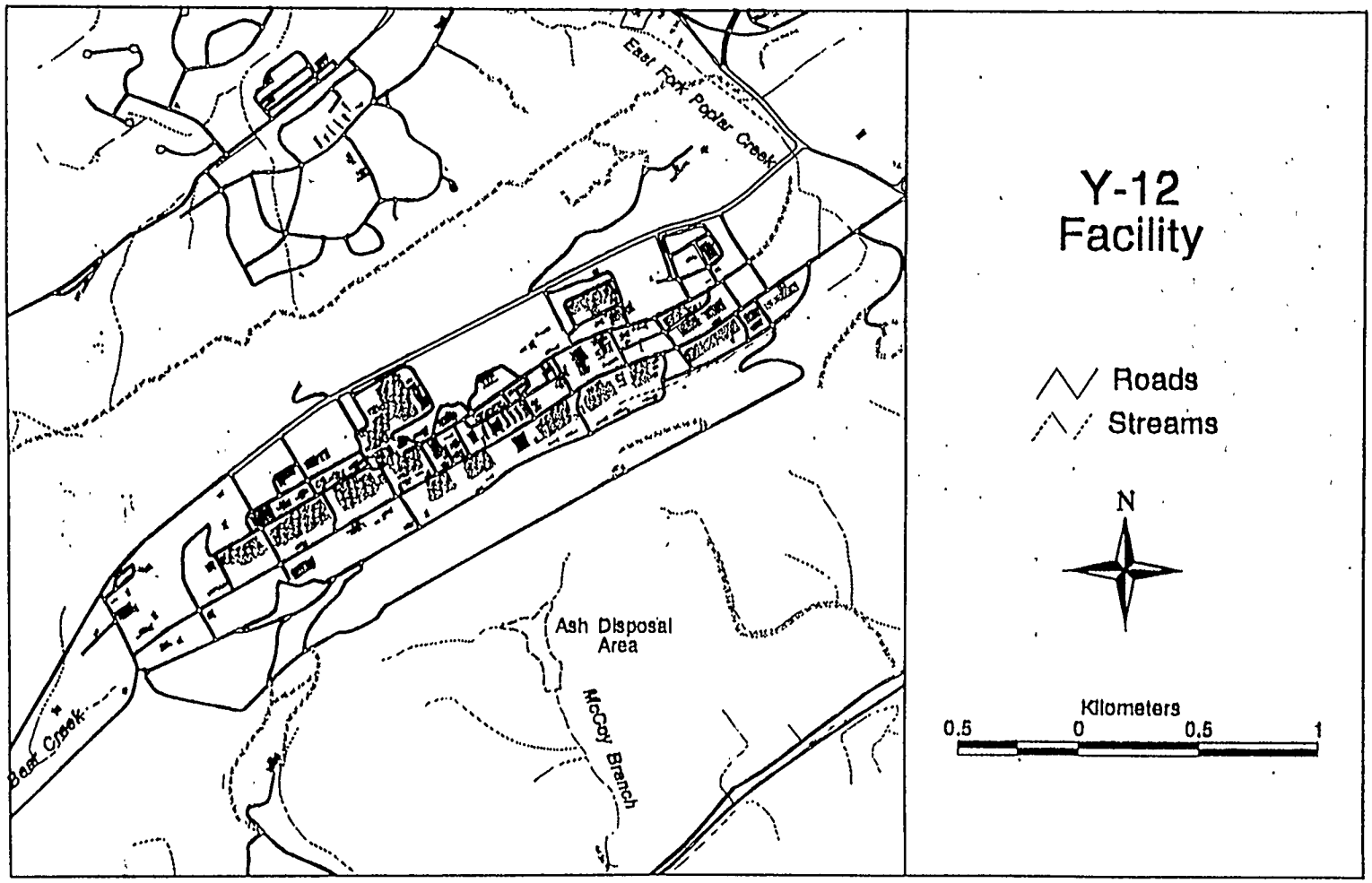


Fig. 3.2. The Y-12 Plant.

large quantities of cutting oils, machine coolant, degreasers, and solvents, including a number of chlorinated solvents, all of which may have been released in small quantities to EFPC. For many years, cutting oils at the Y-12 Plant contained PCBs. Waste PCB oils were collected in storage tanks and also disposed of in the Bear Creek Burial Grounds. These burial grounds are located about 2 miles west of the main plant on the southern slope of Pine Ridge. They were primarily used for the disposal of low-level radioactive waste (primarily uranium), but the disposal of wastes containing organics and metals occurred as well. Runoff and seepage from the burial grounds has contributed contaminants to Bear Creek, a tributary to EFPC (DOE 1994a). The use of cutting oils containing PCBs was discontinued in 1976. The manufacture of nuclear weapons components was discontinued at the Y-12 Plant in 1992. The Y-12 Plant is used today to store weapons-grade uranium from disassembled nuclear warheads.

In the early 1950s, the Y-12 Plant began the large-scale separation of lithium isotopes for use in the production of thermonuclear fusion weapons, or hydrogen bombs. The Colex process was developed to separate ^{6}Li from ^{7}Li, which was a column exchange process that used an aqueous lithium hydroxide solution and a solution of lithium in mercury. Millions of pounds of mercury were required for the process, with large quantities accidentally released to process buildings, soils, and surface water (Wilcox 1983). By the time the Colex process was closed in 1963, an estimated 239,000 lbs of mercury were lost to EFPC, and another 428,000 lbs were lost to the ground in the plant area (Wilcox 1983). Peak releases of mercury occurred in 1957 and 1958, when approximately 73,000 lbs and 64,000 lbs were released to EFPC, respectively (Fig. 3.3). Several hundred thousand pounds remained in buildings and process equipment at Y-12. Mercury releases declined dramatically after 1958, but the contaminated storm sewer system, buildings, and soils at Y-12 continue to contribute several grams per day of mercury to EFPC. These areas are the subject of ongoing remedial actions and decontamination and decommissioning activities. Remedial action on EFPC floodplain soils is slated to be completed by the end of 1996.

In the early 1950s Y-12 also received enriched uranium from the Savannah River Plant and the Idaho Chemical Processing Plant for purification and processing into metal components. The purification of these enriched uranium streams resulted in the accumulation of trace quantities of transuranic radionuclides (neptunium, technetium, and plutonium) in the resulting waste stream, which was then transferred to the S-3 seepage ponds.

The S-3 ponds were a series of four ponds constructed in 1953 at the west end of the plant. They provided a 10-million-gal capacity storage for liquid wastes containing low levels of radionuclides, such as uranium and transuranics. In addition, wastes such as nitric acid, other strong acids, and coolants were disposed of in the ponds. Seepage from the ponds flowed to Bear Creek, a tributary to EFPC. Groundwater in the area beneath the site of the former S-3 ponds is contaminated with nitrates, volatile organic contaminants (VOCs), radionuclides, and trace metals (DOE 1994a). Discharge to the ponds ceased in 1984 (DOE 1988), and the S-3 ponds underwent RCRA closure in 1988 (DOE 1994a).

The Y-12 steam plant and associated operations also contributed contaminants to the aquatic environment. Until 1993, coal ash from the steam plant was discharged as a slurry to the headwaters of McCoy Branch. McCoy Branch drains into Rogers Quarry, which acted as a settling basin for the ash, and then into Melton Hill Reservoir (DOE 1994a).

3.2.2 The K-25 Site

The K-25 site (Fig. 3.4) houses the Oak Ridge Gaseous Diffusion Plant (ORGDP), construction of which began in 1943. The primary mission of the plant was the enrichment of uranium via the gaseous diffusion process (DOE 1994a). This process produces highly enriched ^{235}U from ^{238}U by the

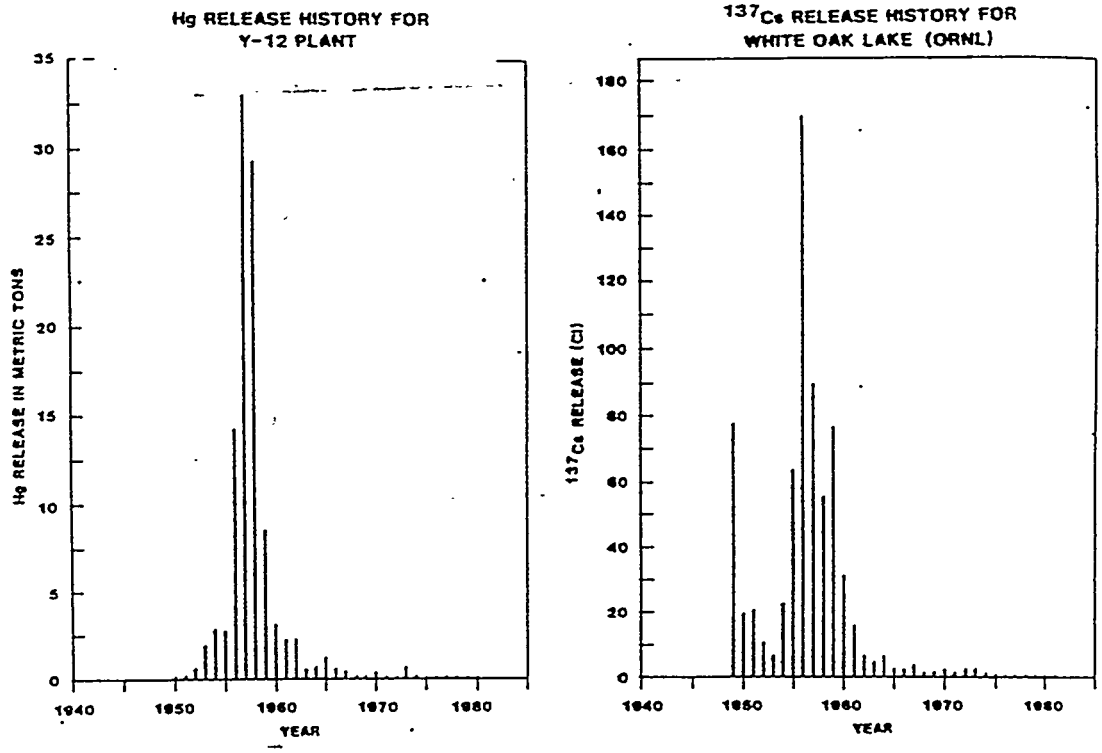


Fig. 3.3. Mercury release history from the Y-12 Plant and ^{137}Cs release history from White Oak Lake (ORNL).

diffusion of gaseous uranium hexafluoride across a long series of porous barriers. At each barrier in the diffusion cascade, the product becomes slightly enriched in ^{235}U as a result of its greater diffusion rate across the barrier as compared to the slightly heavier ^{238}U. Prior to 1964, a long series of diffusion cascades were used to produce highly enriched uranium (96% ^{235}U) for use in nuclear weapons production. After 1964, several of the diffusion cascades were shut down, and less enriched uranium (10% ^{235}U) was produced for use as fuel in commercial nuclear power generating facilities. The gaseous diffusion process at ORGDP was placed on standby in August 1985 and permanently shut down in December 1987.

The ORGDP housed numerous support facilities. Building K-1420 was used for decontaminating equipment and recovering uranium from this and other waste streams. These operations released U, ^{99}Tc, and ^{237}Np as liquid waste (DOE 1988). The transuranic elements were introduced into the waste stream as a result of operations to recover uranium from spent nuclear reactor fuel shipped from the Savannah River and Hanford plants (Egli et al. 1985 in Bruce et al. 1993).

Building K-1420 also housed a metal cleaning and plating operation. The surface corrosion of steel parts by fluorine gases in the diffusion cascade was prevented by coating these parts with nickel. Before plating, parts were cleaned with aqueous solutions of hydrochloric and sulfuric acids, detergents, and clorinated solvents. Parts were rinsed in tanks after cleaning and plating. The flow from these tanks was piped to the K-1407A neutralization pit for pH adjustment and then discharged to the K-1407B holding pond (DOE 1979).

Located near K-1420, building K-1401 served as the primary maintenance facility for the ORGDP from 1945 through 1985. The facility provided services for fabricating, cleaning, assembling, and

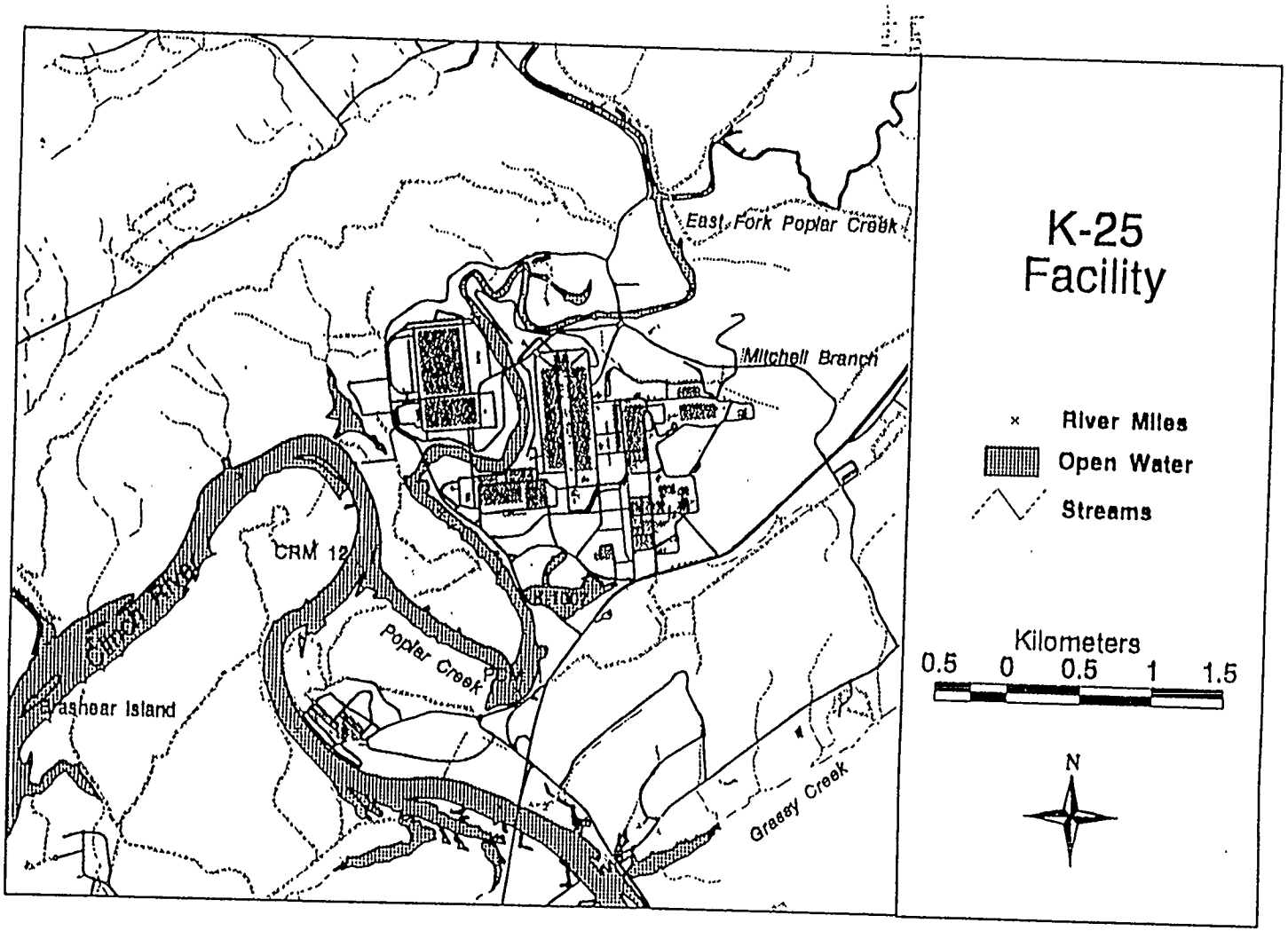


Fig. 3.4. The K-25 site.

painting plant equipment. Cleaning involved the use of cleaning baths, which, over the years, used various acids and chlorinated solvents. Fabrication required the use of metals, cutting oils, paint, and solvents. Waste solutions from these activities were piped to the K-1407A pond for neutralization and then discharged to the K-1407B holding pond (Goddard et al. 1991).

The K-1407A neutralization pit, operated since the 1940s, received wastewater from the uranium recovery operations, metal plating operations, and maintenance facility operations described above. Contaminants in these wastes included uranium, transuranics, metals, chlorinated and nonchlorinated solvents, and corrosives. Wastewater was neutralized with powdered lime or concentrated sulfuric acid and discharged to the K-1407B holding pond. The neutralization of wastewater in the K-1407A pit was discontinued in 1987 with the opening of the new CNF (Goddard et al. 1991).

The K-1407B holding pond was a 1.3 acre, 1.5-million-gal, unlined settling basin that received waste for more than 40 years. The pond received waste organics and metal hydroxides neutralized in the K-1407A pit and functioned primarily to settle the precipitates formed during neutralization. The pond also received effluent directly from several plant buildings. Contaminants known to be discharged to the pond include U, transuranics, solvents and oils, PCBs, and metals such as Cd, Cr, Pb, and Ni. Effluent from the K-1407B pond flowed to Mitchell Branch, a tributary to Poplar Creek (Goddard et al. 1991). In 1973, sludge from the pond was removed and disposed of in the K-1407C Retention Basin. A RCRA closure of the K-1407B pond was initiated in 1988. Sludges from the pond were placed in drums to which cement was added to solidify the wastes. Although the soil beneath the ponds was free of RCRA waste, remaining radionuclide contamination is the focus of a CERCLA remedial action.

The K-1407C retention basin was a 2.5-million-gal surface impoundment constructed in 1973 to store the sludge from the K-1407B pond. It was also subsequently used to store potassium hydroxide scrubber sludge generated at the plant (DOE 1994a). Like the K-1407B pond, a RCRA closure was initiated in 1988, but remaining contamination of the underlying soil with metals and radionuclides was found and is being addressed under CERCLA. The sludges from the K-1407C pond were also collected and fixed in drums as above. The resulting 46,000 drums of sludge from these pond closures were stored outside at the K-1417 Drum Storage Area, where leaking drums were detected in 1989. Runoff from this area went directly to Mitchell Branch. The drums have subsequently been moved to indoor waste storage vaults at the K-25 site (DOE 1994a).

The K-1501 steam plant supplied steam for process purposes and space heating. Liquid effluents consisted primarily of caustic boiler water blowdown and acidic discharge from the treatment of supply water. These discharges were neutralized and then released to the K-1407B pond. The coal storage yard contributed acidic runoff containing the trace metals As, Ni, Cu, and Mn. Before 1985, leachate and runoff from the coal pile were routed directly to Mitchell Branch. (DOE 1979).

Heat generated by the gaseous diffusion process was dissipated via mechanical draft cooling water towers. Recirculating cooling water was pumped to the towers, where losses to the atmosphere occurred. A chromium-based corrosion inhibitor was added to this recirculating water until 1977, when it was replaced with a phosphate system (DOE 1979). Raw water from the Clinch River was provided by the K-901 pumphouse and treated at the K-892 clarification facility. Sludge from this process and blowdown from the cooling towers were discharged to the K-901A Holding Pond (Goddard et al. 1991).

The K-901A holding pond received wastes from the late 1950s until 1985 (Goddard et al. 1991). The pond was initially a marshy area but was dammed in 1965–1966 to create the holding pond proper. In addition to the cooling system wastes described above, the pond was used to dispose of compressed

various fluoridated and chlorinated hydrocarbons (Goddard et al. 1991). The cylinders were reportedly breached prior to placement in the pond (Bruce et al. 1993). The K-901-A Pond discharges directly to the Clinch River.

The gaseous diffusion process required large amounts of electricity. Four on site switchyards received power transmitted from off site. PCB-containing transformers at the switchyard reduced and transformed this electricity for plant use. Releases of PCBs from the switchyards (Goddard et al. 1991) have likely allowed migration of these chemicals to Poplar Creek and the Clinch River.

Wastewater from laboratory drains in several buildings at ORGDP flowed to the K-1007B holding pond. An estimated 2200 gal of laboratory wastes were discharged to these drains each year prior to 1985, when the practice was discontinued (Goddard et al. 1991). Laboratory wastes included uranium and other radionuclides, acids, ethers, alcohols, glycols, chlorinated and nonchlorinated solvents, mercury, PCBs, and cadmium (Goddard et al. 1991). The K-1007B pond discharges directly to Poplar Creek.

In addition to the storage ponds and pits described above, a number of land-based waste disposal operations were used to manage wastes at K-25, which could have contributed to contamination of on-site and off-site surface waters via surface runoff or groundwater flow. Burial grounds included the K-1070A, K-1070B, and K-1070C/D burial grounds (DOE 1994a). The K-1070 area operated from the late 1940s through 1975 for the disposal of low-level and mixed wastes, including thorium, lead, and uranium. The K-1070B area was used from the late 1950s to 1976 to dispose of classified equipment contaminated with Pb, U, Al, Cu, Be, bronze, and asbestos (Goddard et al. 1991). This area was created by filling a low marshy area adjacent to a small creek that flowed into Poplar Creek. The K-1070 C/D classified burial ground received wastes from 1972 to 1989. The area received approximately 9100 gal of waste solvents and 1600 lbs of chemicals (Goddard et al. 1991). From 1979 through 1985, an area known as the K-1070A landfarm was used to dispose of spent Fuller's Earth, a product used to remove impurities in the diffusion cascade oil (Goddard et al. 1991). Several other on-site areas were used for the open burning of waste solvents or the incineration of solid waste. Still other areas were used for waste storage, including the storage of radioactively contaminated scrap metals or of various liquid wastes in drums. The K-720 fly ash pile, used from the 1940s through the 1960s, received fly ash from the on-site coal fired steam plant. This site was located south of the plant near the Clinch River, and runoff from the waste pile was not controlled (Goddard et al. 1991).

3.2.3 Oak Ridge National Laboratory

The original mission of ORNL (Fig. 3.5), or X-10 as it was known then, was the pilot-scale production of plutonium for use in nuclear weapons research at Los Alamos (Johnson and Schaffer 1992). Construction at the X-10 site began in January 1943. Plutonium was produced in the Oak Ridge Graphite Reactor, which was on-line by October 1943. The plutonium was separated from the fission products in a neighboring chemical separation pilot plant. The first shipment of plutonium to Los Alamos occurred in February 1944. By the end of 1944, the use of the graphite reactor shifted from plutonium production to research and the production of other radionuclides. Having completed its original mission, ORNL subsequently became a center for the development and testing of nuclear reactors, for the chemical and physical separation of nuclear materials, and for the production of a wide array of radionuclides for worldwide use in research, medicine, and industry (DOE 1994a).

The most significant operations at ORNL that have released contaminants to off-site surface waters have been the management of liquid and solid wastes. The X-10 site was planned as a temporary pilot facility and, therefore, waste production was anticipated to be small. A series of concrete Gunnite tanks

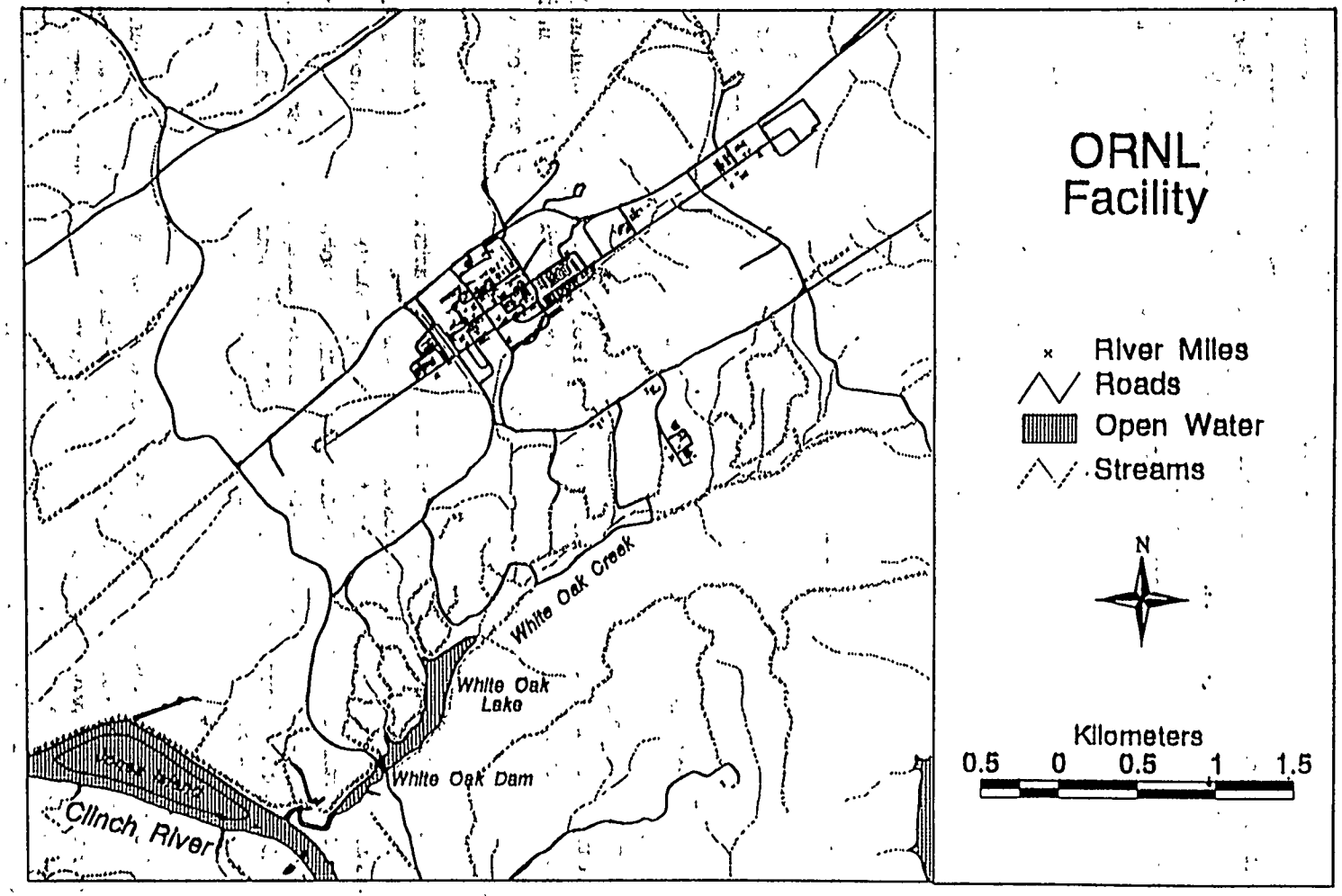


Fig. 3.5. The Oak Ridge National Laboratory.

was constructed to contain the wastes from the operations (Struxness et al. 1967); however, the mission of X-10 was almost immediately expanded, and the Gunnite tanks soon became inadequate for containing the volume of waste being generated. As a remedy, the waste in the tanks was treated to precipitate sludges and particle-reactive contaminants; the remaining liquids were released, with large quantities of diluting water, to WOC. In 1943, White Oak Dam was constructed across the creek to create a basin for the additional settling of any remaining solids. In June 1944, the 3513 holding pond was built to provide an additional settling basin for liquids pumped from the Gunnite tanks and to allow for the additional decay of short-lived radionuclides prior to discharge to WOC. From 1949 to 1954, an evaporator was used to concentrate and thereby further reduce the volume of liquid wastes stored in the Gunnite tanks. Waste volumes continued to increase, however, and in 1951 the use of earthen pits for the disposal of liquid wastes was initiated. Seven separate disposal pits were in use at various times from 1951 through 1976 (Spalding and Boegly 1985). In 1957, a process waste water treatment plant was built to recover fission products from these (and other) liquid wastes prior to disposal. The effluent from this facility was only slightly radioactive compared to the low-level wastes that had previously been discharged to the pits. This waste treatment facility was replaced in 1976 with an upgraded facility (DOE 1994a).

The first liquid waste disposal pit was used from July to early October 1951. Its use was discontinued when it was discovered that radionuclides, primarily ^{106}Ru, were leaking from the pit. Waste Pit 2 was constructed in 1952 and remained in use until 1962. A pipeline to Pit 2 was constructed in 1954, the evaporator shut down, and wastes pumped directly to the waste pit. Pit 3 was in use from 1955 through 1962. Pit 4 was in service from 1956 until 1976, when the new process waste treatment plant went on-line. Large quantities of ^{106}Ru were detected leaking from Pit 4 in 1959, and a trench was constructed down slope to intercept the leachate from Pit 4 and pump it back into the pit. Waste Pits 1–4 were open pits. In 1960, the design changed to an earth-covered trench designed to minimize accidental exposure to contaminants and to minimize the collection of rainwater. Waste Trench 5 was in service from 1960 until 1964, and Trench 6 went into service in June 1961. In October 1961, significant leakage of ^{137}Cs and ^{90}Sr was detected from Trench 6, and its use was discontinued. Trench 7 was built in 1962 and used until 1966, when disposal of liquid wastes using the hydrofracture technology was used (Spalding and Boegly 1985).

The hydrofracture process used hydraulic pressure to initiate cracks in the layers of shale bedrock underlying the disposal site. Alkaline solutions of low-level waste were mixed with cement and injected under pressure into the fracture zone, at a depth of approximately 700–1000 ft. This waste/cement grout mixture filled the cracks that had been developed and, upon setting, immobilized wastes in the deep shale formation. The original hydrofracture facility was in use from 1964 through 1979. A second facility was opened in 1982, but its use was discontinued in 1984 when the possible leaching of contaminants to deep groundwater, resulting from the improper fixation of the wastes, was identified as a concern (Ohnesorge 1986).

The disposal of solid wastes at ORNL has occurred at six different solid waste storage areas (SWSAs) (DOE 1994a). The first three storage areas were located in Bethel Valley near ORNL. The sites were selected primarily on the basis of convenience and with little regard for the potential mobility of the wastes in the soil. SWSA 1 was a 1-acre site in use from 1943 to 1944, SWSA 2 was a 4-acre site in use from 1944 to 1946, and SWSA 3 was a 6-acre site used from 1946 to 1951. SWSAs 4 through 6 were located in Melton Valley, where the soil types were better suited for immobilization of radionuclides. For several years in the late 1950s and early 1960s, ORNL's SWSAs served as a regional burial ground for low-level wastes generated from a number of other federal facilities and private companies (Bates 1983). SWSA 4 was a 23-acre site used from 1951 to 1959, and SWSA 5 was a 50-

acre site in use from 1959 to 1973. SWSA 6 is a 68-acre site opened in 1969 and is still in use (DOE 1994a).

The radionuclides that have been released in the greatest quantities from ORNL directly to surface waters since 1944 are ^{3}H (166,300 Ci), ^{106}Ru (6,931 Ci), ^{90}Sr (1,197 Ci), unidentified beta-emitters (2,694 Ci), and the rare earth elements (1,295 Ci, excluding cerium) (DOE 1988). The radionuclides disposed of in greatest quantities by being either buried on site or discharged as liquid waste to pits and trenches, since 1944, include ^{137}Cs (1,174,709 Ci), ^{90}Sr (880,557 Ci), and unidentified beta emitters (1,152,686 Ci). However, of these totals, only 39% of the ^{137}Cs and 17% of the ^{90}Sr was disposed of in pits and trenches; almost 60% of the ^{137}Cs and 78% of the ^{90}Sr was disposed of in the hydrofracture facility. The remaining quantities were discharged as solid waste to the SWSAs (DOE 1988).

As monitored at White Oak Dam, the radionuclides released in the greatest quantities to the Clinch River are ^{3}H, ^{106}Ru, ^{137}Cs, and ^{90}Sr (Table 3.1). Tritium is an isotope of hydrogen with a 13 year half-life. It is readily incorporated into water and moves through the environment accordingly. Given the 5 day retention time of the Clinch River arm of WBR, all but the most recent releases of tritium have long since flushed through the reservoir. Peak ^{106}Ru discharges of 1400–2000 Ci/yr occurred from 1960 to 1962, corresponding to the period of greatest seepage from Waste Pit 4. Releases have been estimated at zero since the late 1980s (DOE 1988). Ruthenium-106 is a water-soluble radionuclide with a half-life of 368 days and would not be expected to be found currently in the Clinch River. Cesium-137 is "particle-reactive", being readily adsorbed onto the surface of fine-grained sediment particles, particularly clays. Peak releases of ^{137}Cs occurred in 1956 (170 Ci), coinciding with the draining of White Oak Lake, when large quantities of sediment were eroded from the exposed lake bottom. An additional 266 Ci were released through 1961, after which releases continued to decline until by 1975 annual releases were less than 2 Ci, where they have remained since (Table 3.1, Fig. 3.5). Total ^{137}Cs released to the Clinch River from ORNL is approximately 700 Ci (~8 g). Because ^{137}Cs has a half-life of 30 years, much of the material released from the ORR can still be found in the sediments of the Clinch River. Peak releases of ^{90}Sr occurred before 1961, but cannot be correlated with disposal data, which is nonexistent for those years (DOE 1988). Releases had declined to less than 4Ci/yr by the late 1980s. Although it has a half-life similar to ^{137}Cs, ^{90}Sr is more water-soluble and, therefore, has not accumulated in the Clinch River to the same extent (Struxness et al. 1967).

DOE (1988) estimated that 70 to 80% of the radioactive materials released to surface waters from ORNL originate as leakage from waste disposal areas. Radionuclides of concern are primarily ^{137}Cs and ^{90}Sr, with ^{3}H and transuranics being of somewhat less significance. Another 10% of the releases originates from operating facilities at ORNL, such as reactors, laboratories, and processing plants. The remaining 10% originates as surface runoff from areas of contaminated soil in the vicinity of operating facilities that have been affected by spills or equipment leaks.

3.2.4 Summary of Significant Releases

Operations at the ORR have resulted in the release of hazardous substances, including metals, organics, and radionuclides, to the off-site aquatic environment. Reliable estimates regarding the amount of these various contaminants are generally impossible because of a lack of quantitative monitoring information. The Y-12 Plant is known to have released large quantities of mercury to EFPC. Large quantities of ^{238}U have been released from both the K-25 Site and the Y-12 Plant. Peak contaminant releases of mercury and uranium occurred prior to 1959 and have declined drastically since. Large quantities of fission products have been released from ORNL, including ^{3}H, ^{106}Ru, ^{137}Cs, and ^{90}Sr.

Table 3.1. Estimated[a] discharges (Ci) of radionuclides from White Oak Creek to the Clinch River, 1949–1992 (DOE 1988, Blaylock et al. 1993, Energy Systems 1992 and 1993, Vol II).

Year	^{137}Cs	^{106}Ru	^{90}Sr	TRE[b]	^{144}Ce	^{95}Zr	^{131}I	^{60}Co	^{3}H	TRU[c]
1949	77	110	150	77	18	180	77	[d]		0.04
1950	19	23	38	30		15	19			0.04
1951	20	18	29	11		5	18			0.08
1952	10	15	72	26	23	19	20			0.03
1953	6	26	130	110	7	8	2			0.08
1954	22	11	140	160	24	14	4			0.07
1955	63	31	93	150	85	5	7	7		0.25
1956	170	29	100	140	59	12	4	46		0.28
1957	89	60	83	110	13	23	1	5		0.15
1958	55	42	150	240	30	6	8	9		0.08
1959	76	520	60	94	48	27	1	77		0.68
1960	31	1900	28	48	27	38	5	72		0.19
1961	15	2000	22	24	4	20	4	31		0.07
1962	6	1400	9	11	1	2	0.4	14		0.06
1963	4	430	8	9	2	0.3	0.4	14		0.17
1964	6	190	7	13	0.3	0.2	0.3	15	1900	0.08
1965	2	69	3	6	0.1	0.3	0.2	12	1200	0.50
1966	2	29	3	5	0.1	0.7	0.2	7	3100	0.16
1967	3	17	5	9	0.2	0.5	0.9	3	13300	1.03
1968	1	5	3	4	0.03	0.3	0.3	1	9700	0.04
1969	1	2	3	5	0.02	0.2	0.5	1	12200	0.20
1970	2	1	4	5	0.06	0.02	0.3	1	9500	0.40
1971	1	0.5	3	3	0.05	0.01	0.2	1	8900	0.05
1972	2	0.5	6	5	0.03	0.01	0.3	1	10600	0.07
1973	2	0.7	7		0.02	0.05	0.5	1	15000	0.08
1974	1	0.2	6		0.02	0.02	0.2	0.6	8600	0.02
1975	0.6	0.3	7				0.3	0.5	11000	0.02
1976	0.2	0.2	5				0.03	0.9	7400	0.01
1977	0.2	0.2	3				0.03	0.4	6200	0.03
1978	0.3	0.2	2				0.04	0.4	6300	0.03
1979	0.2	0.1	2.4				0.04	0.4	7700	0.03
1980	0.6	0	1.5				0.04	0.4	4600	0.04
1981	0.2	0.1	1.5				0.04	0.7	2900	0.04
1982	1.5	0.2	2.7				0.06	1.0	5400	0.03
1983	1.2	0.2	2.1				0.004	0.3	5600	0.05
1984	0.6	0.2	2.6				0.05	0.2	6400	0.03
1985	0.4	0.007	3.0					0.6	3700	0.008
1986	1.0	0	1.8					0.54	2600	0.024
1987	0.6	0	1.2					0.12	2500	0.006
1988	0.4	0	1.1					<0.07	1700	
1989	1.2	0	2.9					0.13	4100	
1990	1.1	0	3.1					0.12	3100	
1991	1.7		2.7					0.12	2100	
1992	0.6		2.1					0.04	1900	
1993	0.5		2.1					0.04	1700	
1994	0.5		2.8					0.07	2200	
Total	700.6	6931.6	1214.6	1295	341.93	376.61	175.33	325.53	183100	5.248

[a] All digits carried through to avoid rounding errors. Only first two are significant.
[b] Total Rare Earth Elements, exclusive of cerium.

Because of its particle-reactive nature, ^{137}Cs is the principal long-lived radionuclide (30 year half-life) expected to be found in the Clinch River, where it would be associated with sediments. The greater solubility of the other radionuclides mentioned results in their being rapidly diluted and flushed downstream. Other possible contaminants released from the ORR include various metals (including As, Pb, Cr, Be, and Ni), various organic compounds (including PCBs, chlorinated and nonchlorinated hydrocarbons, and various laboratory chemicals), and various radionuclides (including transuranic radionuclides and fission products).

3.3 WATER CHARACTERIZATION

This section characterizes the nature and extent of contaminants in surface waters of the CR/PC OU. Data from historical studies are summarized (Sect. 3.3.1), and recent data from the ORR environmental monitoring program is then used to provide a general characterization of current conditions (Sect. 3.3.2). The CRRI Phase 2 investigation involved 6 tasks; data from these tasks is presented in Sects. 3.3.3–3.3.7. An originally planned task, the characterization of contaminant distribution downstream of point sources (DOE 1993), was discontinued after some initial data were collected. These data are not discussed in this section but are summarized in Tables A1–A3. Conclusions regarding the characterization of contaminants in surface water are presented in Sect. 3.3.8.

3.3.1 Historical Studies

This section summarizes the results of selected studies of surface water contamination in the Clinch River. The information from each of these studies is used to help formulate a site model of surface water contamination.

Clinch River Study. The comprehensive Clinch River Study was a multi-agency, interdisciplinary, 5-year (1960–1964) investigation into the effects of radionuclide releases from ORNL into the Clinch River. Organizations participating in the study were the U.S. Atomic Energy Commission, the U.S. Geological Survey, the U.S. Public Health Service, the TVA, the Tennessee Department of Public Health, the Tennessee Stream Pollution Control Board, the Tennessee Game and Fish Commission, and ORNL. The objectives of the study were to (1) determine the fate of radioactive materials that were currently being discharged to the river, (2) develop an understanding of the mechanisms of dispersion of radionuclides released to the river, (3) evaluate the limitations of the river for receiving radioactive effluents safely, and (4) suggest long-term monitoring procedures (Struxness et al. 1967).

The radionuclides of interest in the study (determined *a priori* based on quantities released, radioactive half-lives, and recommended maximum permissible concentrations in water) were ^{90}Sr, ^{60}Co, ^{106}Ru, and ^{137}Cs. A mass balance approach was used to inventory the radionuclides entering, leaving, remaining, or decaying in the river (Struxness et al, 1967). The study area included the Tennessee River downstream to Chickamauga Dam (TRM 471).

The results of the study indicated that ^{106}Ru, ^{90}Sr, and ^{60}Co occurred principally in solution in WOC. Upon release to the Clinch, the concentrations of these radionuclides were rapidly diluted and almost the entire quantity transported downstream in the dissolved state (Churchill et al. 1965). For example, the calculated mass balance curve for ^{90}Sr is depicted in Fig. 3.6. Maximum total concentrations of ^{90}Sr in water during the study period ranged from 17,450 pCi/L at White Oak Dam to 14.1 pCi/L at Chickamauga Dam. The maximum concentration recorded for the Clinch River was 42.6 pCi/L at the Centers Ferry station (CRM 5.5). Flow-weighted mean concentrations for the study period were an order of magnitude less than maximum values at all stations. Average concentrations over time were not

possible given the basic data (Churchill et al. 1965). In contrast to the other radionuclides studied, approximately 70% of the ^{137}Cs in WOC waters was sorbed to suspended sediments. Upon release to the Clinch River, these suspended sediments were largely transported downstream to a point (around CRM 15.0) where decreased turbulence allowed significant sedimentation and concomitant accumulation of ^{137}Cs. Figure 3.7 depicts the calculated mass balance curve for ^{137}Cs. Maximum total concentrations of ^{137}Cs in water during the study period ranged from 6,409 pCi/L at White Oak Dam to 6 pCi/L at Chickamauga Dam. The maximum value in the Clinch River was 35 pCi/L at the Centers Ferry Station. Flow-weighted means were not calculated because the maximum values listed were all substantially below the maximum permissible concentration standards in effect at that time (Churchill et al. 1965).

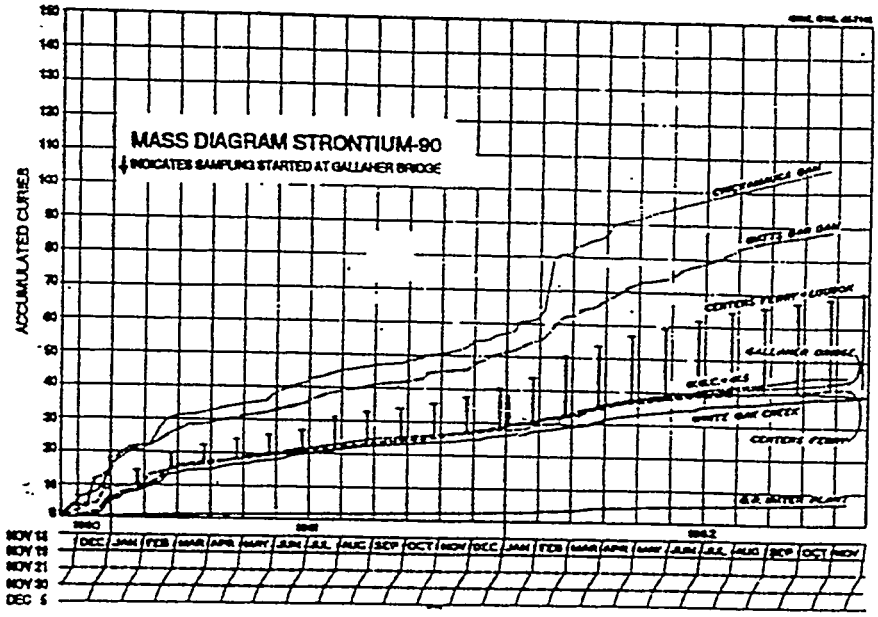


Fig. 3.6. Mass balance diagram for ^{90}Sr in surface water downstream of ORNL (Churchill et al. 1965). Note that accumulated Curies is consistently greatest at downstream stations, indicating no net loss of contaminant mass.

Oak Ridge Reservation Environmental Surveillance Reports. Monitoring data has been collected for a number of years for surface waters on and around the ORR. Table 3.2 summarizes the mean concentrations of selected metal and radionuclide analytes in surface water at CRM 9.9 for the period 1987–1992 (Energy Systems 1988–1993). The CRM 9.9 (Brashear Island, Fig. 3.1) station is downstream of all known ORR contaminant sources. Mean values are consistently below ambient water quality criteria (AWQC) and are expected to be representative of the Clinch River at this location. Organic analytes have rarely been detected in Clinch River surface water at this location.

CRRI Phase 1. The purpose of the Phase 1 water sampling was to verify, using rigorous quality assurance methods, historically reported water contaminant concentrations. A single sample was collected from each of numerous sites (Cook et al. 1992). Inorganic and organic analyte concentrations were within ranges reported in previous monitoring reports (e.g., Energy Systems 1991) and below AWQC. Concentrations of radiological constituents were comparable with the mean values reported by

Energy Systems (1991) and in previous investigations (Olsen et al. 1992). The majority of potential contaminants-of-concern were detected in reaches 2 and 3. Inorganic mercury and lead were detected in reach 3. Elevated levels of cadmium and lead were observed in reach 4. Bis-(2-ethylhexyl)-phthalate was the only organic contaminant observed in any of the samples collected for Phase 1 site characterization. These Phase 1data have been combined with the Phase 2 data for purposes of site characterization and risk assessment.

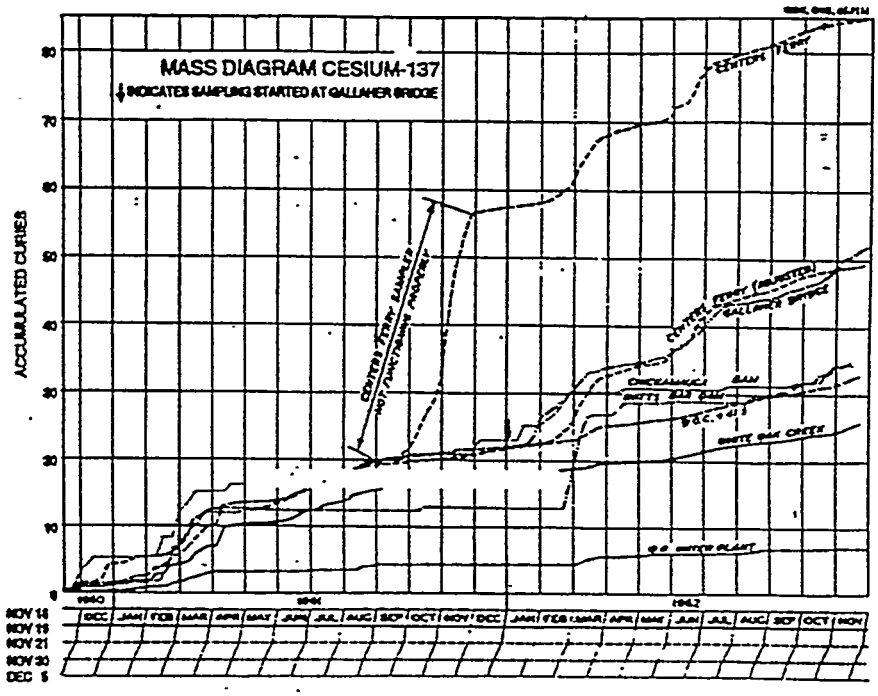


Fig. 3.7. Mass balance diagram for ^{137}Cs in surface water (Churchill 1965). Note that total accumulated Curies is less at Watts Bar and Chickamauga dams than at Gallaher Bridge, indicating a net loss of contaminant mass (to sediments) in Watts Bar Reservoir.

Arsenic Biogeochemistry in the Clinch River and Watts Bar Reservoir. The purpose of this study was to evaluate the distribution of arsenic species in the off-site surface water environment, with an emphasis on identifying potential sources of arsenic to the water column (Ford et al. 1995). This study involved the collection of surface water, sediment, and sediment pore water from the Clinch River and WBR for analysis of several arsenic species. Sensitive and precise processing and analytical techniques were used to measure arsenic species (arsenate, arsenite, and organic arsenic) at levels well below the ecological (190 μg/L for arsenate and 8.1 μg/L for arsenite) and human health (4.7 μg/L for arsenite) risk screening criteria; absolute detection limits using these techniques are approximately 0.0015 to 0.003 μg/L.

Inorganic arsenic levels were elevated (up to 1.5 μg/l) in surface waters (0 to 5 m) in the Kingston area. Values dropped with depth in the water column and were lowest near the sediment-water interface, suggesting an arsenic source directly to surface water in the Kingston area, downstream of the ORR.

Table 3.2. Mean, maximum , and minmum concentrations of selected analytes in surface water at Clinch River Mile 9.9 (Brashear Island) for the period 1987–1992[1]

Analyte	AWQC[2]		Year					
	HH[2]	Aquatic Life[3]	1987	1988	1989	1990	1991	1992
Arsenic	50	190[4]	ND[5] <5	ND <5	ND <5	ND <5	ND <5	4 2/5[6]
Cadmium	5	1[7]	<2 <2/3	ND <2	ND 2	ND <2	ND <2	1.2 0.5/2
Chromium	100	100	ND <10	ND <10	ND <10	18 <10/ 440	ND <10	
Lead	NA[8]	3[7]	<7 <4/25	<4 <4/11	ND <4	ND <4	ND <4	3.3 2/4
Manganese	50	NA	20 <10/74	67 20/200	79 69/ 100	49 25/94	74.4 30.6/ 150	69.3 30/140
Mercury	2	0.012			ND <0.2	ND <0.2	ND <0.2	
Nickel	100	160	ND <50	<52 <50/74	ND <50	12 <10/21	ND <10	23.3 10/50
^{137}Cs	NA[9]	NA[10]	ND <100	<3.8 -100/ <100	ND 0	0.75 0/1.97	0.037 -21.6/ 18.3	2.23 -15.3/ 17

[1] All units are μg/L except ^{137}Cs, which is pCi/L. Blank cells indicate no analyses reported. Data from Energy Systems (1988–1993).
[2] AWQC = ambient water quality criteria. HH = human health.
[3] Criteria continuous concentration
[4] Arsenic III
[5] ND = analyte not detected.
[6] Minimum/maximum values for the year.
[7] Calculated for hardness = 100 mg/L (approximate hardness of Clinch River water); values are for dissolved form.
[8] No AWQC for water supply available.
[9] AWQC is 4 mrem/yr for all radionuclides combined.
[10] DOE Order 5400.5 specifies 1 rad/day

Sediments in Poplar Creek deeper than 15 cm were grossly contaminated with arsenic. Sediment pore water values averaged 2850 μg/L. However, surface sediment arsenic concentrations did not differ from those at Kingston or in Melton Hill Reservoir. The Poplar Creek site received fly ash directly from disposal operations at the K-25 site on the ORR until 1963. Evidence suggests that deposition and accumulation of cleaner sediment, in combination with stream-like flow rates and oxic conditions throughout the water column, may be preventing significant release of this arsenic to surface waters of Poplar Creek.

Arsenic concentrations in Rogers Quarry outfalls (McCoy Branch mile 1.0) dropped greatly during this study as a result of actions taken to curtail and eventually eliminate fly ash disposal in Rogers Quarry. However, arsenic concentrations in the Rogers Quarry discharge were in excess of human health and ecological risk screening criteria for all sample collection periods. Arsenic concentrations in surface waters (0- to 2-m deep) decreased with distance downstream in McCoy Branch.

Seasonal increases in dissolved inorganic arsenic were observed both in the sediment pore waters and surface waters throughout the McCoy Branch Embayment. In summer, maximum values in upper McCoy Branch Embayment exceeded human health risk screening criteria. The maximum summer values in lower McCoy Branch Embayment were elevated, but did not exceed human health risk (drinking water) criteria. Changes in surface water arsenic values in McCoy Branch Embayment may be attributed largely to seasonal changes in sediment pore water chemistry, rather than to changes in Rogers Quarry outflows.

TVA Recreational Areas and Water Intakes Study. The purpose of this study was to provide screening-level data to evaluate the potential threat from contaminants to persons whose drinking water supply is Melton Hill or WBR, or to persons using the recreational facilities on these waters (TVA 1991). The analysis of water samples was limited to ^{3}H. A single grab sample was collected from each of 18 recreational areas and 11 water intake locations in Watts Bar, Melton Hill and Norris reservoirs in May and June 1991. Tritium levels were very low, with only six samples above detection limits (200 to 230 pCi/L) and activities that ranged from 300 to 853 pCi/L. The maximum value detected at the Kingston water intake (TRM 568.4) was well below the maximum contaminant level (MCL) of 20,000 pCi/L. Tritium was also detected at 3 beach areas in WBR and 2 water intakes in the Clinch River (TVA's Kingston steam plant and the DOE intake at Grassy Creek).

Summary of Historical Data. The historical data, considered together with the hydraulic conditions in the Clinch River (Chap. 2), tentatively point to the following site conceptual model for contaminants in water. Organic contaminants are infrequently detected and are present at very low concentrations when detected. Inorganic analytes are present at levels generally below AWQC. Radionuclide concentrations are generally very low and do not exceed water quality criteria. Sources of contaminants to off-site waters are generally via point-source discharges, tributary flow, or non-point source runoff. However, McCoy Branch surface water receives soluble arsenic that is released seasonally from contaminated sediment; maximum values exceed certain human health criteria at some locations. Despite gross arsenic contamination in Poplar Creek sediment, migration of arsenic to surface water appears limited by sediment and hydraulic conditions.

3.3.2 Oak Ridge Reservation Environmental Monitoring Data

The Oak Ridge Reservation Environmental Monitoring (ORREM) Program is designed to collect and analyze surface water data to assess the impact of contaminants on the ORR on human health and the environment (DOE 1994a). Surface grab samples are collected bimonthly from several sites (Fig. 3.8). Samples are analyzed for general water quality parameters, total metals, and volatile organics.

Samples are also screened for radioactivity and analyzed for specific radionuclides when appropriate. Data from 14 ORREM sites collected during 1993/1994 (n = 9 to 10 at each site) are used here to verify the conceptual model above.

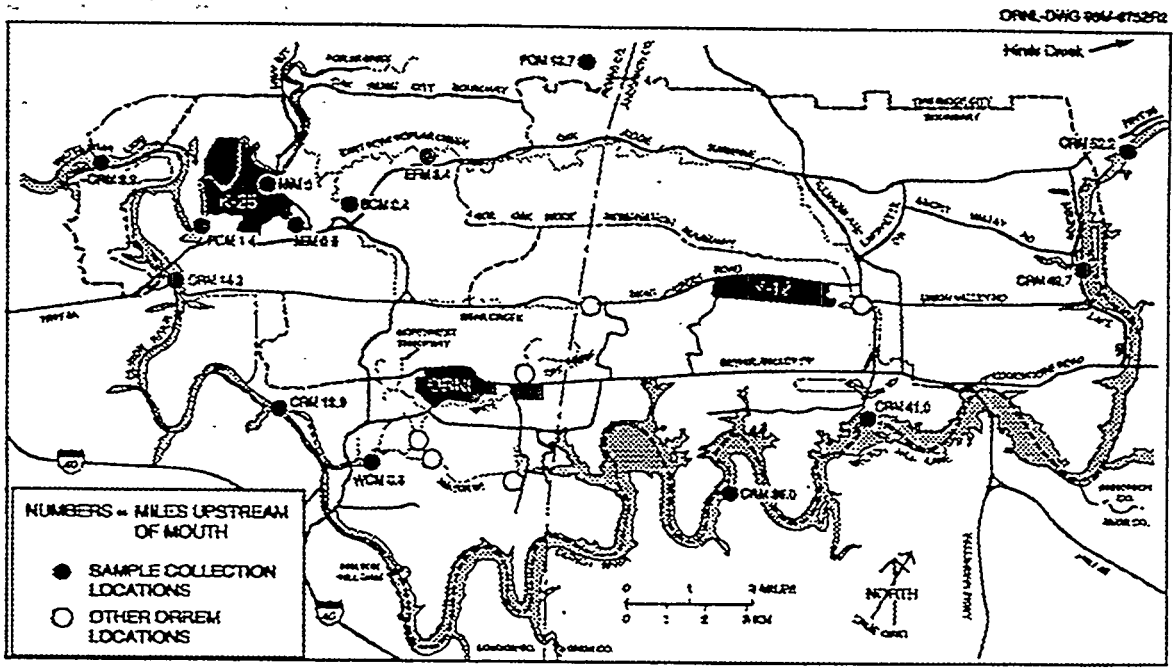


Fig. 3.8. Selected surface water sampling sites from the Oak Ridge Reservation Environmental Monitoring Program.

Many analytes were detected infrequently (i.e., in less than half of the samples at every location), including all organic compounds, cyanide, Sb, As, Be, Cd, Co, Cu, Pb, Se, Ag, and Tl (Table A4). Analytes detected in more than half the samples from any site are listed in Table A5 along with summary descriptive statistics. In general, mean concentrations of these analytes did not differ significantly ($p < 0.05$) among sites in the Clinch River or Poplar Creek. [Gross beta values below WOC (CRM 19.9) were significantly higher than at one reference site (CRM 52.2), and gross alpha values at PCM 1.4 were significantly higher than at one reference site (CRM 41.0).] The mean concentrations of each analyte in Table A5 are below AWQC for all Clinch River and Poplar Creek stations.

These data are combined with data collected during the CRRI and used to calculate representative concentrations for surface water exposure pathways in the baseline risk assessment (Chaps. 5 and 6).

3.3.3 Characterization of Contaminant Concentrations During Extreme Flow Events

This task was designed to characterize the maximum contaminant concentrations in the Clinch River resulting from uncontrolled releases from the ORR. Three hydrologic conditions were considered to bound this worst-case scenario: (1) high baseflow/high runoff (spring rain), to maximize contaminant flux from both groundwater and runoff but allowing high dilution; (2) low baseflow/high runoff (summer rain) to minimize contaminant flux from groundwater while maximizing contaminant flux via surface runoff; and (3) low baseflow/low runoff (summer dry), minimizing contaminant flux from both sources

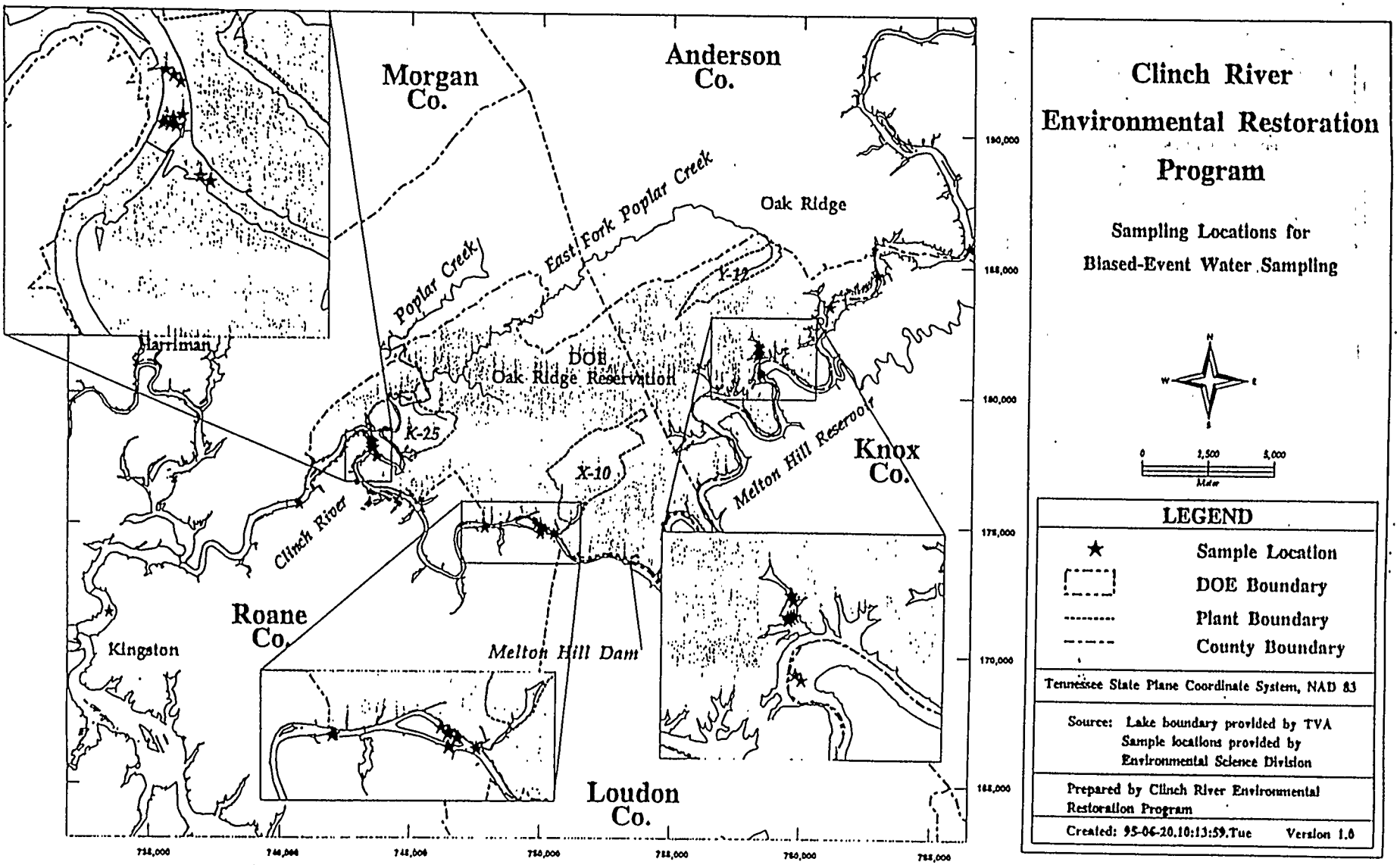


Fig. 3.9. Sampling locations for characterizing contaminant concentrations associated with extreme hydrologic events.

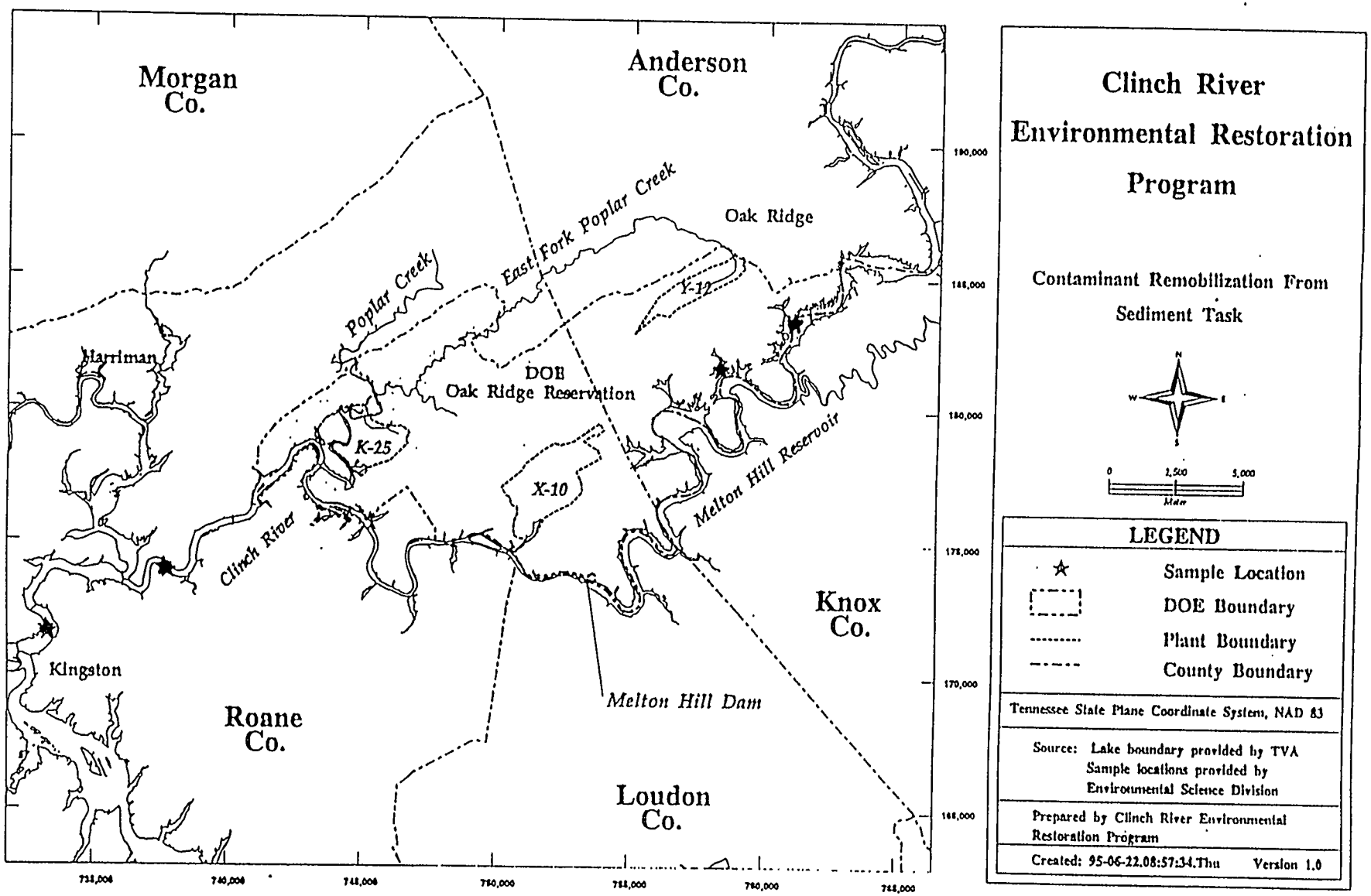


Fig. 3.10. Sampling locations for evaluation of contaminant remobilization for sediments.

but also minimizing dilution (DOE 1994b). Initially a fourth condition, high baseflow/low surface runoff was to be sampled, but these hydrologic conditions were not observed during the study period.

Because the maximum Clinch River concentrations would be highest at the mouth of streams draining known contaminant sources on the ORR, sample collection focused on three such streams: McCoy Branch, WOC, and Poplar Creek (Sect. 3.2). The "spring rain" event was sampled on April 19 and 20, the "summer rain" event July 28 and 29, and the "summer dry" event August 29 and 30, 1994 (Figs. A1 and A2). Ideally, flow in the Clinch River would be minimal during sampling to minimize dilution, but due to extensive rainfall throughout the region in the early spring of 1994 (Sect. 2.5.3), low flow was not observed during the high baseflow/high runoff condition.

Samples were collected from 5 locations (Fig. 3.9) at each of the three streams as follows: (1) mid-channel in the mouth of the source stream; (2) along a three-site transect in the Clinch River (at 25%, 50%, and 75% of the channel), 0.2 to 0.6 miles downstream of the source stream; and (3) one mid-channel site in the Clinch River located sufficiently far downstream to ensure uniform mixing of contaminants. Four reference sites were also sampled (Fig. 3.9). Each of the 19 sites were sampled once per flow event. Information regarding analytical classes, sampling locations, and frequency of collection for these data is listed in Table A6. Water quality parameters for all sites reflected seasonally expected norms (Sect. 2.5.3).

Results for each source stream are presented in Tables A7–A10. With the exception of ^3H at the WOC source location and arsenic in the McCoy Branch source location, no analyte concentrations exceeded AWQC during any event. Other than the exceptions noted above, analyte concentrations at reference locations were similar to the source and near-source locations. Therefore, no large-scale flux of contaminants leading to increased contaminant concentrations was evident during any of the presumed worst-case hydrologic events.

Interestingly, arsenic concentrations at CRM 1.0 were higher than at all study sites except the McCoy Branch source location. These data reinforce the evidence of Ford et al. (1995) that a significant arsenic source exists downstream of the ORR. Another interesting finding was that, during the "summer rain" event, dissolved and total mercury concentrations, although low at all locations, appeared higher in the Clinch River (CRM 11.8) than in the mouth of Poplar Creek. This finding is contrary to the expected decrease in concentrations expected from dilution of Poplar Creek water, but the data are too scant to draw any conclusions.

3.3.4 Contaminant Remobilization from Sediment Study

This task evaluated the potential for sediments to serve as a contaminant source to Clinch River surface waters through mechanical or chemical means (DOE 1994b). Samples from 1 m above the sediment surface were collected at four locations (Fig. 3.10), three times per season for two seasons and analyzed for metals, radionuclides, and organic contaminants (Table A6). Results are presented in Tables A11–A17. These data were compared to near-surface data for the same locations for evidence of contaminant remobilization at depth. Although the data are limited and the near-surface to near-sediment comparisons are severely hampered by the fact that the data were not collected concurrently, no evidence of migration of contaminants from sediment to the water column was found at any location.

3.3.5 Characterization of Additional Sources of Contaminants to the CR/PC OU

(Data for this task were received too late for inclusion in this report. Text and data will be included in the D2 version. Sample locations will be identified in Fig. 3.11. Data will be summarized as Table A18 in that report.)

3.3.6 Characterization of Contaminants in Poplar Creek Surface Water

The goal of this task was to characterize the average ambient conditions in Poplar Creek with respect to contaminant concentrations. Samples were collected from eight sites in Poplar Creek (Fig. 3.12) four times in each of three seasons (winter, spring, and summer). Because stratification was never observed in the water column, all samples were collected 1 m from the surface. Samples were analyzed for water quality parameters, metals, organics, and radionuclides (Table A6). Results are presented in Tables A19–A26.

Mean concentrations of all analytes were below AWQC at all locations over the study period as a whole. Concentrations of several inorganic analytes (Tables A19–A21) varied seasonally and were often highest in summer. Spatially, concentrations were similar across all sites (including reference sites) and were within the range historically reported (Gaydos et al. 1983) for a reference site on Poplar Creek. An exception to this was nitrate/nitrite, concentrations of which were significantly elevated below the mouth of Mitchell Branch (Fig. 3.13). In addition, total inorganic mercury and total methyl mercury concentrations were significantly elevated downstream of EFPC (Fig. 3.14), as expected. Although it was expected that mercury flux would be largely associated with periods of increased suspended sediment load, correlation of mercury concentrations and total suspended particle values were weak ($R^2<0.2$). Contrary to expectations, the highest mercury concentrations were observed near the mouth of Poplar Creek rather than immediately below EFPC. One explanation may be resuspension of sediment between EFPC and the mouth of Poplar Creek. Few organics were detected (Tables A22–A23) and reference concentrations were similar to those at the study sites. Measures of gross-alpha and gross-beta emission in water samples did not differ significantly among sites over the study period as a whole. In winter, however, both measures were significantly elevated below the mouth of Mitchell Branch compared to reference sites (Fig. 3.15). No individually measured radionuclides demonstrated spatially significant patterns.

3.3.7 Aqueous Toxicity Tests

Ambient water from the CR/PC OU was also evaluated for toxicity to aquatic organisms. Toxicity was evaluated as measures of (1) survival and growth of fathead minnow (*Pimephales promelas*) larvae; (2) fecundity and survival of the cladoceran *Ceriodaphnia dubia*; (3) hatching success, frequency of abnormal development, and survival of Japanese medaka (*Oryzias latipes*) embryos and larvae; and (4) genotoxicity as measured via microbial assay. Study sites (Fig. 3.16) in Melton Hill Reservoir were sampled twice for each type of test above; sites in the Clinch River below Melton Hill Dam and in Poplar Creek were sampled six times each for the cladoceran and fathead minnow tests, and three times each for the medaka and genotoxicity tests. To facilitate interpretation of test results, the collection of aqueous samples for toxicity testing in Poplar Creek was coordinated with samples collected for the characterization task in that reach (Sect. 3.3.6). Samples for contaminant analysis were also collected in conjunction with toxicity testing at sites in Melton Hill Reservoir and in the the Clinch River below Melton Hill Dam (for three of the toxicity sampling dates). In the fathead minnow and *Ceriodaphnia* tests, data from the Clinch River were analyzed separately from data from Poplar Creek. These data are summarized in Tables A27–A29. Standard test protocols for fathead minnow and *Ceriodaphnia* tests are described by Kszos et al. (1994). Medaka test procedures can be found in ER/CR-SOP 2162.

Fig. 3.11. Sampling locations for characterization of additional contaminant sources to the CR/PC OU (TVA 1995). (TO BE PROVIDED IN THE D2 VERSION.)

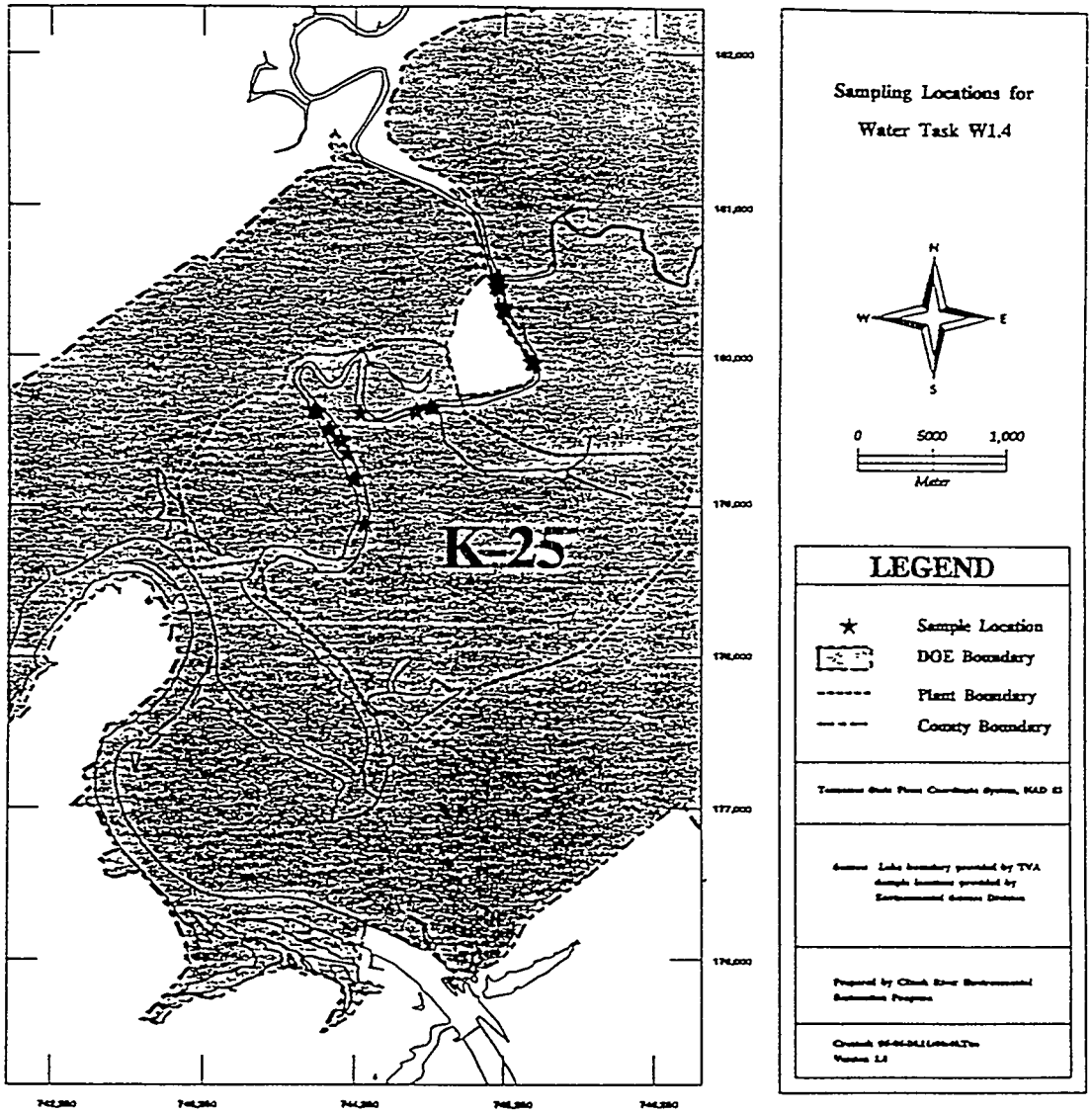


Fig. 3.12. Sampling locations for characterization of average ambient contaminant concentrations in Poplar Creek.

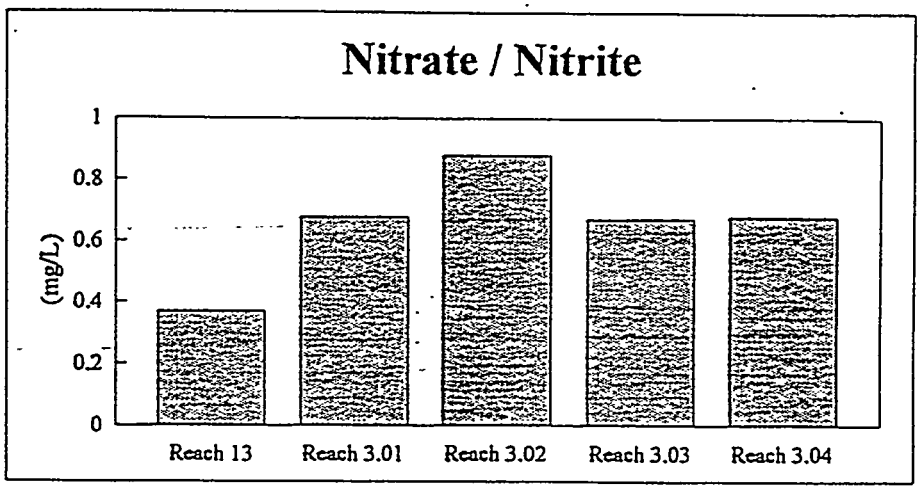


Fig. 3.13. Mean dissolved nitrate/nitrite concentrations in Poplar Creek by reach.

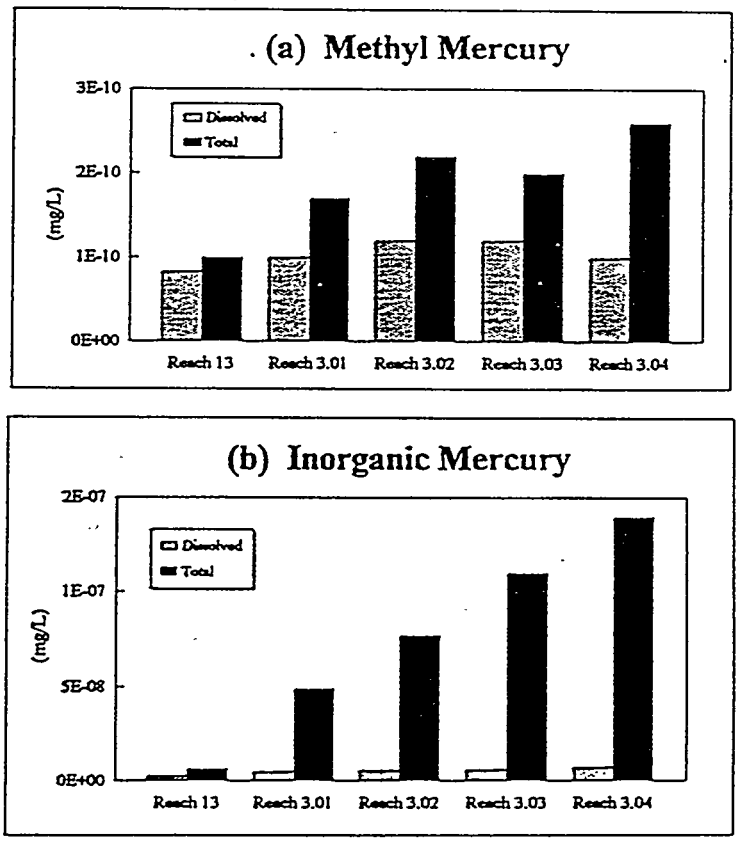


Fig. 3.14. Mean mercury concentrations by reach in Poplar Creek (a) methyl mercury and (b) inorganic mercury. The Tennessee water quality criteria for designated uses for inorganic mercury is 0.0024 mg/L maximum concentration and 0.000012 mg/L continuous concentration.

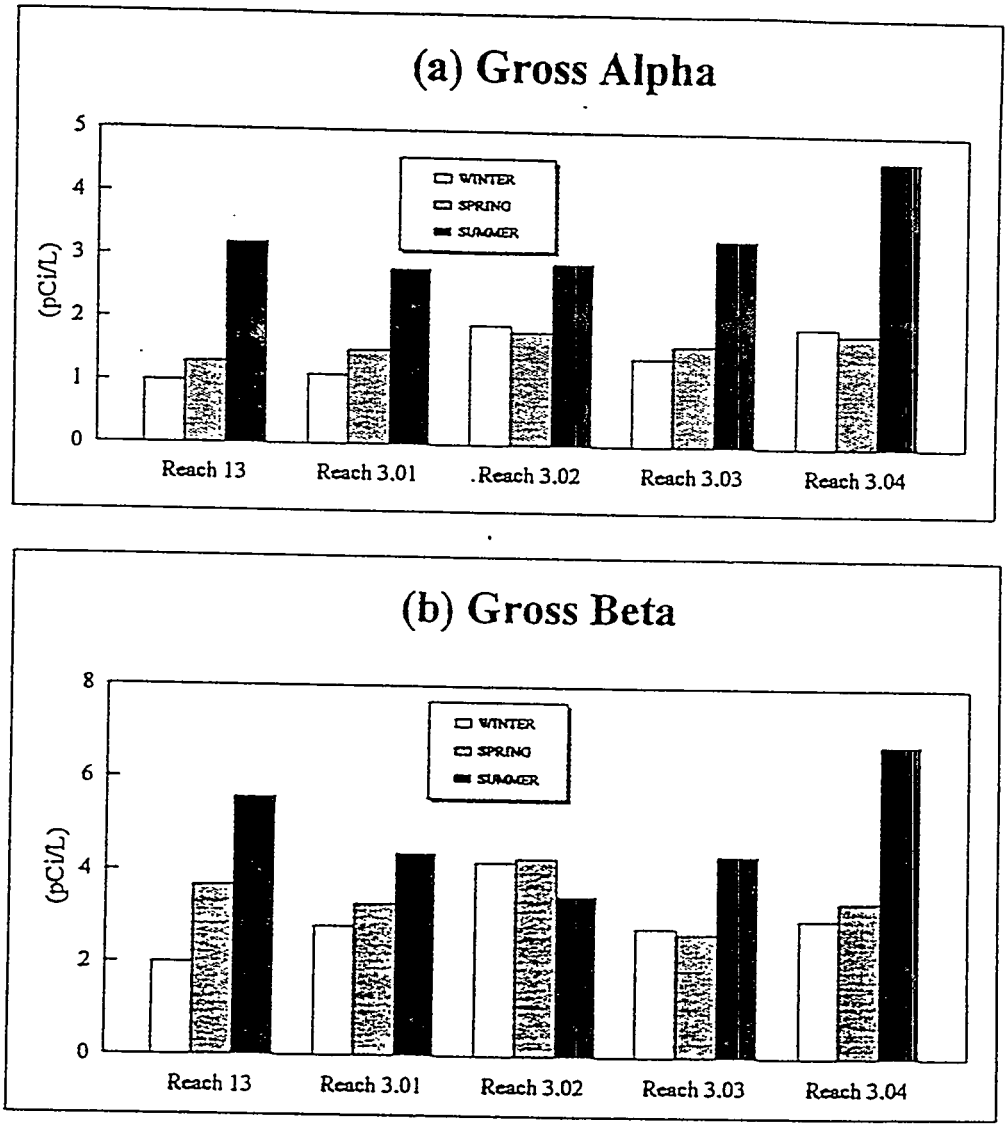


Fig. 3.15. Mean radioactivity concentrations by season within each reach for Poplar Creek (a) gross alpha and (b) gross beta.

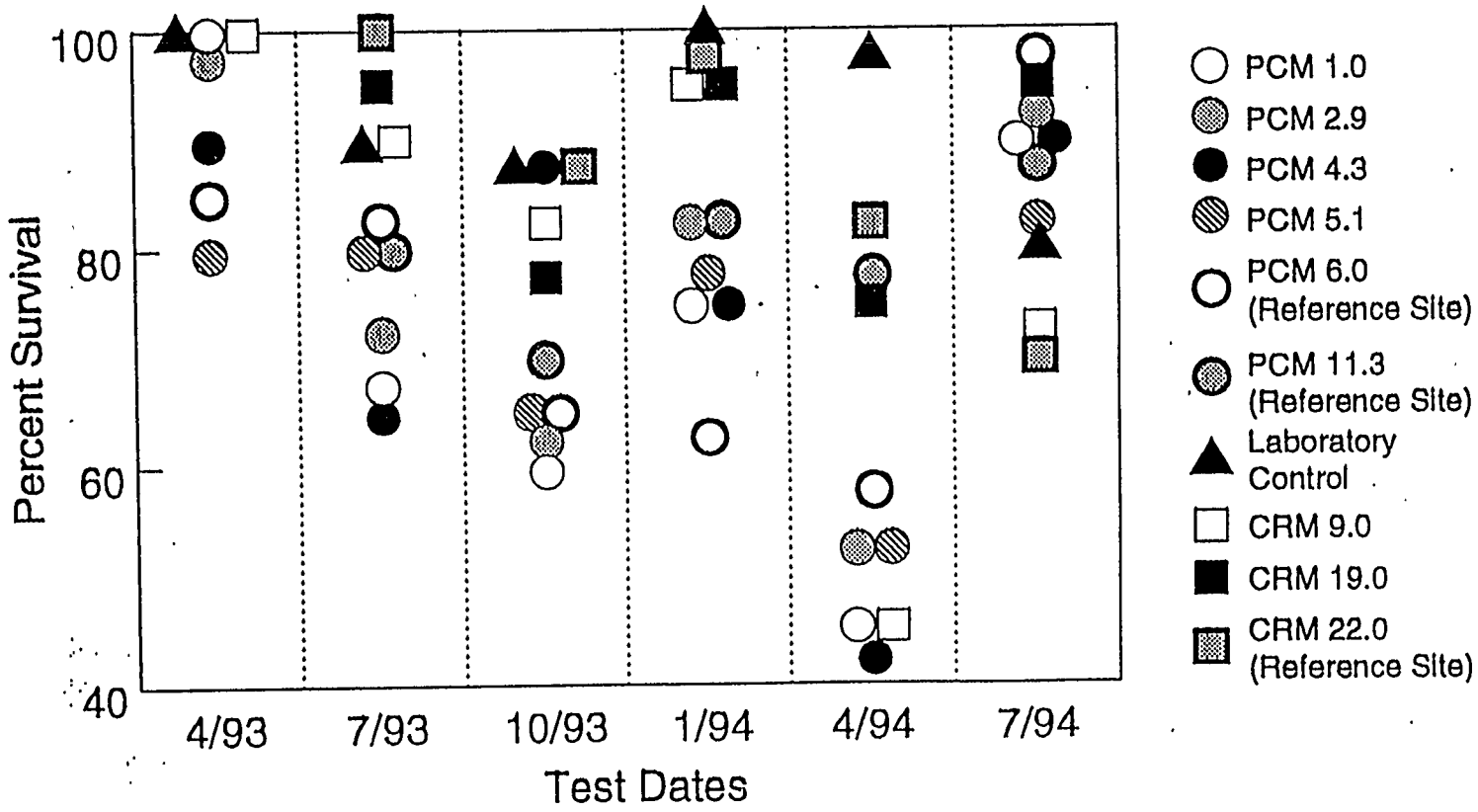


Fig. 3.17. Fathead minnow survival in water samples from Poplar Creek and Clinch River sites by test date.

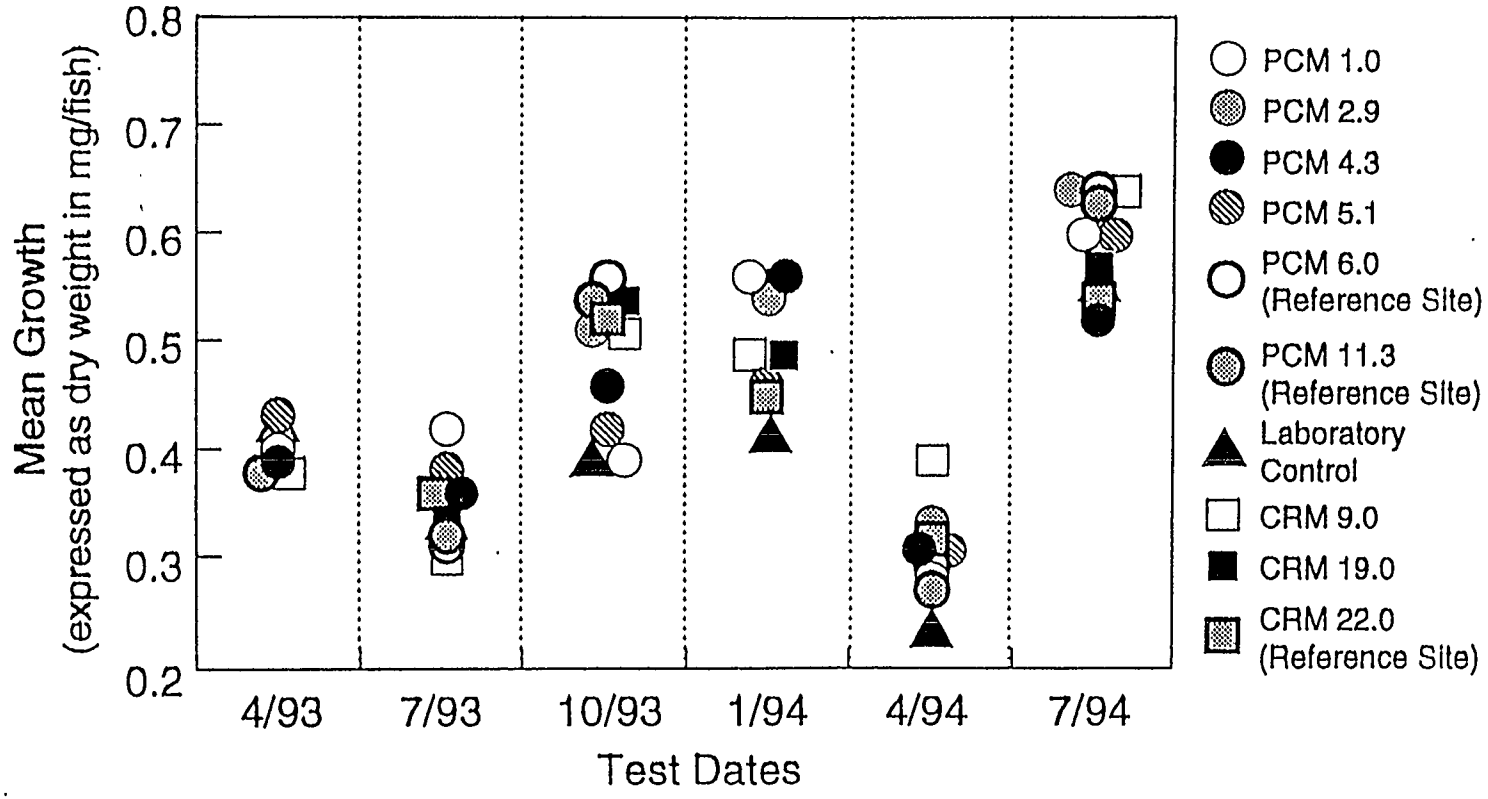
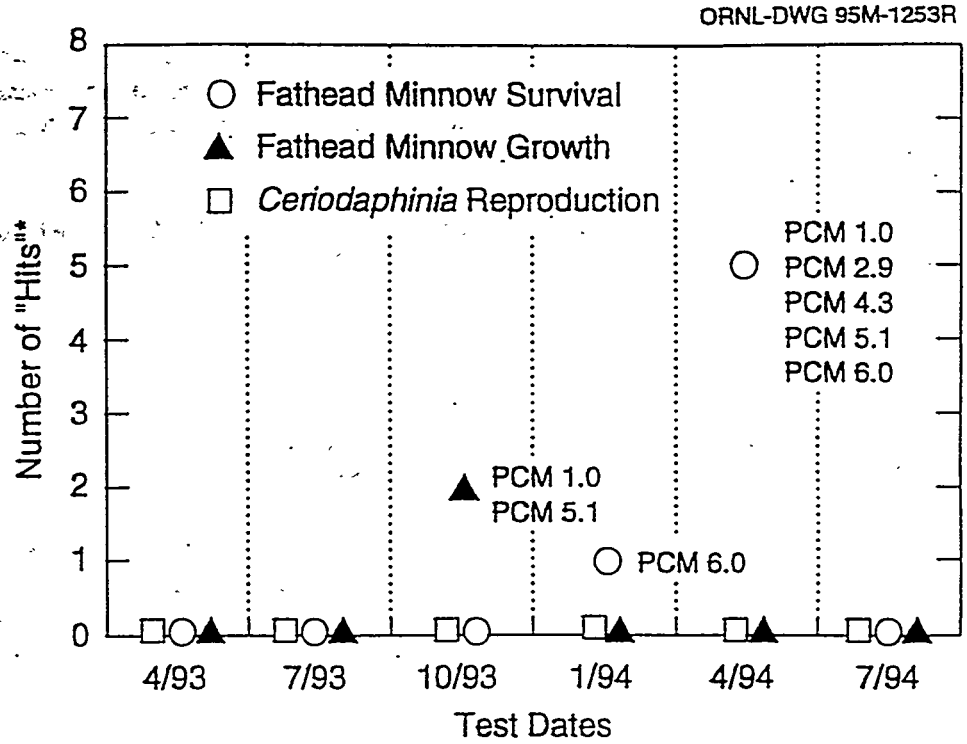
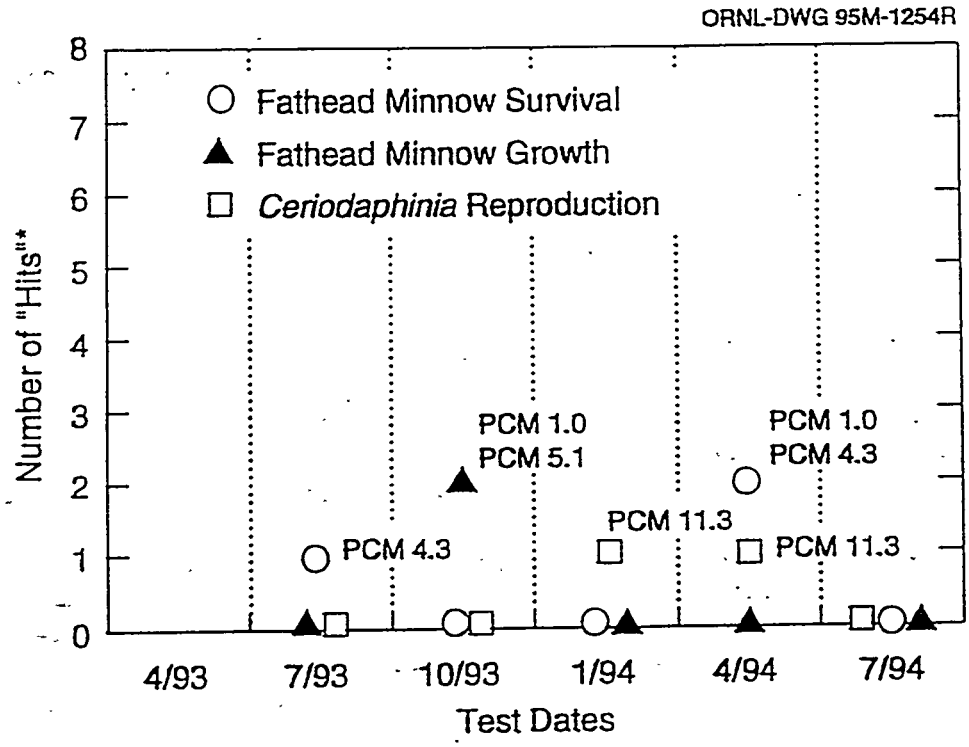


Fig. 3.18. Fathead minnow growth in water samples from Poplar Creek and Clinch River test sites by test date.



*Differences of 20% or greater; comparisons made to reference site PCM 11.3

Fig. 3.19(a). Comparisons made to reference site PCM 11.3 of fathead minnow survival and growth and *Ceriodaphnia* reproduction; number of hits by test date.



*Differences of 20% or greater; comparisons made to reference site PCM 6.0

Fig. 3.19(b). Comparisons made to reference site PCM 6.0 of fathead minnow survival and growth and *Ceriodaphnia* reproduction; number of hits by test date.

Though there were significant temporal differences, the organisms tended to produce more offspring in ambient water than in laboratory control water. Ambient waters may provide additional nutrients such as algae, bacteria, and detritus that contribute to an increase in fecundity (Kszos et al. 1992). *Ceriodaphnia* fecundity data are summarized in Table A32.

The only (statistically nonsignificant) reductions in fecundity of 20% or more between sites were reductions in one Poplar Creek reference site (PCM 11.3) relative to the other Poplar Creek reference (PCM 6.0) (Fig. 3.18).

3.3.7.3 Medaka embryo-larval test results

Five medaka embryo-larval tests were conducted for the CR-ERP Phase 2 Investigation on surface water samples from six sites in Poplar Creek and three sites in the Clinch River (DOE 1994b) at quarterly intervals from July 1993 through July 1994 . Subsequent to these tests, two additional medaka embryo-larval tests were conducted on many of the same sites for the K-25 Site BMAP. Two tests were also conducted in the summer of 1994 on two sites in lower McCoy Branch and a site in Walker Branch as a reference. In all tests, survival, hatching success, and the incidences of various developmental abnormalities were scored for individual medaka embryos exposed throughout embryonic development to water samples from the study sites.

Largemouth bass (*Micropterus salmoides*) and redbreast sunfish (*Lepomis auratus*) embryos were obtained by artificially spawning sexually matire adults and used in a limited series of tests to directly examine the toxicity to gamefish of surface water from many of the sites tested with medaka embryos. Methods for these one-time tests were adapted from the medaka embryo-larval test.

Results of embryo-larval tests were statistically examined by Chi-square analysis, with significant differences (α=0.05) between sites determined by comparison of sample proportions as described in Daniel (1987).

Hatching success was similar to survival in all tests. Apparently as a result of a relatively long pre-hatching interval (10–12 days on the average), the medaka embryo appears most sensitive to adverse water conditions in the period prior to hatch. Further discussion will thus focus only on the survival and developmental abnormality statistics of these tests.

Survival in water from three sites in the Clinch River (CRM 22, CRM 19, and CRM 9) was excellent in four of the five Phase 2 tests (Table A34) and in both of the K-25 Site BMAP tests (Table A35). The only exceptions occurred in the final quarterly Phase 2 test initiated in July of 1994, when survival at the two upstream sites in the river (CRM 22 and CRM 19) plummeted to 36% and 16%, respectively. Survival in control solutions was uniformly high ($\geq$80%) in all tests.

Survival of medaka embryos and fry in water from sites in Poplar Creek was more variable. For example, survival in water from a reference site (PCM 11.0) located well upstream of any influences from the ORR differed significantly from control survival in four of seven tests (Tables A34 and A35). Nonetheless, the general pattern throughout the tested portion of Poplar Creek was for a decrease in mean survival in comparison to the reference situation for all downstream sites adjacent to the ORR (Fig. 3.20), with greatest impacts observed in subreach 3.02 (PCM 4.3) and subreach 3.04 (PCM 1.0).

The incidences of developmental abnormalities observed in medaka embryos exposed to water from the Clinch River differed significantly from controls only in the July 1994 test (Tables A34 and A35).

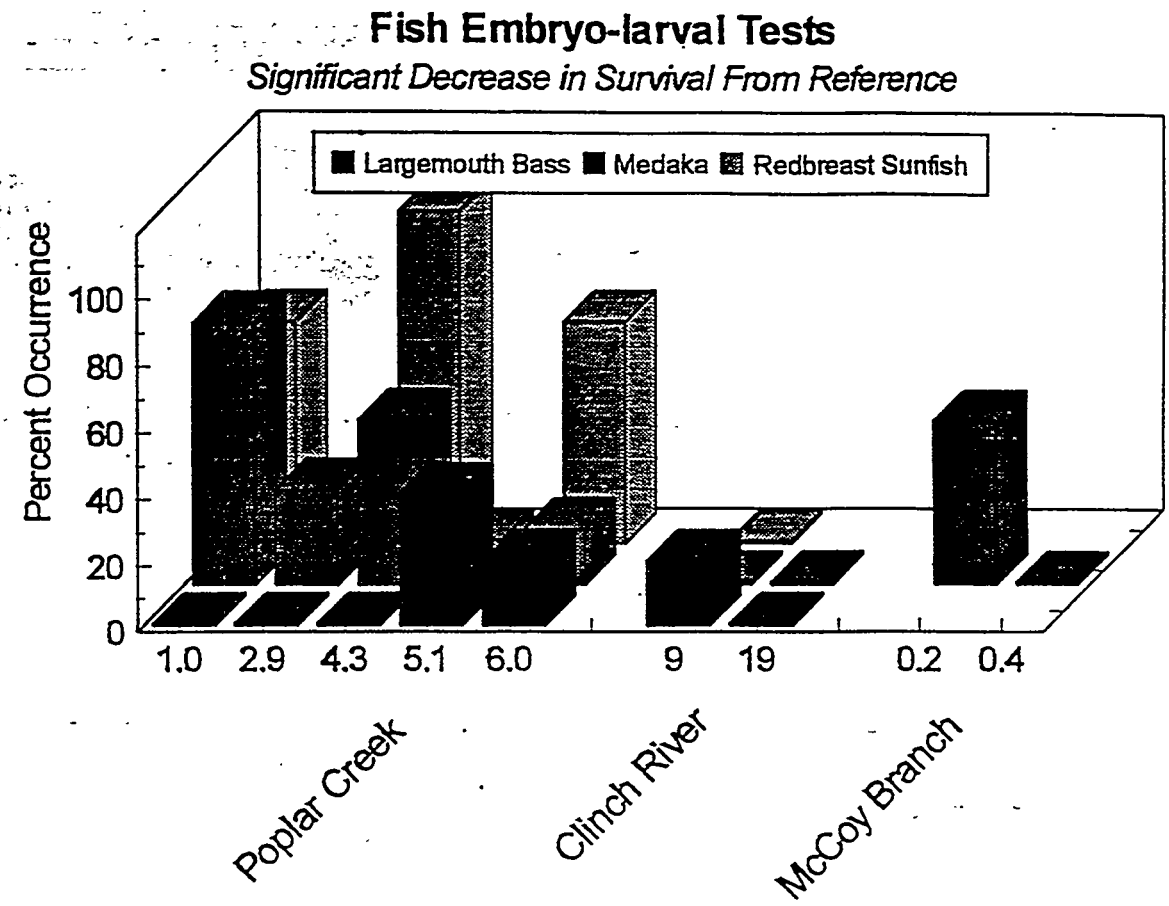


Fig. 3.20. Mean frequency of occurrence of significant decreases in fish embryo-larval survival in water from the various study sites as compared with the appropriate reference. For medaka, the values are based on a series of five to eight different tests of water from Poplar Creek and Clinch River sites and two tests for McCoy Branch sites. Values for largemouth bass and redbreast sunfish are based on tests of single water samples against embryos derived from multiple female and male *in vitro* pairings (totals of five and three, respectively).

Certain abnormalities were seen more frequently at the two downstream sites (subreach 2.02 at CRM 19 and subreach 4.01 at CRM 9) as compared with the upstream reference site (subreach 2.01 at CRM 22) (Fig. 3.21), but overall there was little significant pattern to the occurrences of developmental abnormalities in medaka exposed to water from any sites in the Clinch River.

In contrast, developmental abnormalities were much more common in embryos exposed to water from all sites in Poplar Creek, particularly the sites adjacent to the ORR (Tables A34 and A35). For example, overall incidences of developmental abnormalities significantly higher than in controls were noted in six of seven medaka embryo-larval tests conducted on water samples from subreach 3.02 (PCM 4.3). The incidences of many specific abnormalities were also greatest in embryos exposed to water from sites in lower Poplar Creek adjacent to the ORR (Fig. 3.21). The most frequent abnormalities noted for these lower Poplar Creek sites were associated with the chorionic layer, which encloses the embryo until hatching. In fact, the poor survival of medaka embryos in water from the lower Poplar Creek sites appears due in many instances to problems with the proper maintenance of chorionic integrity, leading to premature and largely unsuccessful attempts to hatch.

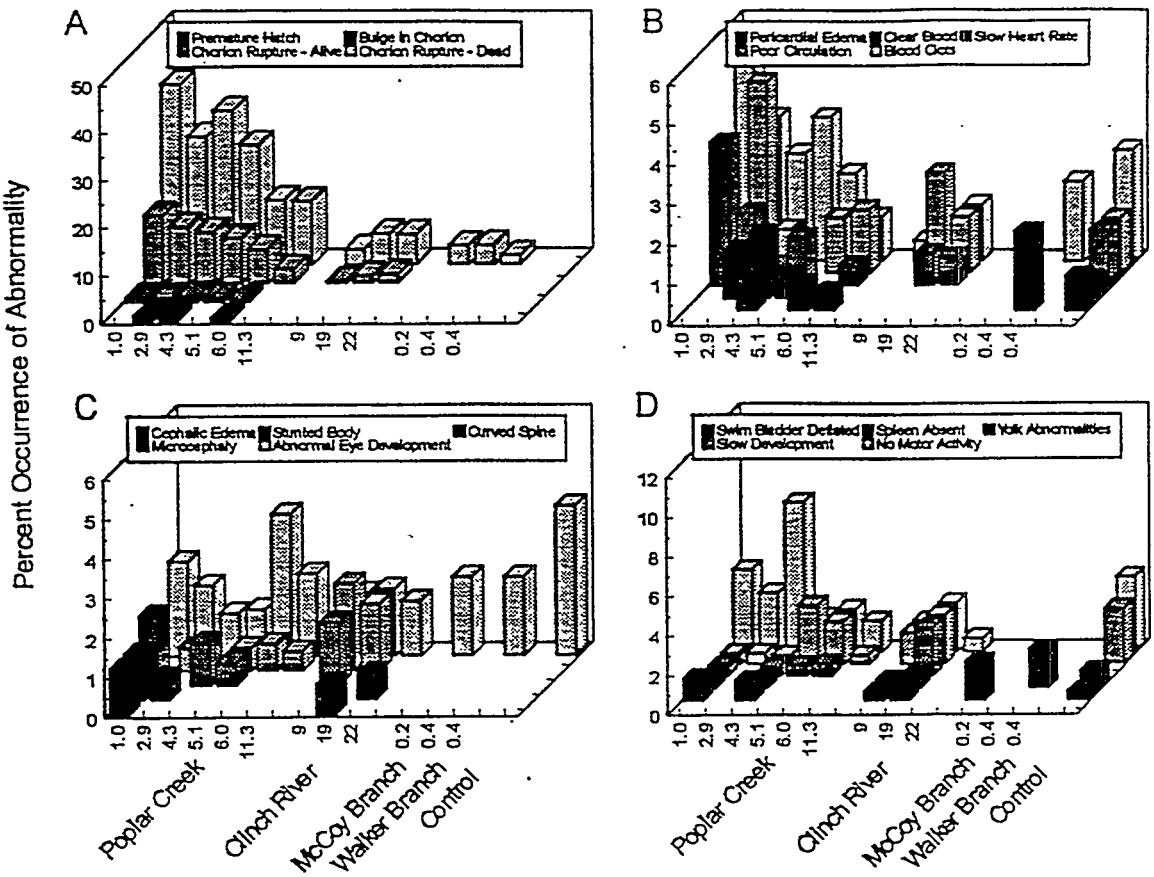


Fig. 3.21. Percent occurrence of developmental abnormalities during medaka embryo-larval tests. Abnormalities are grouped according to the following major classifications: (a) chorion-associated abnormalities; (b) circulation-associated abnormalities; (c) skeletal-muscular and head region abnormalities; and (d) other abnormalities.

Survival of medaka embryos in two tests of water from sites in lower McCoy Branch (subreach 7.02) and Walker Branch (subreach 8; reference for McCoy Branch) was generally very high (Table A35). Although survival was significantly less at MBM 0.2 as compared with the Walker Branch reference site (WBM 0.4) in one of the two tests (Fig. 3.20), it was still at a very acceptable 84% level. Very few developmental abnormalities were observed in embryos exposed to any of these water samples (Table A35 and Fig. 3.21).

Redbreast Sunfish Toxicity Tests. A set of fish embryo-larval tests was initiated in July 1994 for the purpose of comparing the responses of medaka and redbreast sunfish embryos and fry to water from select sites in Poplar Creek and the Clinch River. Medaka tests were conducted as outlined in Table A27; redbreast sunfish tests were conducted with eggs from females collected from a reference site and fertilized *in vitro*. The normal control was not included in this series of tests because of uncertainties as to the suitability of the millipore-filtered distilled water control for use with redbreast sunfish. Instead, all comparisons within tests were made to the appropriate reference site.

In this comparison test, survival was again very high (80 and 85%, respectively), and the incidences of developmental abnormalities relatively low (10 and 20%, respectively) for medaka embryos and fry

exposed to water from both CRM 22.0, the reference site on the Clinch River, and CRM 9.0 (Table A31). Survival was only slightly less (70%), and the incidences of medaka embryos with developmental abnormalities even lower (5%), at PCM 11.3, the reference site on Poplar Creek. Survival plummeted (to 11% in both instances), and the incidences of embryos with abnormalities increased significantly (to 50 and 58%, respectively) following exposure of medaka embryos to water from PCM 4.3 and PCM 1.0.

Similarly, the survival of redbreast sunfish embryos and fry was uniformly high in water from both the Clinch River sites, as well as the upstream reference site on Poplar Creek (Table A37; Fig. 3.20). Furthermore, survival of redbreast sunfish embryos and fry was also adversely affected by exposure to water from downstream study sites on Poplar Creek, although the results were not as consistent nor as pronounced as in tests involving medaka embryos. Few developmental abnormalities were observed during the course of these redbreast sunfish toxicity tests.

Largemouth Bass Toxicity Tests. Embryo-larval tests were also conducted during April of 1994 on largemouth bass embryos and fry exposed during early development to water from several sites in the Clinch River and Poplar Creek and one site in the Tennessee River. Because of time-constraints caused by difficulties in collecting female largemouth bass that possessed mature, but not over-ripe, fertilizable eggs from reference sites, no attempt was made to conduct a medaka embryo-larval test concurrent with these largemouth bass tests. Largemouth bass embryo-larval test procedures were similar to those employed in tests with redbreast sunfish and medaka embryos, except that hatching success was not scored in the bass tests.

Survival statistics for embryos and fry derived through *in vitro* fertilization techniques from each of five different largemouth bass pairings are presented in Table A37 and summarized in Fig. 3.20. Survival was uniformly high in these tests; however, small but statistically significant decreases in survival as compared with controls were observed in two of five groups of embryos tested against water from CRM 9.0. There were also minor, but again statistically significant, decreases in survival in water from several downstream sites in Poplar Creek. As with the redbreast sunfish embryo-larval tests, obvious developmental abnormalities (other than mortality) were rarely encountered in these largemouth bass embryo-larval tests (Table A38).

Conclusions and Summary. The results of the medaka embryo-larval tests clearly demonstrate an intermittent toxicity to fish embryos by water from lower Poplar Creek. This toxicity does not appear to extend into the Clinch River. Redbreast sunfish embryos appear to respond similarly to medaka embryos to water from both systems, although to a lesser degree. Largemouth bass embryos and fry appear to be the least sensitive of the fish species tested, although the absence of concurrent medaka test data weakens this comparison.

3.3.7.4 Genotoxicity test results

Surface water from the Clinch River and Poplar Creek was evaluated for its potential to cause genotoxic or toxic effects in DNA or the cell, respectively, using the SOS-Chromotest kit ~~(Table A27)~~. No significant genotoxic or toxic effects were observed in the Clinch River and Poplar Creek samples tested. Isolated samples exhibited slight genotoxicity, but no trends were established.

3.3.8 Summary of Water Characterization

Historical data indicated that the quality of water in the CR/PC OU was generally good and that contaminant concentrations in the Clinch River in the past generally met applicable water criteria.

Monitoring data from ambient sites throughout the OU were used to augment data collected during the remedial investigation. For the Clinch River, the present characterization attempted to answer specific questions regarding what were presumed to be worst-case conditions for contaminant flux to the river and the potential for mobilization of contaminants from sediment. Average ambient conditions in Poplar Creek were characterized over three seasons. Finally, the toxicity of surface water from a number of sites in the OU was evaluated using several test organisms and several measures of toxicity.

Ambient concentrations in the Clinch River, as evidenced by the ORREM data, revealed no contaminants whose mean concentrations exceeded AWQC or that were elevated over reference values.

No evidence of large-scale migration of contaminants from known source streams during extreme hydrologic events, leading to increased ambient concentrations in the Clinch River, was found. Maximum concentrations of contaminants in source streams were generally within the range of historically reported mean values.

No evidence was found of significant contaminant remobilization from sediment to surface water, although the study was limited in scope and design.

Both the ORREM data and the site characterization data indicated that mean concentrations of all analytes in Poplar Creek were below AWQC, and, with few exceptions, mean concentrations did not differ significantly from upstream reference concentrations. The site characterization data did reveal statistically significant elevated levels of total mercury and total methylmercury downstream of EFPC. Mean concentrations were highest near the mouth of Poplar Creek rather than immediately below EFPC. In addition, concentrations of dissolved nitrate/nitrite were significantly elevated downstream of Mitchell Branch. Gross measures of both alpha-emitting radionuclides and beta-emitting radionuclides were also significantly elevated downstream of Mitchell Branch in winter. As expected, concentrations of organic compounds were low throughout the system, with many compounds undetected anywhere (Table A39).

No site-related patterns of toxicity were observed in the majority of toxicity tests. The exception was the Japanese medaka embryo-larval series of tests, which clearly demonstrates intermittent toxicity to fish embryos of water from study sites in Poplar Creek. These results are corroborated by similar results using redbreast sunfish, a species native to the Clinch River/Poplar Creek area. Toxic effects apparently do not extend into the Clinch River downstream of Poplar Creek. While medaka fry were not sensitive to water from Poplar Creek, the susceptibility of embryos is thought to be due to disruption of chorionic integrity, resulting in premature hatching and embryo death.

3.4 SEDIMENT CHARACTERIZATION

3.4.1 Introduction

Many contaminants of concern in the Clinch River system have an affinity for, and rapidly become associated with, particulates. Uptake or sorption onto particles is the primary mechanism for removing such contaminants from the water phase, and sedimentation is the principal mechanism for the accumulation of these contaminants in off-site areas over time. Therefore, knowledge of the depositional patterns and contaminant levels within deposition zones is critical in the characterization of sediments in Poplar Creek and the Clinch River. This section summarizes current understanding of the sediment contaminant distribution in Poplar Creek and the Clinch River by presenting a review of historical studies and a synthesis of the data collected during the CRRI.

3.4.2 Historical Studies

Sediments in the Clinch River has been studied since the early 1950s. Most of the early studies focused on radiological contamination, particularly gamma-emmitters. However, more recent studies have included analysis for uranium isotopes and metals, particularly mercury, and to a lesser extent, organic chemicals. The following discussion describes the general findings of these studies.

3.4.2.1 Annual surveys of gamma activity in Clinch and Tennessee rivers bottom sediments

From 1951 to 1966, various researchers (Garner and Kochitzky 1956, Cottrell 1960, ORNL 1961–1967) measured total gamma radiation at the surface of the sediment using a submersible Geiger-Mueller counter (called a "flounder"). In the Clinch River, surveys were conducted from CRM 27.5 to the mouth.

Transects were established across the river at various intervals and gamma readings taken annually at points along the transect. Readings (gamma counts per second) were averaged across the transect. Beginning in 1954, composite surface grab samples were also collected along each transect for radionuclide analysis (Cottrell 1960). The principal radionuclides contributing to gamma activity in most years were ^{137}Cs, ^{60}Co, ^{144}Ce, total trivalent rare earths (TRE), and ^{90}Sr (Fig. 3.22). The distribution of activity along a transect was generally proportional to the depth of the water (e.g., Fig. 3.24); most of the activity was found in the main channel.

In general, gamma count rates in the Clinch River gradually increased downstream from the mouth of WOC. The highest count rates found throughout the entire Clinch and Tennessee rivers system typically occurred between CRM 11.0 and 8.0, although annual variations exist (Fig. 3.23). Count rates remained relatively constant from CRM 8.0 to the mouth of the river, except for low counts at scour points at CRM 4.7 and 2.6.

An increase in activity in 1952 (Fig. 3.23) was attributed to the release of an unspecified short-lived radionuclide, possibly barium, which had largely decayed by 1953 (Garner and Kochitzky 1956). The large increase in activity during the period 1956–1960 was due primarily to the draining of White Oak Lake with the attendant scouring of contaminated sediment from the lake bottom. The increased activity in the 1961 survey probably resulted from increased releases of ^{106}Ru in 1960.

The gamma surveys demonstrated that the general distribution of radioactive sediments has remained the much the same in the Clinch River over time. Annual variations in surface activities typically reflected the quantity of particle-associated radionuclides released at White Oak Dam.

3.4.2.2 Clinch River Study

The purpose and scope of the Clinch River Study are outlined in Sect. 3.3.1 The following briefly summarizes salient findings with respect to contaminated sediment.

In 1962, 113 cores were collected from 14 locations in the Clinch River and used to estimate the radionuclide inventory of the sediment. A total inventory of 200 Ci was estimated for the river as of July 1, 1962 (Table 3.3). The bulk of this inventory was ^{137}Cs (150 Ci, or 77% of total). The remaining inventory was composed of an estimated 18 Ci (8.7%) of ^{60}Co, 16 Ci (7.7%) ^{106}Ru, 10 Ci (5.1%) TRE elements, and 2.9 Ci (1.5%) ^{90}Sr. Approximately 95% of the total inventory was downstream of CRM 15, and at least 60% was downstream of CRM 9. The inventories listed here represent approximately 1.5% of the total activity released from ORNL to that time, including approximately 21% of the ^{137}Cs, 9% of the ^{60}Co, 0.4% of the ^{106}Ru, and 0.2% of the ^{90}Sr (Carrigan and Pickering 1967).

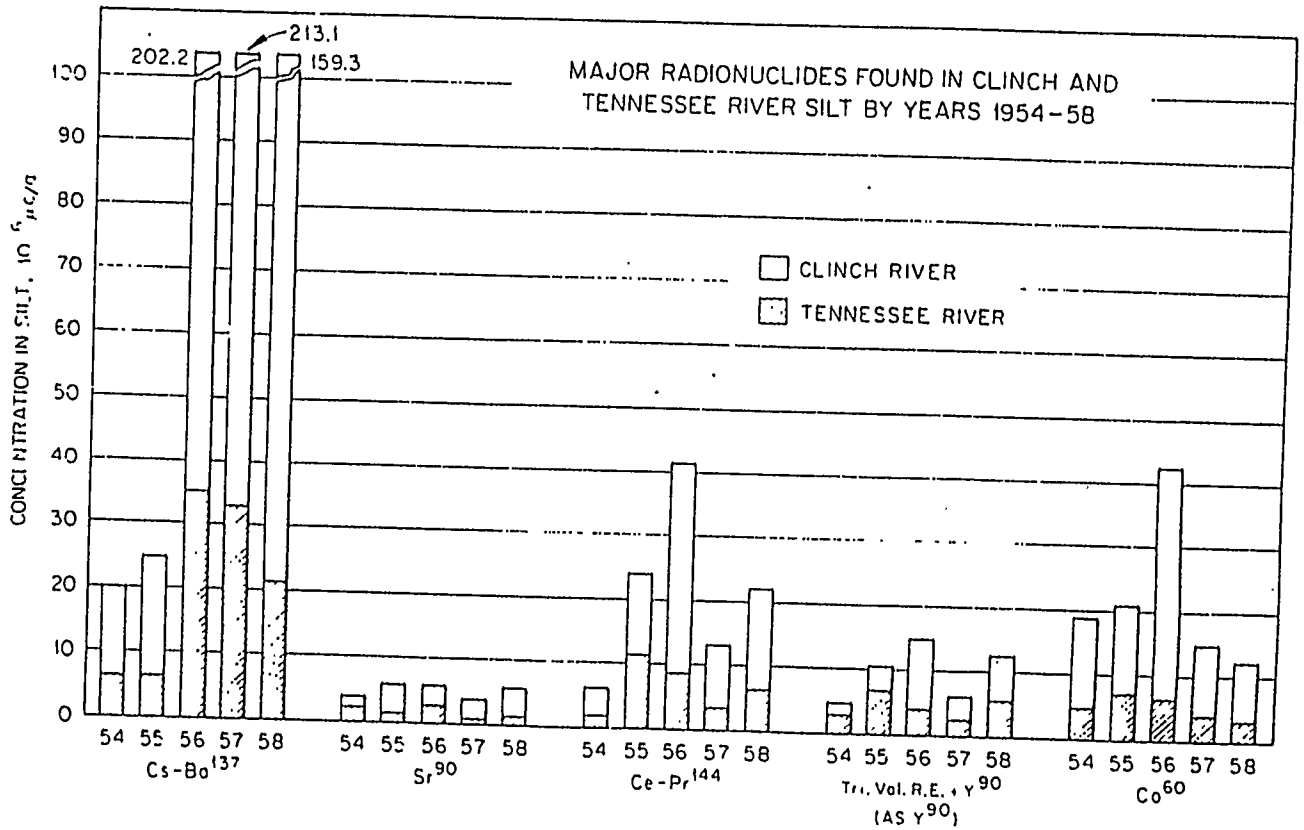


Fig. 3.22. Major radionuclides found in Clinch and Tennessee rivers silt by years, 1954 through 1958 (Cottrell 1960).

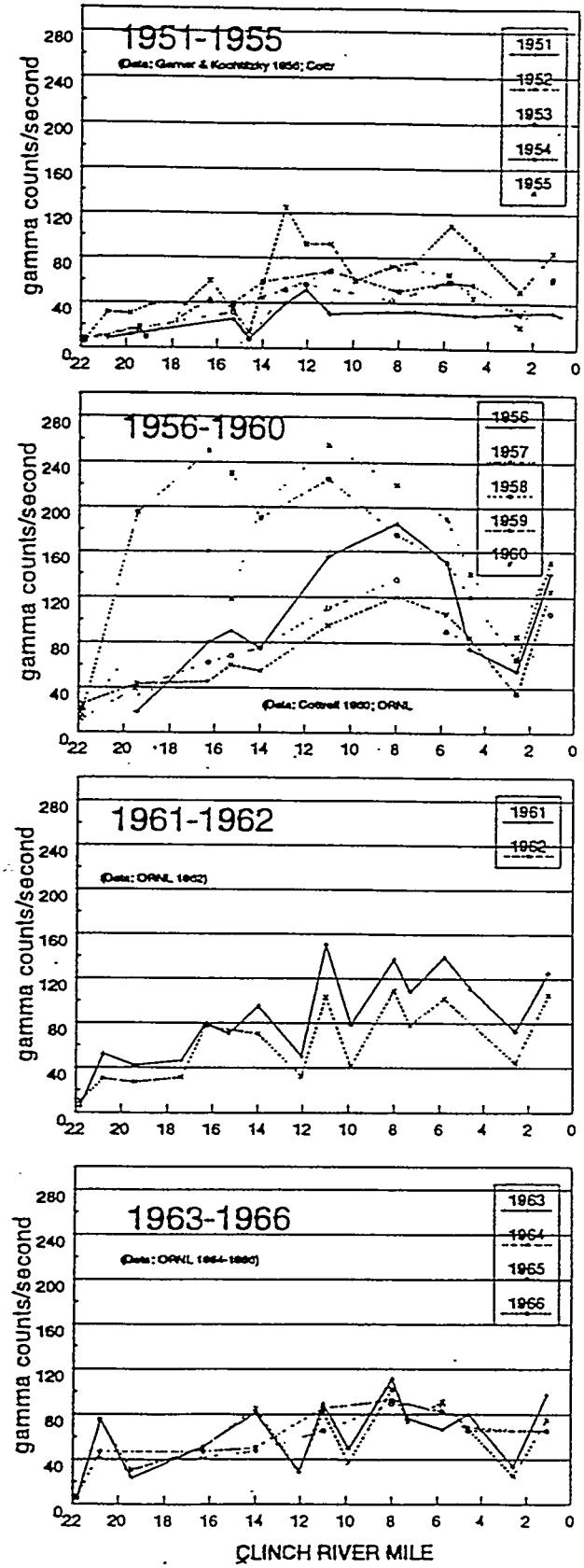


Fig. 3.23. Results of gamma surveys in the Clinch River, 1951 through 1966.

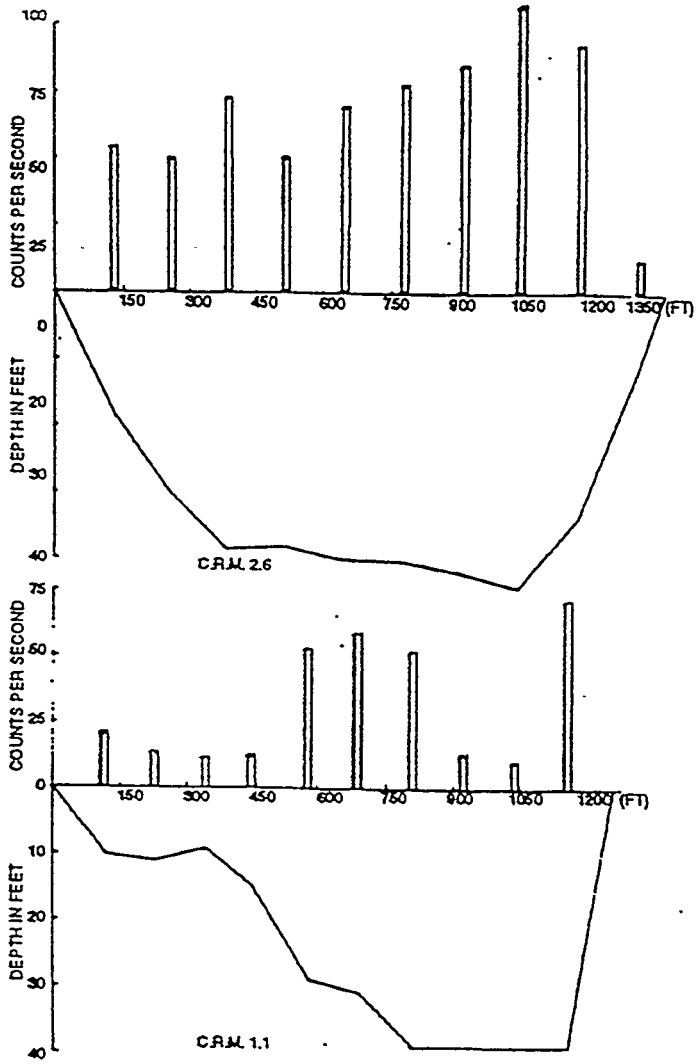


Fig. 3.24. Gamma activity vs. depth profile for selected locations in the Clinch River (Cottrell 1960).

Table 3.3. Estimated radionuclide inventory of the Clinch River below the Oak Ridge Reservation, as of July 1, 1962 (Carrigan 1969)

Location of Subreach		Total identified activity (Ci)		Volume of Radioactive Sediment (acre-feet)	
From CRM	To CRM	In subreach	Cumulative	In subreach	Cumulative
0	2.80	22	22	340	340
2.8	5.9	42	64	380	720
5.9	8.95	54	118	480	1200
8.95	10.95	46	164	430	1630
10.95	12.00	9.3	173	93	1720
12.00	13.05	10	183	85	1810
13.05	15.00	6.8	191	38	1850
15.00	16.75	2.2	193	33	1880
16.75	18.35	4.7	198	39	1920
18.35	19.85	0.1	198	4.7	1920
19.85	20.65	2.3	200	5.9	1930
20.65	20.90	0.1	200	1.4	1930
20.90	21.00	0.2	200	0.3	1930

In general, the distribution of radionuclides in the Clinch River is controlled by the mechanics of sedimentation. The longitudinal distribution among individual radionuclides was similar (Fig. 3.25) and each exhibited the same general pattern (e.g., Fig. 3.26) identified in the gamma surveys (Sect. 3.4.1). Although areas of greater and lesser deposition are evident, there was a general tendency for the thickness of radioactive sediment to increase linearly from CRM 21 to the mouth of the Emory River (Fig. 3.27) (Carrigan 1969). Laterally, radiation levels in sloughs of the Clinch River were not as high as those in sediments of the main channel, and radionuclide levels in areas exposed during winter drawdown were less than in areas that were continuously inundated.

Carrigan and Pickering (1967) found that peak concentrations of gamma activity (almost entirely from ^{137}Cs) in core samples occurred at depth; the greater the sediment accumulation rate in an area, the greater the depth of the ^{137}Cs peak in the core (Fig 3.28). The ^{137}Cs profile in a core was found to correlate with the release history from ORNL (Fig. 3.29).

Pickering (1969) found that, in general, radioactive bottom sediment in the Clinch River could be classed as clayey silt, composed of approximately 35% mica and other clays and 65% quartz. The potential for desorption of radionuclides was investigated using contaminated sediments from WOC

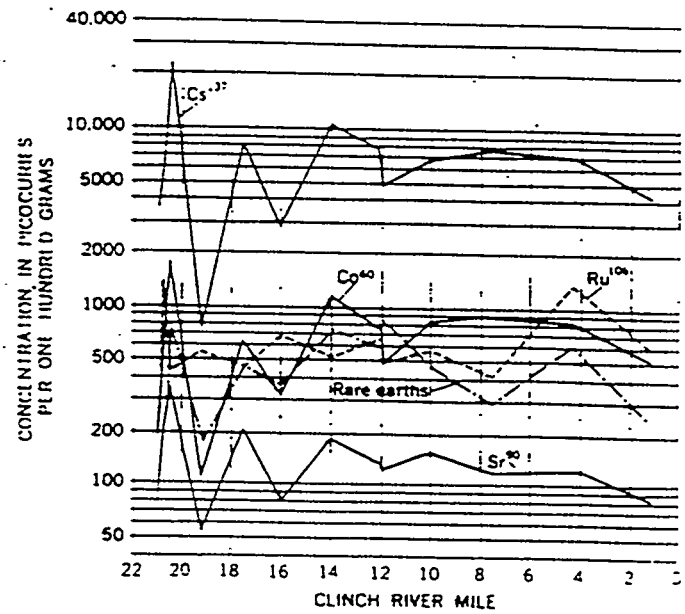


Fig. 3.25. Longitudinal distribution of radionuclides in the Clinch River downstream of the Oak Ridge Reservation (from Carrigan 1969).

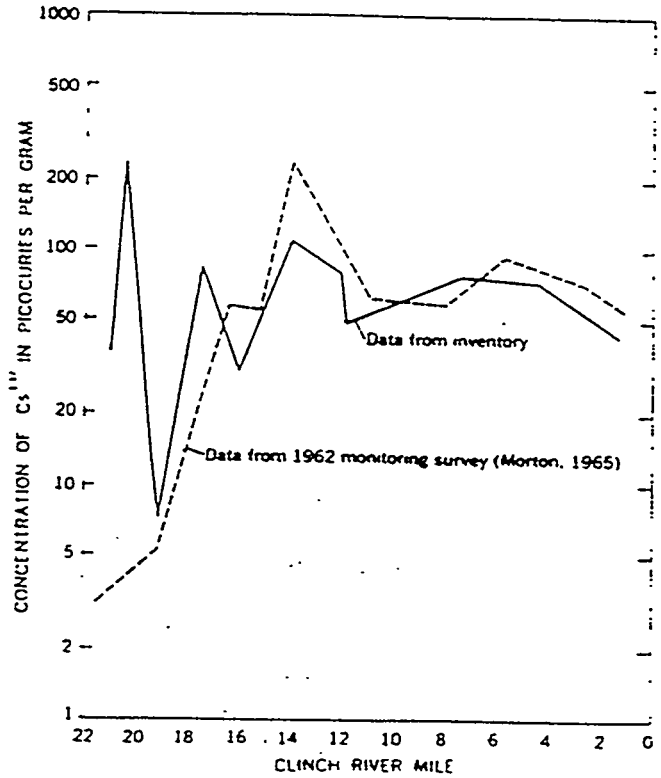


Fig. 3.26. Comparison of the longitudinal distribution of ^{137}Cs with gross gamma activity in the Clinch River downstream of the Oak Rdige Reservation (from Carrigan 1969).

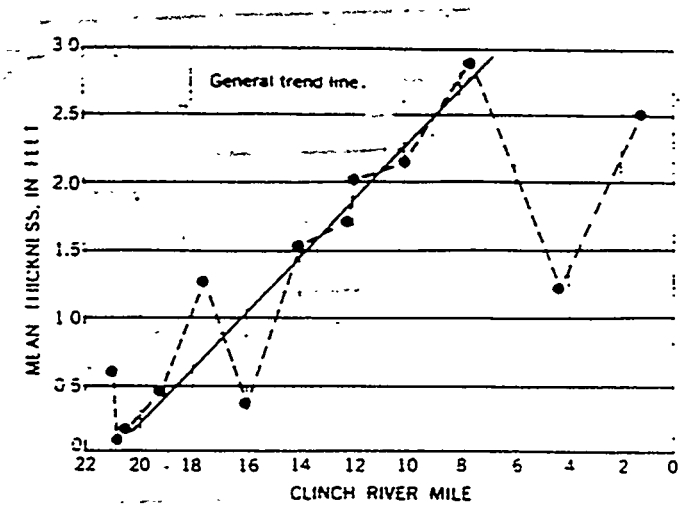


Fig. 3.27. The thickness of radioactive sediment in the Clinch River was found to increase between the mouth of White Oak Creek and CRM 8, after which it declined sharply (from Carrigan 1969).

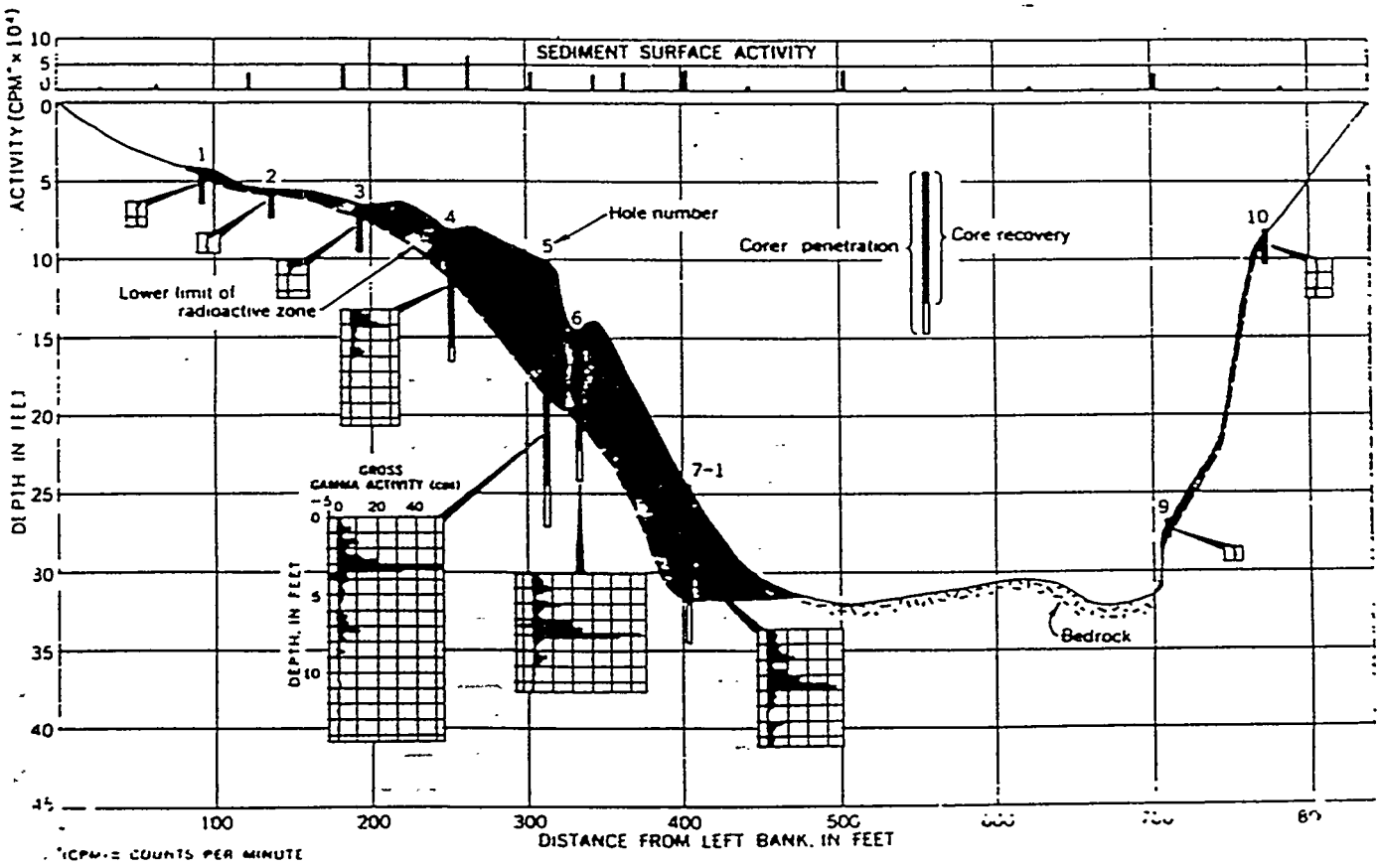


Fig. 3.28. Cross section of the Clinch River at Mile 7.5, showing lateral distribution of sediment and vertical distribution of gross gamma activity (from Carrigan and Pickering 1967).

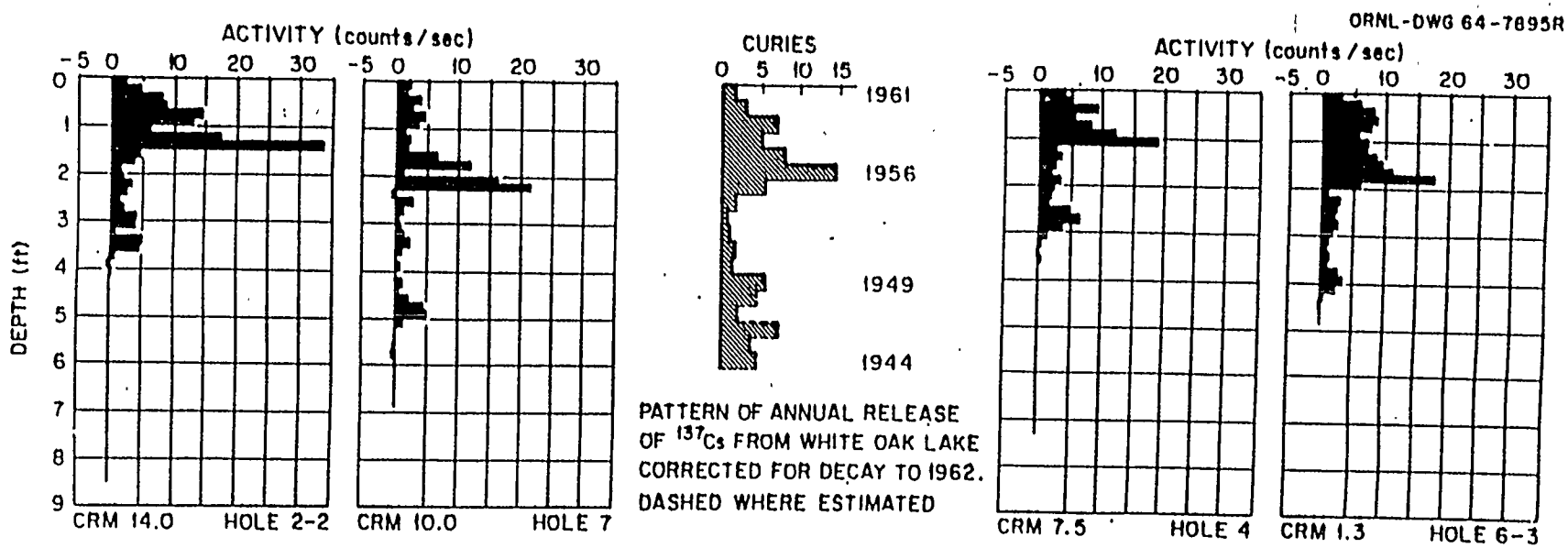


Fig. 3.29. Comparison of patterns of variation with depth of gross gamma radioactivity in four bottom sediment cores to variations in annual releases of ^{137}Cs to Clinch River (Carrigan and Pickering 1967).

(Morton et al. 1965). Only ^{90}Sr was found to be held by simple ion exchange and easily removed by circumneutral salt solutions. Strongly acidic solutions desorbed 80–90% of the ^{90}Sr and 65–80% of the ^{60}Co, while strongly alkaline solutions were more effective in desorbing ^{106}Ru. Regardless of treatment, less than 6% of the ^{137}Cs was desorbed, indicating a strong affinity for particles. This affinity is greatest for certain clay minerals.

3.4.2.3 1977 Clinch River sediment survey

Sediments in the vicinity of the proposed Clinch River Breeder Reactor site (CRM 20.8) were sampled in 1977 to determine the fate and distribution of radionuclides in the Clinch River (Oakes et al. 1982). Specific objectives were to analyze selected cores for transuranic radionuclide activity (previous studies had not reported alpha emitters) and to examine the effect of the altered flow regime, resulting from operations at Melton Hill Dam, on the distribution of fission products in the sediment. A total of 250 cores were collected along the length of the Clinch River, from the mouth of WOC to the confluence with the Tennessee River; cores were also collected from the Tennessee River above and below the mouth of the Clinch River. An attempt was made to purposely sample areas of elevated gamma activity by first identifying those areas through use of the flounder. However, subsequent analysis of the cores revealed that the flounder had been more strongly influenced by background radiation than by radionuclides discharged from ORNL. An additional limitation affecting the representativeness of this sampling effort was that the sampling device could only be used effectively in water depths of 15 ft or less. This restriction limited sampling to the extreme near-shore environment and overbank areas.

The investigators attempted to duplicate the methodologies used in the Clinch River Study for sample core analysis (automated scanning of the core profile to locate areas within the core that were emitting high levels of gamma rays). However, the approach failed because the core profiles were now different from those collected in the early 1960s. The decay of high specific-activity ^{106}Ru since that time resulted in gamma levels that were too low to make the approach successful. As an alternative, a cork-borer was used to extract 1-in.-diameter cores from the sample core at intervals (of 1, 3, 5, 7, 9, 11, 13, 16, 20, 24, 30, 36, 40, and 45 in.) from the top of the core for spectroscopic analysis of ^{137}Cs and ^{60}Co. Radiochemical analysis for ^{90}Sr and transuranic radionuclides were made of subsamples taken from the top, middle, and bottom of about half of the cores (Oakes et al. 1982).

The report of Oakes et al. (1982) is a data summary report, and as such, it offers only limited discussion and interpretation of the data. As in the Clinch River Study, however, peak concentrations of radionuclides were found to occur at varying depths within cores. Peak concentrations recorded in the study are presented in Table 3.4.

Table 3.4. Maximum concentrations of radionuclides reported in the 1977 Clinch River Sediment Survey (data from Oakes et al. 1982)

Radionuclide	Maximum Concentration	Location	Depth in Core
^{137}Cs	606 pCi/g	CRM 14.25	28 cm
^{60}Co	12.2 pCi/g	CRM 14.25	28 cm
^{90}Sr	11.7 pCi/g	CRM 14.25	31 cm
$^{238,239}Pu$	6.5 pCi/g	CRM 14.0	23 cm

3.4.2.4 Environmental fate of mercury and ^{137}Cs discharged from ORR facilities

Turner et al. (1984) collected sediment cores from the Clinch and Tennessee rivers in 1983 to independently confirm the release histories of mercury from the ORR facilities and to discover the fate of mercury discharged into area streams. Sediment cores were collected at CRM 6.8 and 1.0 and in the Tennessee River in both Watts Bar and Chickamauga reservoirs. Sample collection was intentionally biased for areas of stable sediment deposition. All cores were sectioned into 1-, 2-, 3-, or 5-cm intervals for analysis. The core from CRM 1.0 was analyzed for total mercury, gamma emitters, total uranium and selected metals. The core from CRM 6.8 was analyzed for total mercury only.

The results are illustrated in Fig. 3.30. The strong correlation between mercury and ^{137}Cs concentrations was observed throughout WBR, where peak concentrations were typically located 60 cm or more below the core surface. The peak uranium concentration in the CRM 1.0 core (7.8 mg/kg) also coincided with the mercury and ^{137}Cs peaks.

The authors concluded that the peak releases of mercury and ^{137}Cs from ORR facilities in the 1950s are reflected in well-defined peak concentrations in the sediment cores and that they provide an accurate method of dating sediment layers. The authors postulated that dredging and extreme water-level drawdown were the only likely activities that could resuspend the buried contaminants and bring them into contact with the biosphere (Turner et al. 1984).

3.4.2.5 TVA Instream Contaminant Study

TVA conducted the Instream Contaminant Study for the Oak Ridge Task Force, a multiagency body investigating the mercury releases from the Y-12 Plant (TVA 1986).

Eight fine-particle surface sediment samples (the upper 10–15 cm of sediment) were collected from four locations in the Clinch River arm of WBR (CRM 3.7, 10.0, 15.6, and 18.3). A total of four reference samples were collected from locations in Melton Hill (CRM 24.0) and Norris reservoirs (CRM 85.3 and 94.1 and Powell River Mile 6.0). All samples were analyzed for radiological contaminants, base/neutral organic priority pollutants, priority pollutant metals, cyanide, phenols, and PCBs (TVA 1985a).

None of the 53 organic contaminants for which analyses were conducted was detected in any of the Clinch River surface sediment samples. Total phenols were detected at levels (6 μg/kg) comparable to those at the Norris and Melton Hill reservoirs reference areas (5 μg/kg). Results of the metals analyses are presented in Table B1. Values for selected radionuclides are presented in Table B2.

In addition, cores from eight locations in the Clinch River downstream of Melton Hill Dam were collected and analyzed for mercury; limited radiological analyses were also performed. Five of these cores were collected on Jones and Grubb islands rather than from instream locations, and all contained less than detectable levels of mercury (<0.1 mg/kg). The core samples were analyzed in two groups based on sediment particle size fraction: (1) the fine sands and smaller fraction (containing particles < 500μ m) and (2) the silt and clay fraction only (containing particles <62μm). Fine sands, silts, and clays collectively accounted for 90% or more of the sample volume at all sites (TVA 1985a). The Clinch River core data for mercury are presented in Fig. 3.31.

The study concluded that (1) concentrations of mercury in sediment of both the Clinch and Tennessee rivers were elevated and (2) an estimated 500 lbs of mercury were being transported each year out of EFPC to downstream environments.

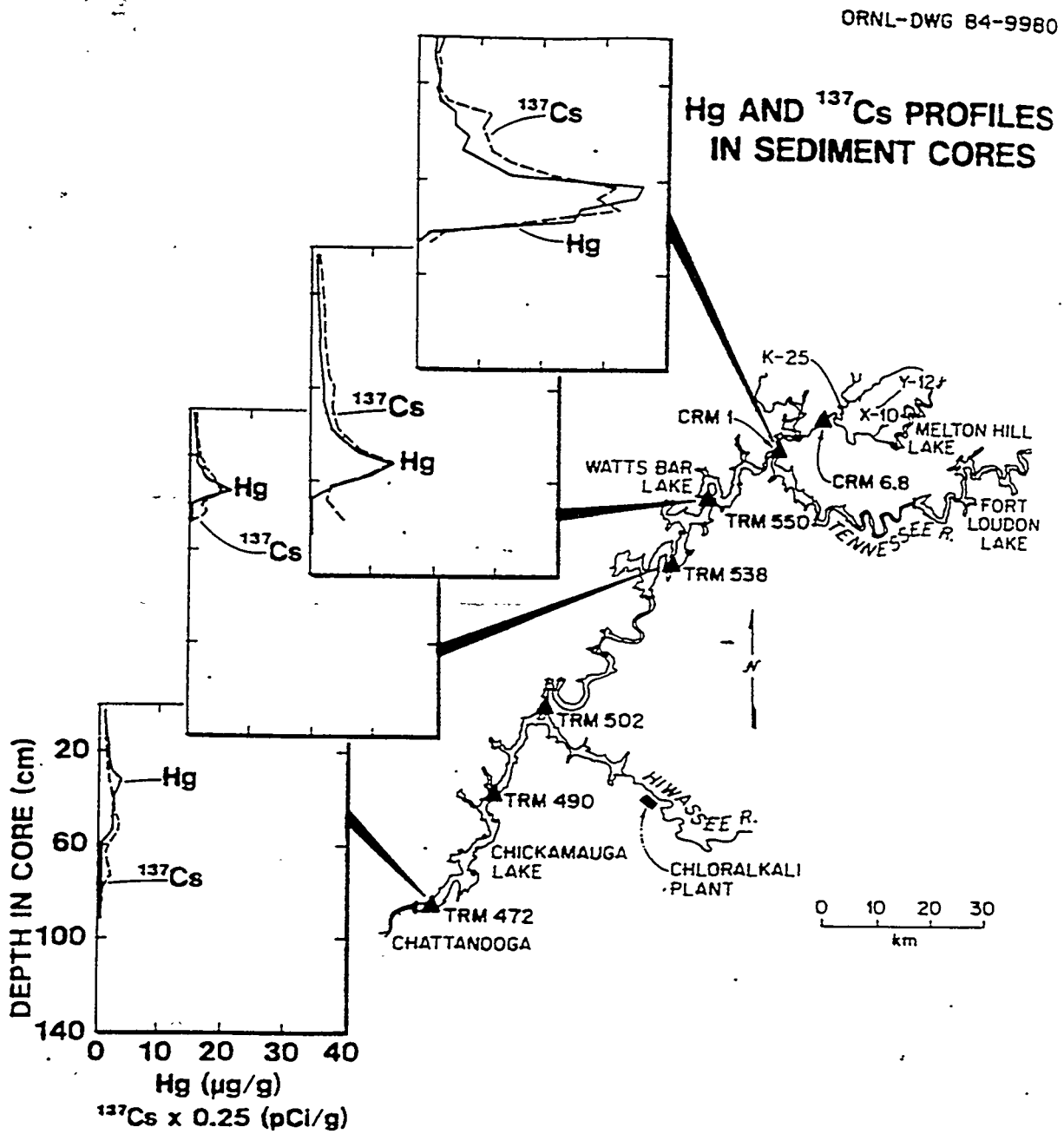


Fig. 3.30. The vertical distributions of mercury and ^{137}Cs in selected sediment cores obtained from Watts Bar and Chickamauga reservoirs (Turner et al. 1984).

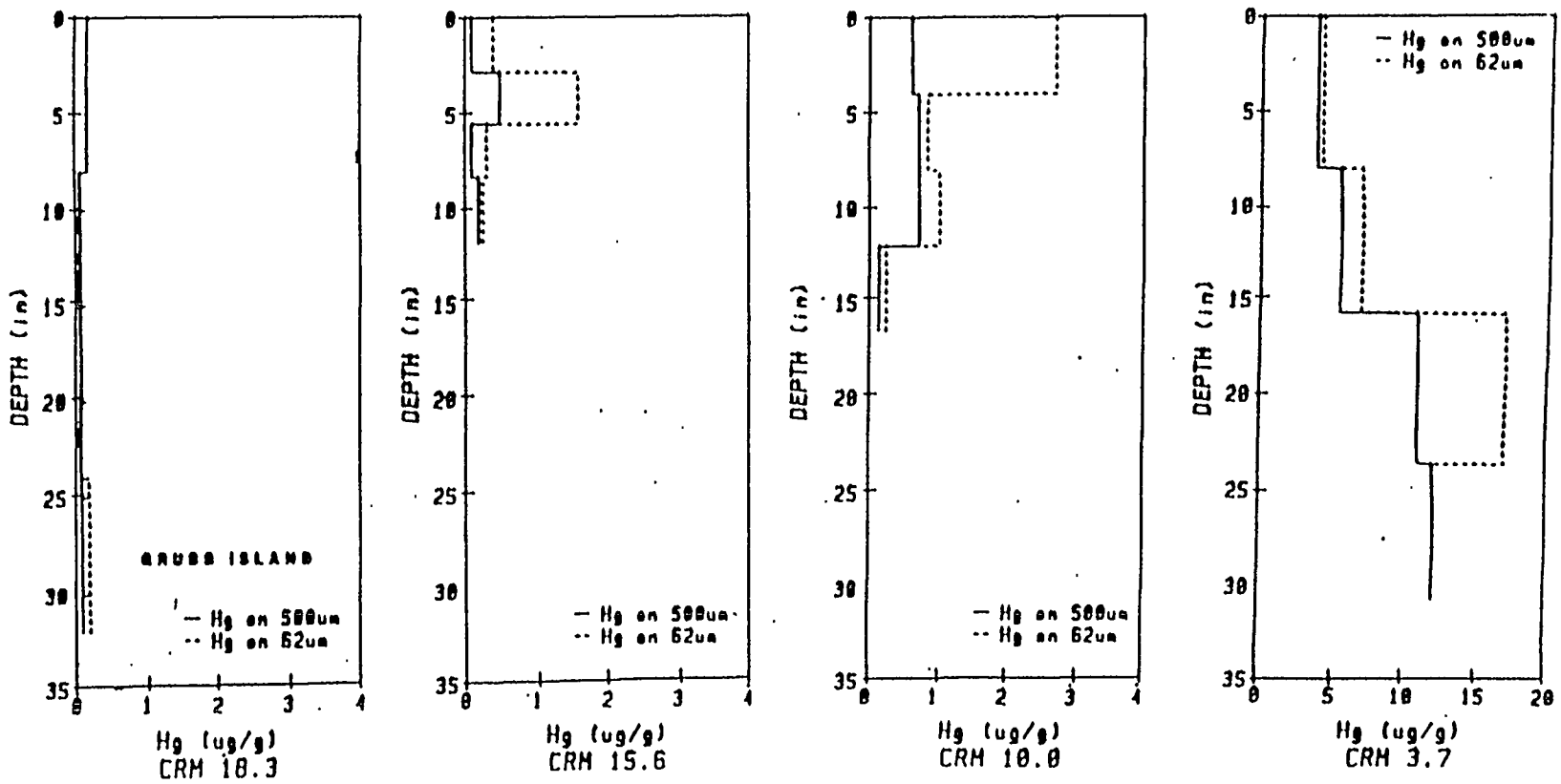


Fig. 3.31. Mercury concentrations vs. depth and particle size for Clinch River core sampling (TVA 1985a).

3.4.2.6 ORGDP sediment survey

Ashwood et al. (1986) collected approximately 180 surface sediment samples from streams around the K-25 Site. Samples were collected from the Clinch River, Poplar Creek, and tributaries draining the ORR. Samples were anlayzed for radionuclides, metals, and organic contaminants. In addition, three core samples were collected, including one from the Clinch River near Kingston. The purpose of the study was to identify sites from which pollutants originating at K-25 had historically entered or were currently entering the surface water. Samples were collected in January and February 1985. The study focused on contaminants identified by Hoffman et al. (1984), based on data from the TVA Instream Contaminants Study (TVA 1986), as warranting further study on the ORR.

Because the objective of the study was to determine areas of high concentration relative to K-25 values, not relative to background, data are presented as contaminant levels for areas that exceed 150% of the K-25 mean. It was concluded that the Clinch River samples contained elevated levels of Se (up to 130 μg/g; K-25 mean = 91 mg/kg), ^{137}Cs (up to 14.9 pCi/g; K-25 mean = 2 pCi/g), ^{60}Co (up to 1.34 pCi/g; K-25 mean < 1 pCi/g), and ^{238}U (up to 5.5 pCi/g; K-25 mean = 30 pCi/g) relative to K-25 mean values (i.e., the source of these contaminants would be other than the K-25 Site). Core data indicate below-surface peaks of ^{137}Cs, Hg, ^{238}U, and several metals in the Clinch River sample. This core also contained trace quantities of polycyclic aromatic hydrocarbons (PAHs) and phthalates; PCBs were not detected in any core segment (Ashwood et al. 1986).

3.4.2.7 TVA recreation area and water intake sampling

The overall scope and purpose of this sampling are described in Sect. 3.3.1. Sediment samples were analyzed for radionuclides, metals, and organic compounds. Sediment sampling at the beach sites consisted of collecting five 12-in. cores from each site which were composited for analysis. Volatile organic analyses were conducted on three cores from each beach site without compositing. Sediment sampling at the intake locations consisted of a single core sample from each site (TVA 1991). Results of the sediment analyses are presented in Table B3.

No radionuclides other than ^{137}Cs were detected at any location during the study. Mercury levels downstream of Poplar Creek were elevated above maximum reference concentrations (Table B3). No other metals were found at levels that exceeded upstream reference values. No organic compounds other than PAHs and phthalates were detected in any Clinch River samples; these compounds were generally present at reference sites at comparable levels.

3.4.2.8 Clinch River Remedial Investigation—Phase 1

The purpose and scope of Phase 1 of the CRRI are discussed in Sect 3.3.1. Sediment cores were collected at nine locations in the CR/PC OU (Fig. 3.34). Cores were sectioned vertically into 6-cm increments (upper 18 cm of core only) and 4-cm increments (remaining length of core). Each core segment was analyzed for inorganic and organic contaminants and radionuclides. Cook et al. (1992) summarize the Phase 1 data. Results indicated that elevated levels of As, Be, Cd, Cr, Cu, and Hg were present in Poplar Creek and in the Clinch River immediately downstream of the mouth of Poplar Creek. Organic compounds were detected infrequently in sediment, consisting primarily of PAHs and phthalates at low concentrations. Most alpha-emitting radionuclides were present at or near background concentrations at all sites, but concentrations of ^{234}U, ^{238}U and ^{235}U were elevated in Poplar Creek. Gamma-emitting radionuclides exhibited expected spatial patterns, generally found at background levels above WOC (the exception being ^{60}Co in Melton Hill Reservoir below Braden Branch, a known source

of ^{60}Co) and elevated below WOC. Peak mean concentrations of ^{137}Cs (63.64 pCi/g) were found downstream at CRM 9.5, the first significant sediment accumulation zone sampled downstream of WOC.

During the Phase 2 sampling and analysis, high concentrations of ^{137}Cs (> 40,000 pCi/g dry wt) were found in surface sediment of WOC Embayment (Blaylock et al. 1992). These sediments were typically exposed as mudflats during periods of low flow in the Clinch River. An action was immediately initiated to prevent erosion of these sediments into the Clinch and to prevent direct exposure to sediment during periods of low flow. By the end of April 1992, a coffer dam was constructed across the mouth of WOC. This dam was designed to minimize the constant washing effect of water level fluctuations resulting from reservoir operations at Melton Hill Dam and to keep the sediment in the embayment inundated.

The data from CRRI Phase 1 are combined with the CRRI Phase 2 data to aid in characterizing the nature and extent of contamination in the CR/PC OU.

3.4.2.9 Near-shore surface sediment characterization

Concentrations of ^{137}Cs and ^{60}Co in near-shore surface sediments of the Clinch River, Poplar Creek, Tennessee River of WBR, and upstream reference locations were evaluated as part of the CRRI. The near-shore area, where potential human exposure to contaminants is highest, had not been an area of focus in earlier contaminant studies. Between 1991 and 1994, 926 surface sediment samples, 300 from the Clinch River arm of WBR, were collected for analysis. Results are summarized by Levine et al. (1994).

The spatial patterns of contaminant accumulation are depicted in Figs. 3.32 and 3.33. In general, mean near-shore surface sediment concentrations are greatest in reach 4, 7 to 22 miles downstream of the mouth of WOC. The slightly lower concentrations immediately below WOC (reach 2) are attributed to less sediment accumulation in this reach. The variability in mean concentrations observed throughout the Clinch River is thought to be a function of equally variable sediment deposition. As expected, concentrations declined sharply at the mouth of the Clinch River due to dilution by clean sediment from the Tennessee River. Concentrations of ^{137}Cs and ^{60}Co in the Emory and Tennessee rivers near their confluences with the Clinch River suggest some contamination due to reverse flows in the system. Reference concentrations were at background, except for the expected increase in ^{60}Co downstream of Braden Branch.

Data from the near-shore surface sediment characterization task are used in Sect. 3.4.3 of this report to assist in the characterization of contaminants in surface sediment and in the ecological (Chap. 6) and human health (Chap. 5) baseline risk assessments included in this report.

3.4.2.10 Summary of historical studies

The early sediment studies focused on radionuclides, identifying several areas in the Clinch River where sediment deposition, and, therefore, sediment-associated contaminant accumulation, was greatest. Subsequent studies have demonstrated that since the period of peak releases, many of these radionuclides have decayed, been transported down river, or have been buried under layers of cleaner sediment.

Mercury is known to be present at elevated concentrations in Poplar Creek and in the Clinch River below the mouth of Poplar Creek. Because of their concurrent release histories, peak mercury concentrations are coincident with peak ^{137}Cs concentrations in sediment profiles collected downstream of Poplar Creek. The distribution of other metals in Clinch River and Poplar Creek sediments is not well

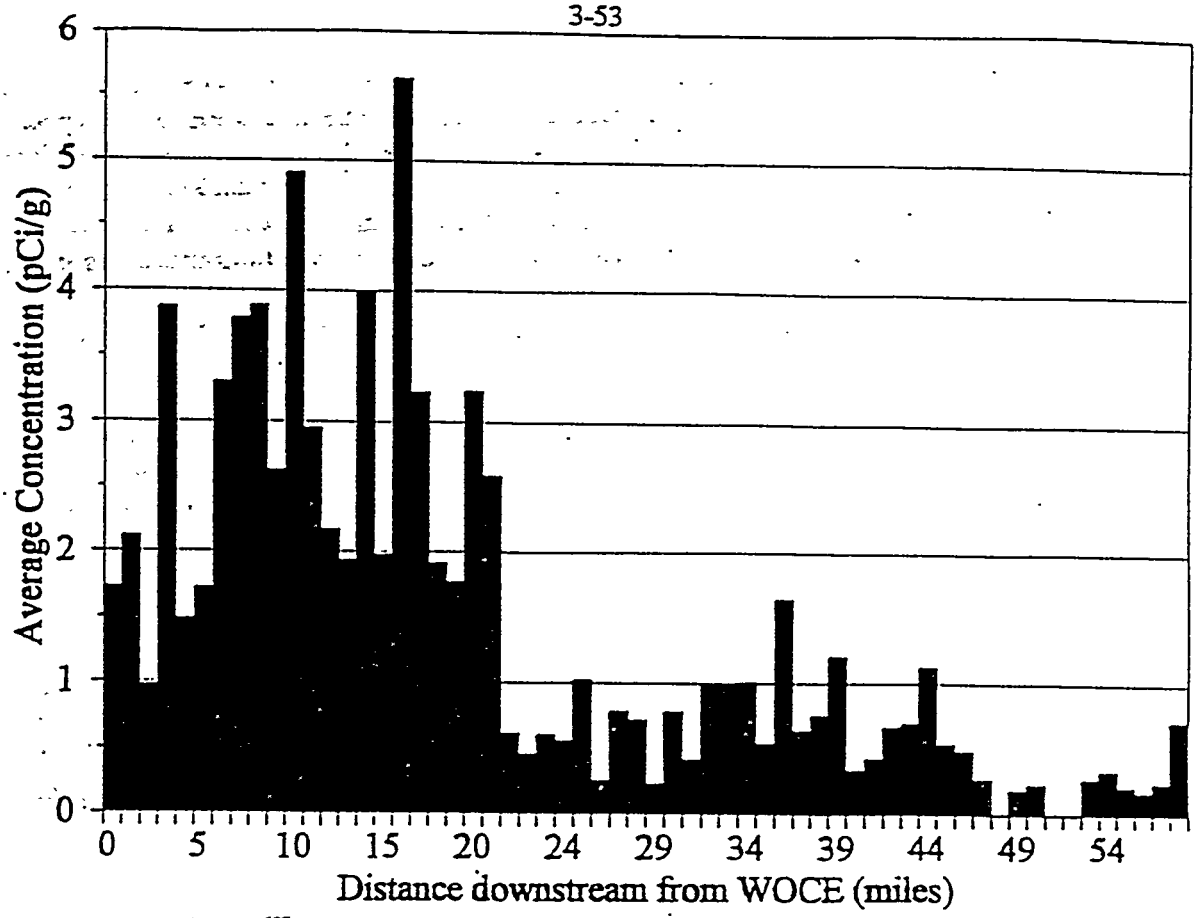


Fig. 3.32. Mean ^{137}Cs concentrations relative to distance downstream from White Oak Creek Embayment.

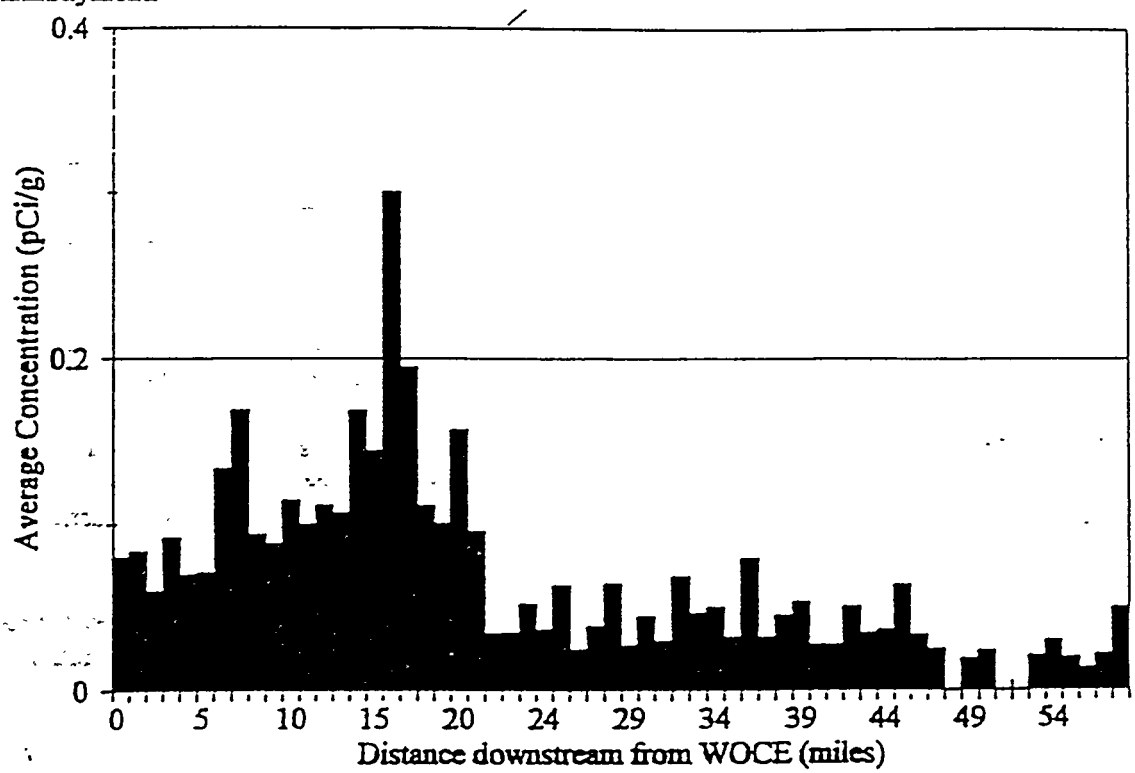


Fig. 3.33. Mean ^{60}Co concentrations relative to distance downstream from White Oak Creek Embayment.

characterized, but concentrations would be expected to be highest in areas of sediment deposition, as with the contaminants above. The areas of greatest potential for contaminant accumulation appear to be depositional areas immediately downstream of Grassy Creek (CRM 14.5), downstream of Poplar Creek (between CRM 8 and CRM 11), and near CRM 4.5 and CRM 0.5. Although limited in scope, historical data on organic pollutants in sediment indicate low levels of a relatively few compounds, most of which are ubiquitous in sediments near or downstream of urban or industrial areas (phthalate esters and PAHs).

3.4.3 Clinch River Remedial Investigation—Phase 2 Characterization of Sediments

Phase 2 of the CRRI included several sediment characterization tasks: spatial characterization of contaminantion in the Clinch River and Poplar Creek, characterization of sediment toxicity to benthic organisms, and sediment and contaminant transport modeling. Characterization focused on areas of sediment deposition, primarily downstream of Melton Hill Dam. These areas were indicated by the release histories and historical data as being the areas of greatest potential concern.

3.4.3.1 Characterization of contaminants in sediment and pore water

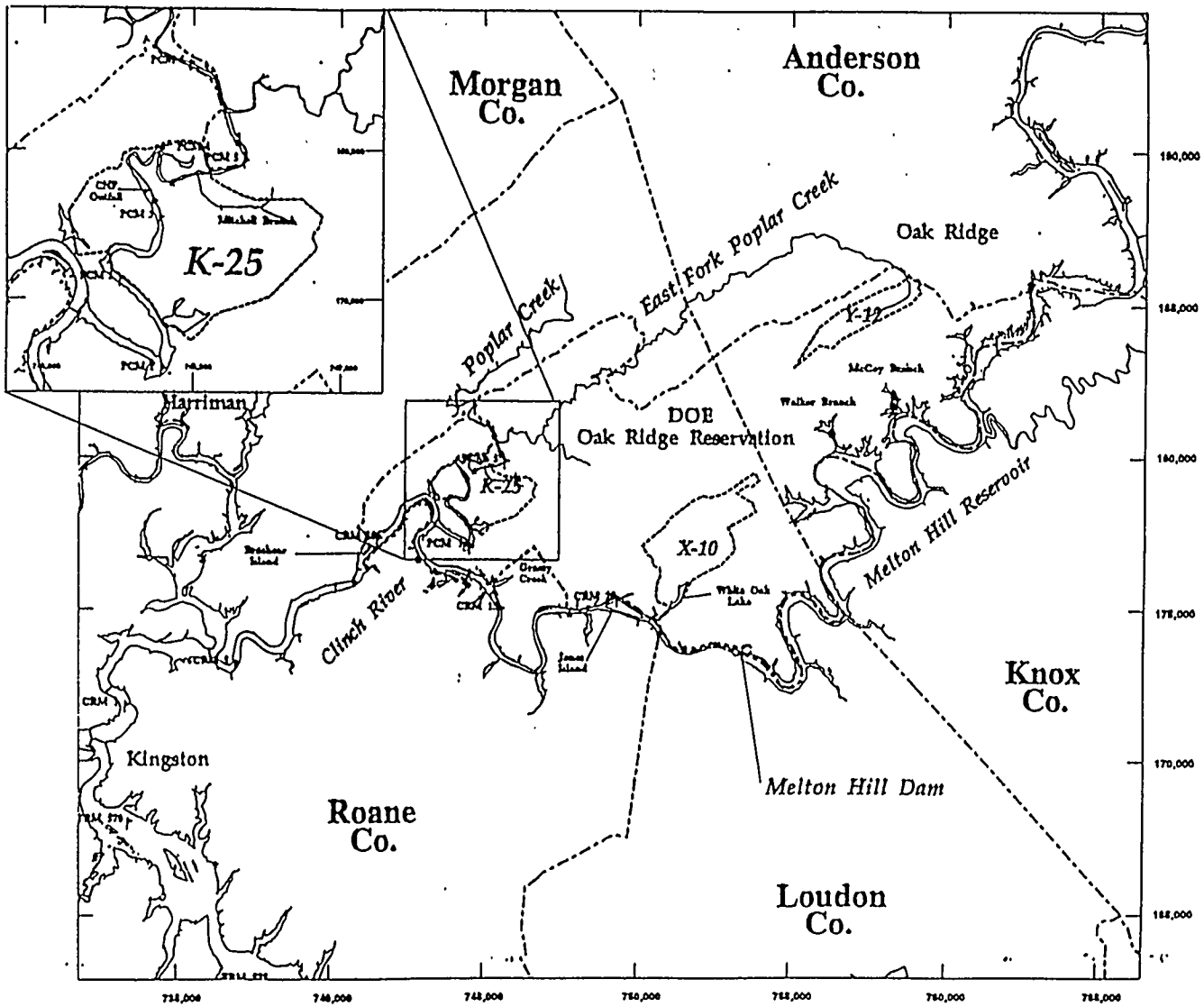
Data were collected regarding contaminant concentrations in surface sediment, in sediment cores, and in sediment pore water. These data are used in Chaps. 5 and 6 to characterize risk to human and ecological receptors. The following discussion attempts to identify meaningful spatial patterns of contamination in these media and interpret these patterns both in relation to known or suspected contaminant sources and to the dynamics of the river system.

Sample locations are illustrated in Fig. 3.34. Sample collection methods are described in Table B4. Sample sizes for each reach and subreach are tabulated in Table B5. Data for surface sediment, core samples, and pore water are summarized in Tables B6–B11 (inorganics), B12–B15 (organics), and B16–B21 (radionuclides).

Data regarding several noncontaminant-related sediment parameters important in characterizing ecological health were collected for use in the ecological baseline risk assessment (Chap. 6). Whole sediment parameters measured included particle size, total organic carbon content (TOC), pH, and total Kjeldahl nitrogen (TKN). Pore water analysis included TOC, TKN, ammonia nitrogen, and total hardness. As expected, most surface sediment consisted of fine material, although spatial variability was high. Results for the other parameters are illustrated in Fig. 3.35.

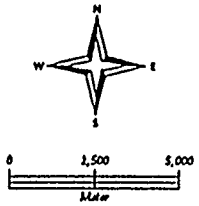
To identify trends in contamination, mean contaminant concentrations in a study reach or subreach are compared to those from the appropriate reference reach and upstream study reaches. Discussion focuses on contaminants that are elevated above reference values in at least two of the three sediment media sampled. For this analyses, "elevated" means the concentrations that are statistically elevated (at the 0.05 level) as measured by one-way ANOVA and subsequent pairwise comparisons. In addition, the concentrations that are elevated by a factor of two or more as compared to reference or upstream values, even though not statistically significant, are considered elevated for the purpose of this discussion.

In this discussion, elevated surface contaminant values are considered evidence of recent deposition and, therefore, some upstream source of contamination. Elevated contaminant concentrations in core samples generally indicate areas of stable sediment deposition and (where surface sediment values are low) are considered indicative of historical contamination. Sediment pore water values are influenced by complex physical and chemical factors in the sediment, pore water, and surface water; the solubility of the analyte itself; and the amount of contaminant present in surface sediment available for release to pore



Clinch River Environmental Restoration Program

Sampling Locations for Sediment Toxicity Task



LEGEND

- Sample Location
- River Mile Marker
- DOE Boundary
- Plant Boundary
- County Boundary

Tennessee State Plane Coordinate System, NAD 83

Source: Lake boundary provided by TVA
Sample locations provided by Environmental Science Division

Prepared by Clinch River Environmental Restoration Program

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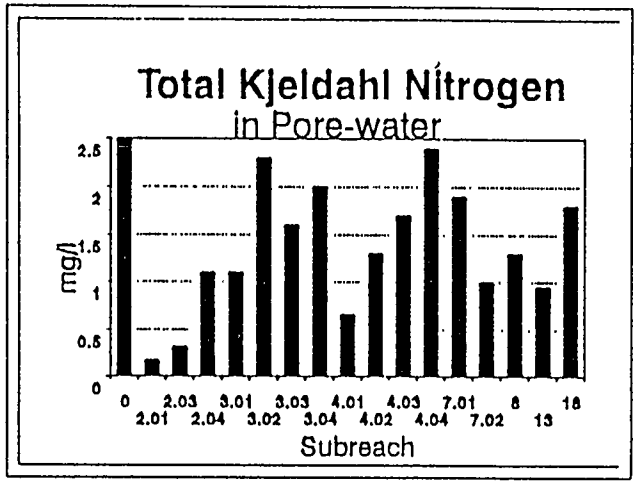
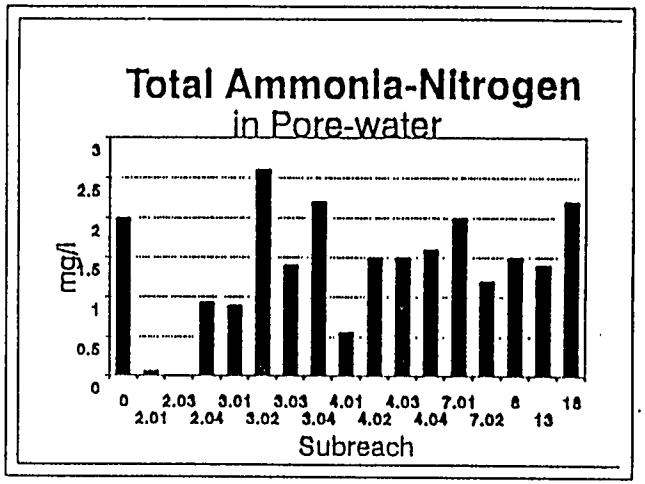
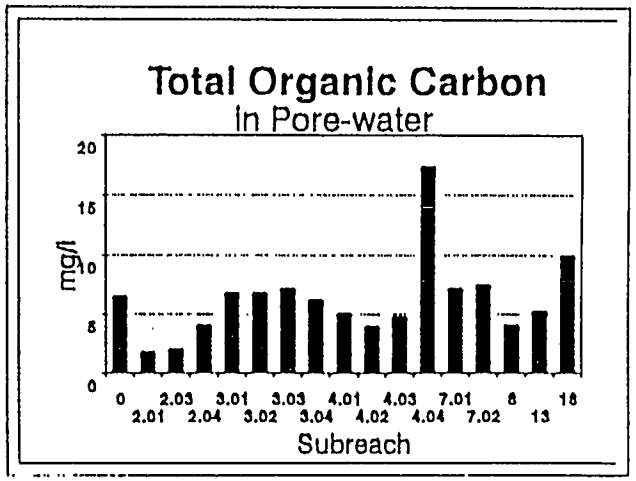






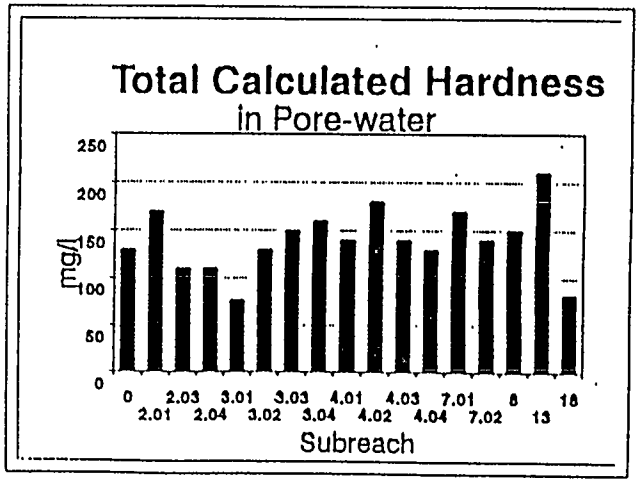
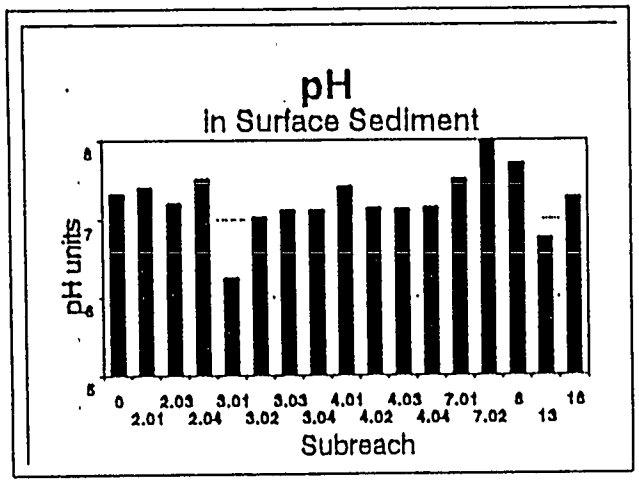
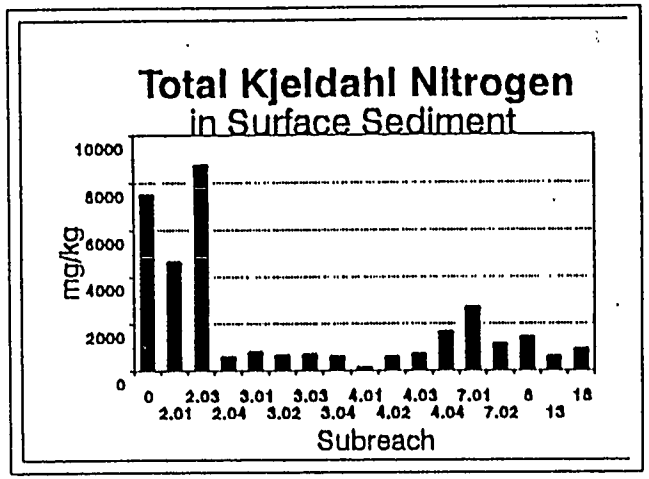


Fig. 3.35. Mean concentrations of selected noncontaminant parameters relevant to ecological health of benthic communities.





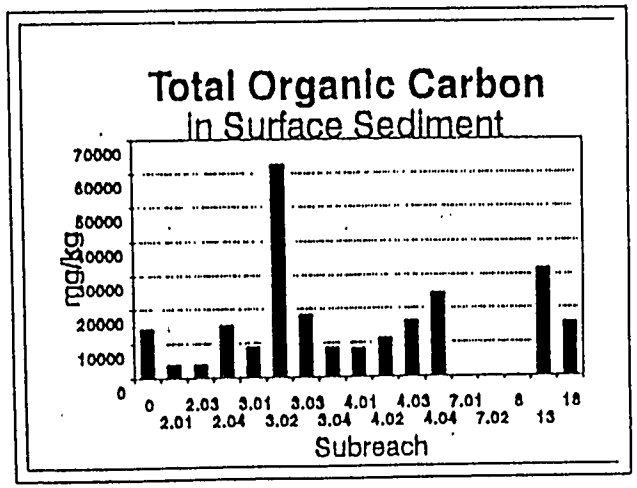


Fig. 3.35 (continued)

water. Pore water concentrations often do not correlate with surface sediment values from the same location.

Mean concentrations of contaminants in surface sediment, core samples, and pore water, by subreach, are illustrated in Figs. 3.36–3.38 (inorganics), 3.39–3.40 (organics) and 3.41–3.43 (radionuclides).

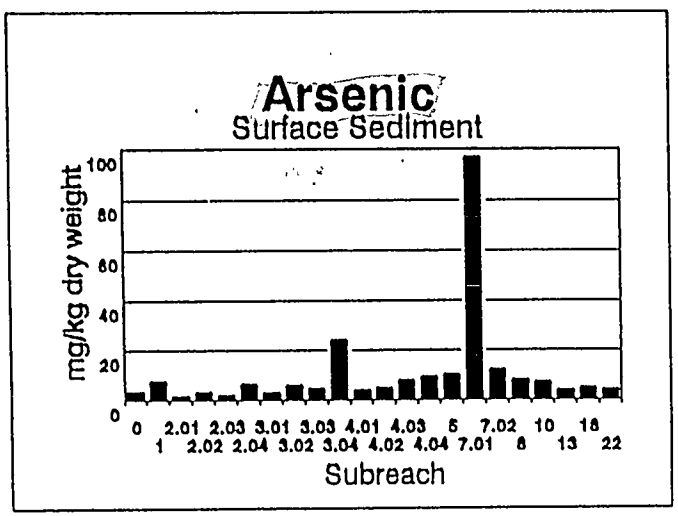
Poplar Creek.

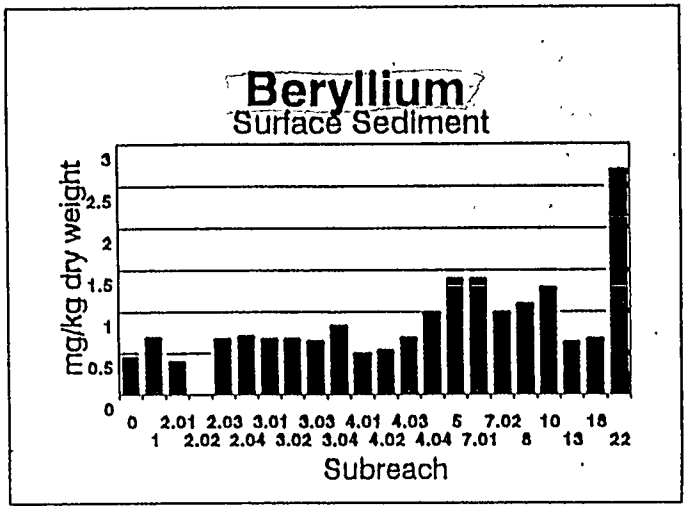
Subreach 3.01—Below EFPC. Interpretation of data in this subreach is limited by sample size (n=2), but mean concentrations of mercury, cadmium, chromium, and copper are elevated above reference values (reach 13) in at least two sediment media downstream of EFPC (Figs. 3.36–3.38). As noted in Sect. 3.1, EFPC is a known source of mercury to Poplar Creek. Ashwood et al. (1986) also identified EFPC as a potential source of each of the metals above. However, none of these analytes exhibits its peak core or surface sediment concentrations in subreach 3.01, probably due to a relative lack of long-term, large-scale sediment deposition in this subreach. Peak pore water concentrations of mercury, methyl mercury, and copper (as well as several other metals) were observed in this subreach (Fig. 3.38).

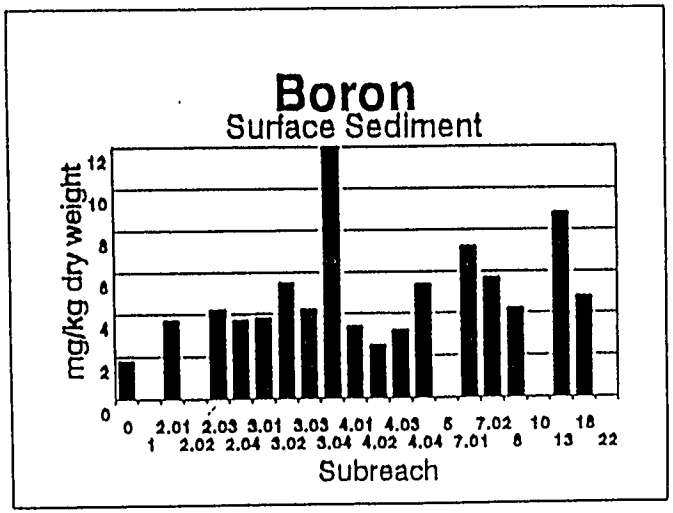
Subreach 3.02—Below Mitchell Branch. Mean concentrations of mercury, cadmium, copper, and chromium remain elevated over reference values and are generally increased over values in subreach 3.01, probably partly a result of increased sediment deposition (Figs. 3.36–3.38). However, concentrations of chromium and copper in surface sediment peak here, are significantly elevated over subreach 3.01, and likely indicate a significant source of these analytes from Mitchell Branch. Analytes that are significantly elevated in two or more sediment media for the first time are nickel, silver, several isotopes of uranium, ^{99}Tc, and benzo(b)fluoranthene, indicating sources of these contaminants in Mitchell Branch as well. Aroclor-1254 is also elevated in this subreach for the first time, but the samples in which this PCB mixture was found appear to be associated with a source other than Mitchell Branch. Each of the analytes above, except benzo(b)fluoranthene and silver, exhibits peak core and surface sediment values in this subreach; silver exhibits mean surface sediment concentrations here. The sediment of Mitchell Branch has previously been identified as containing elevated concentrations of Ni (Fig. 3.44) Cr, Cu, Ag, Zn, U isotopes (Fig. 3.45), and ^{99}Tc (Ashwood et al. 1986).

Subreach 3.03—Below CNF. Mean concentrations of each analyte above remain elevated in at least two sediment media in subreach 3.03. Peak values of Hg, Ag, Cd, and Cr in core samples occur here (Fig. 3.37). Concentrations of nickel, copper, and benzo-(b)fluoranthene remain elevated in core samples (Fig. 3.37) but drop significantly in surface sediments (Fig. 3.38). Levels of Arochlor-1254, isotopes of U, and ^{99}Tc decline in both core and surface sediment samples. The organic compound 4-methylphenol is elevated in both surface and core sediment samples for the first time in this reach.

Subreach 3.04—Below fly ash disposal area. Mean concentrations of Hg, Ag, Cr, Cu, Cd, 4-methylphenol, PCB-1254, U, and ^{99}Tc remain elevated in both surface and core sediment samples relative to reference values; nickel and copper remain elevated in core samples. Most of these analytes, however, have decreased from peak upstream concentrations. Notable exceptions are total and methyl mercury; peak surface sediment concentrations are found in this subreach. Peak surface sediment and core values for As, B, and V occur here (Figs. 3.36–3.37) and are significantly elevated in both media for the first time. Increased core values are attributed to the historical disposal of fly ash in Poplar Creek (Sect. 3.1). Surface sediment concentrations of B and V, while elevated relative to subreach 3.03, are also relatively high in the reference reach. Cesium-137 and ^{60}Co are also elevated in core and surface sediment in subreach 3.04, most likely the result of backflow from the Clinch River or the discharge of cooling water drawn from the Clinch River and released to Poplar Creek from the K-1770 steam plant.







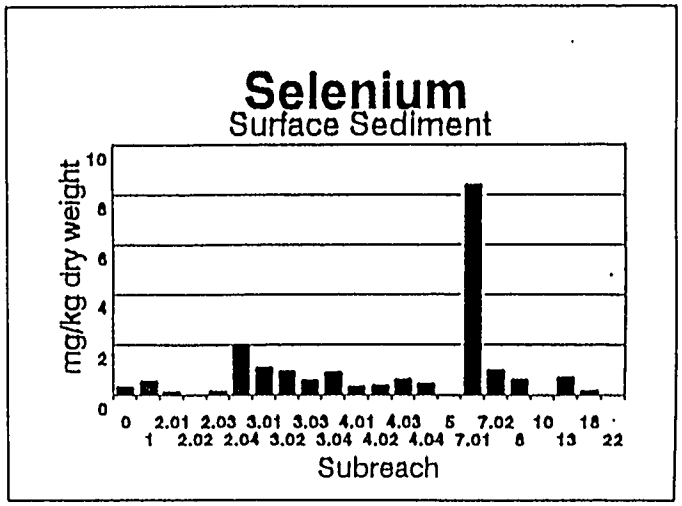
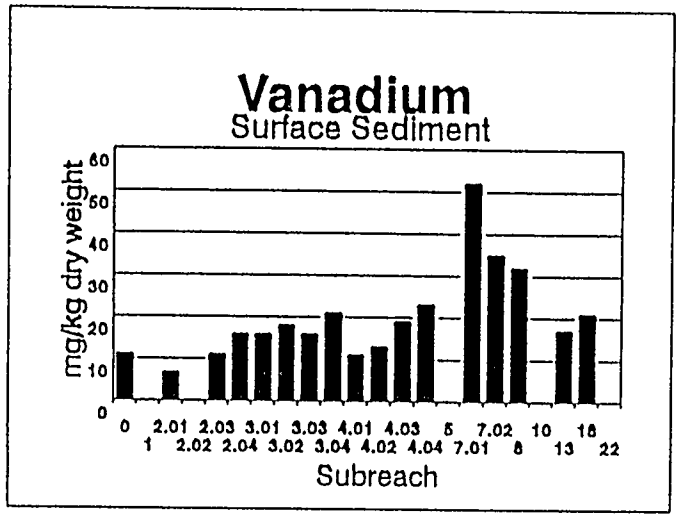
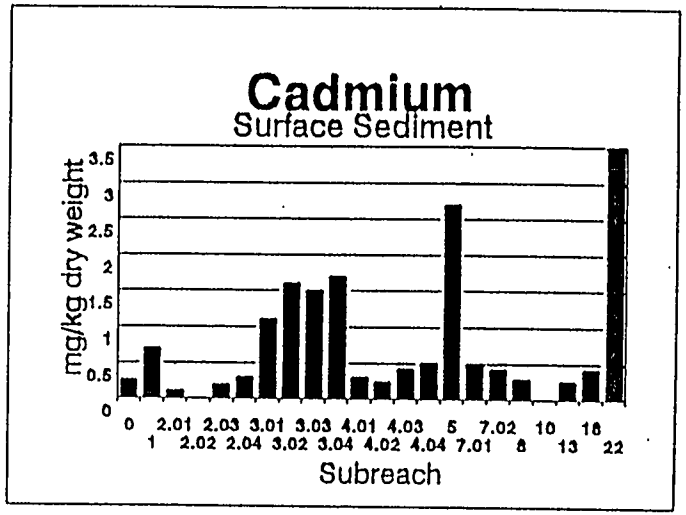
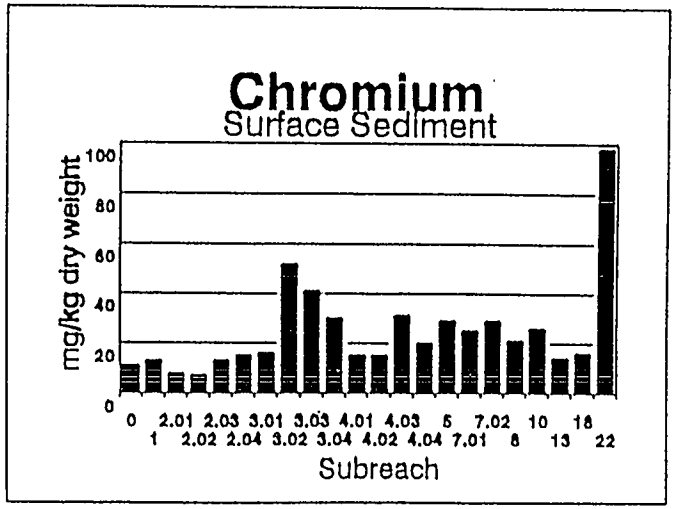


Fig. 3.36. Surface sediment mean concentrations for subreaches of inorganic contaminants.







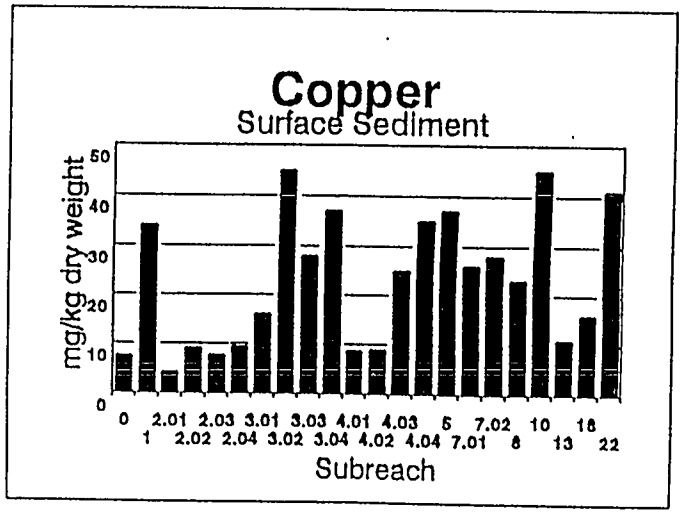
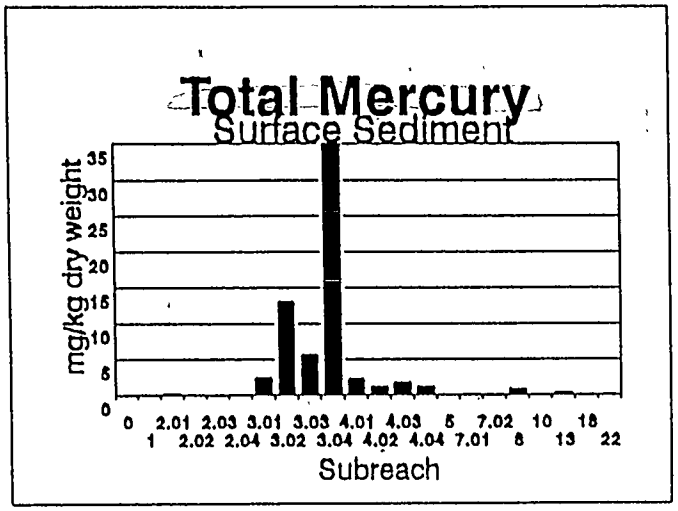
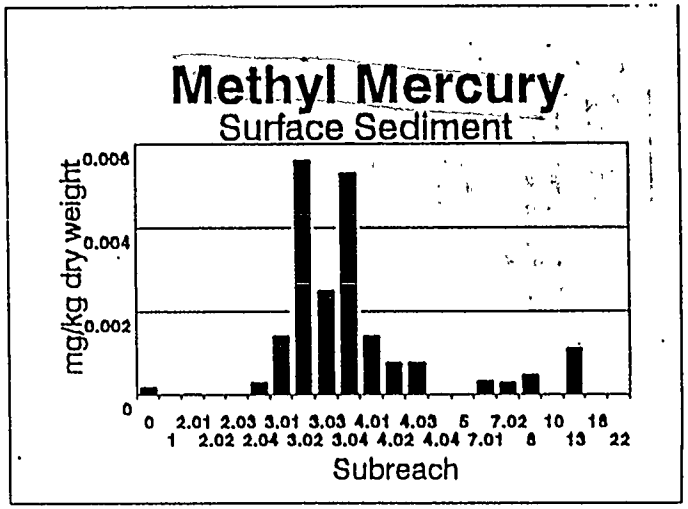
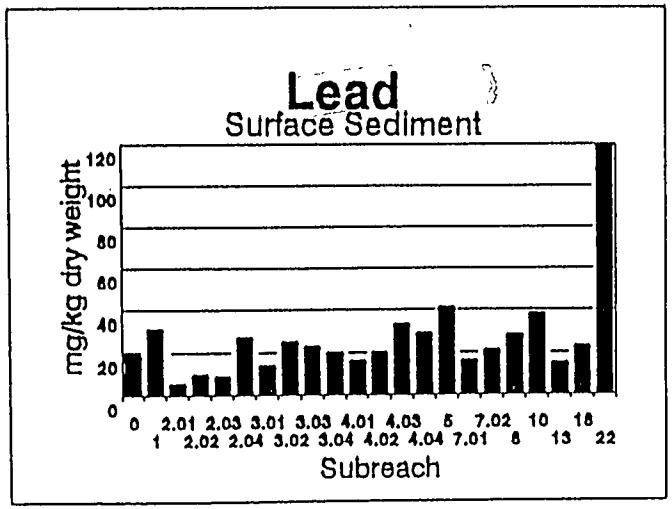
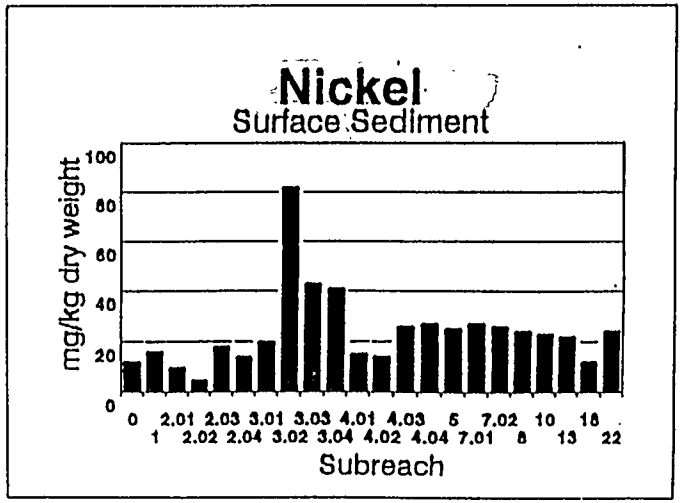


Fig. 3.36 (continued)









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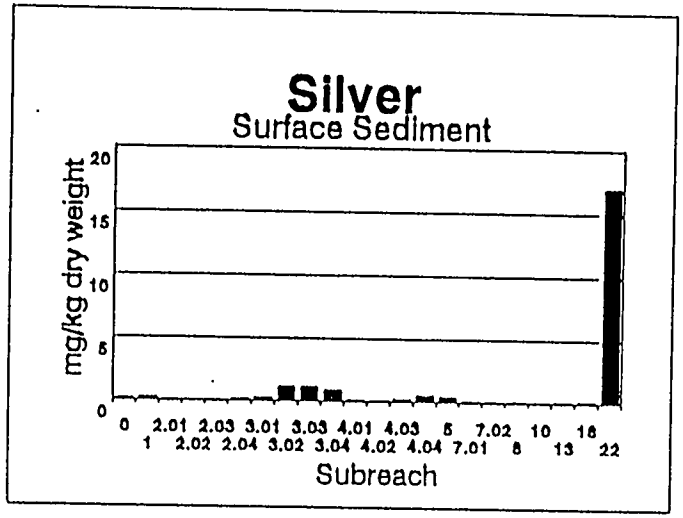

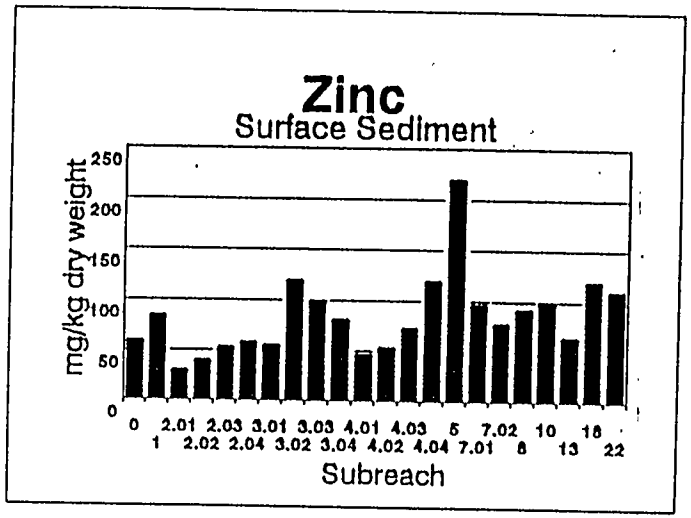

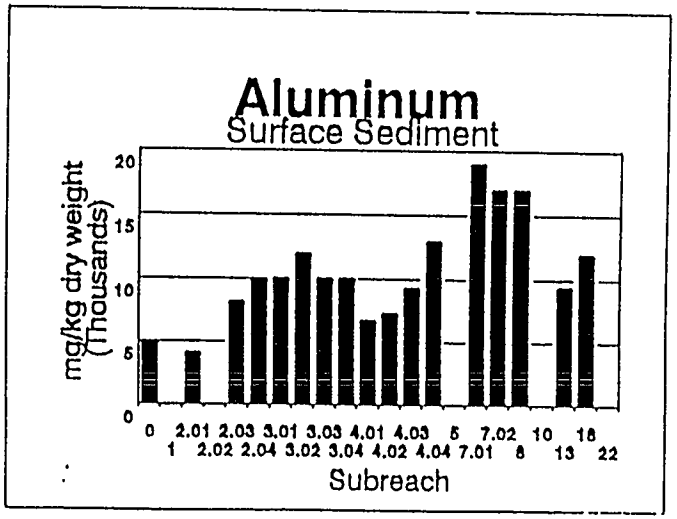

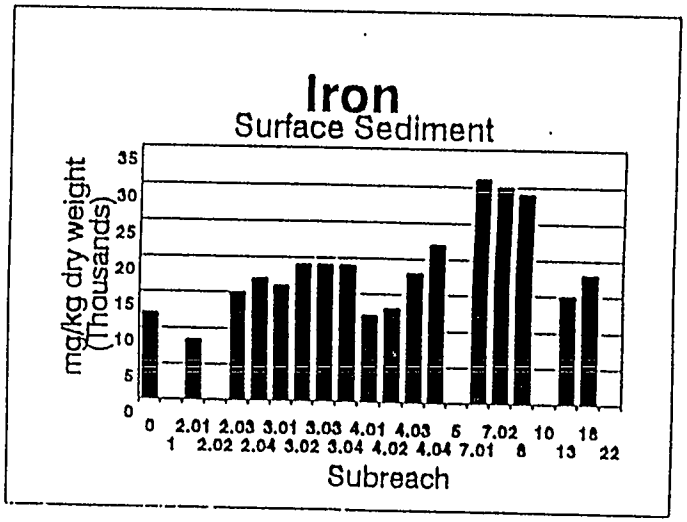

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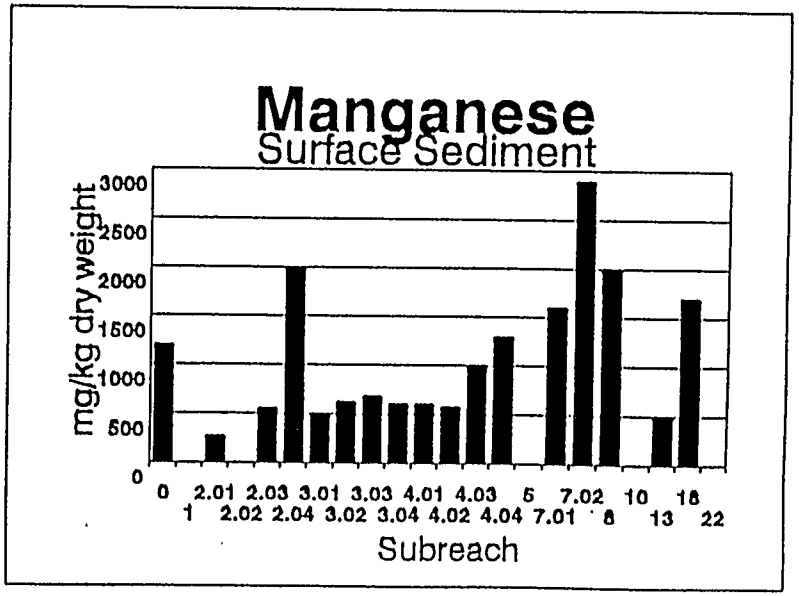

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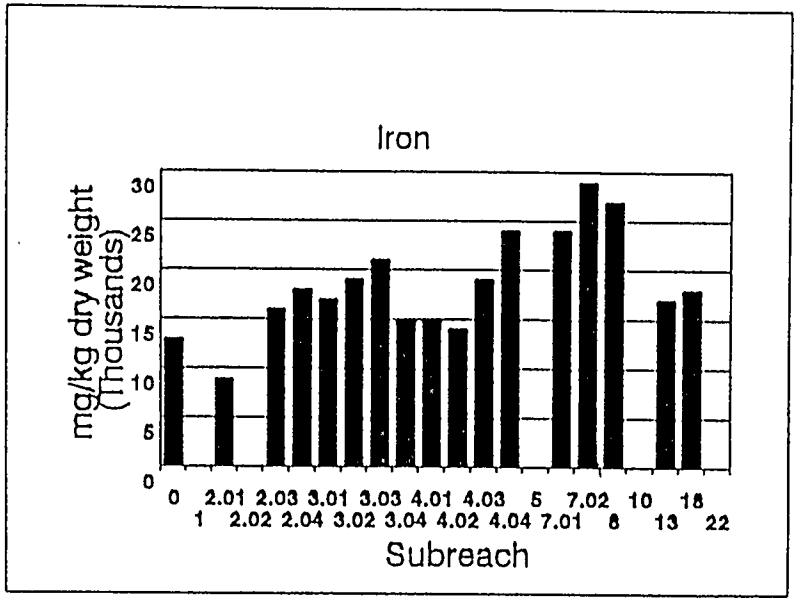
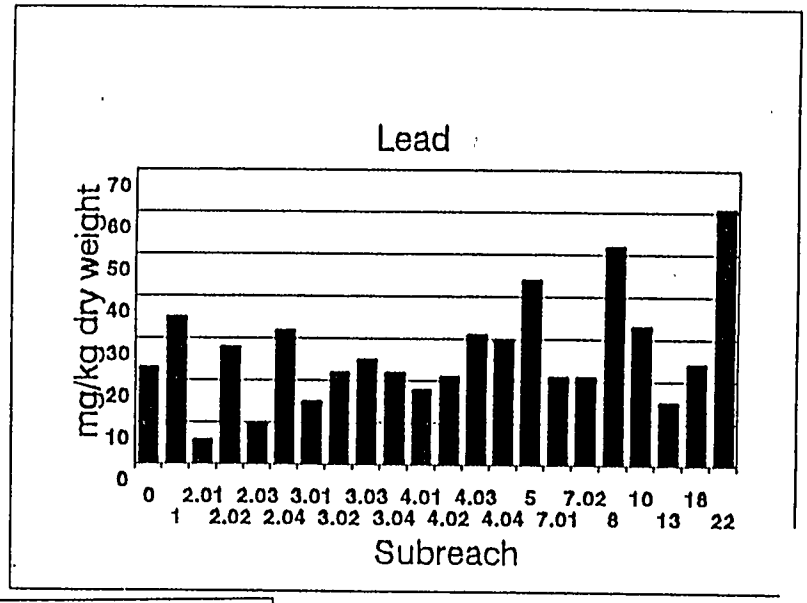




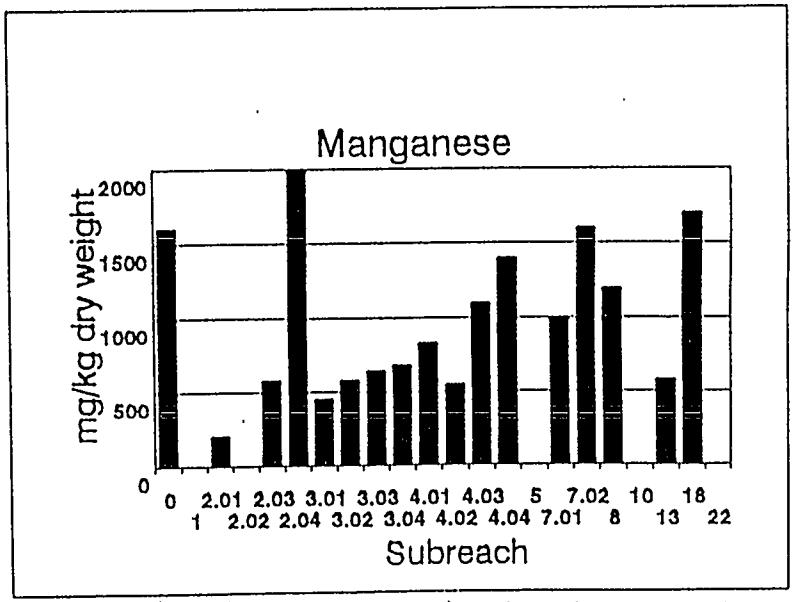
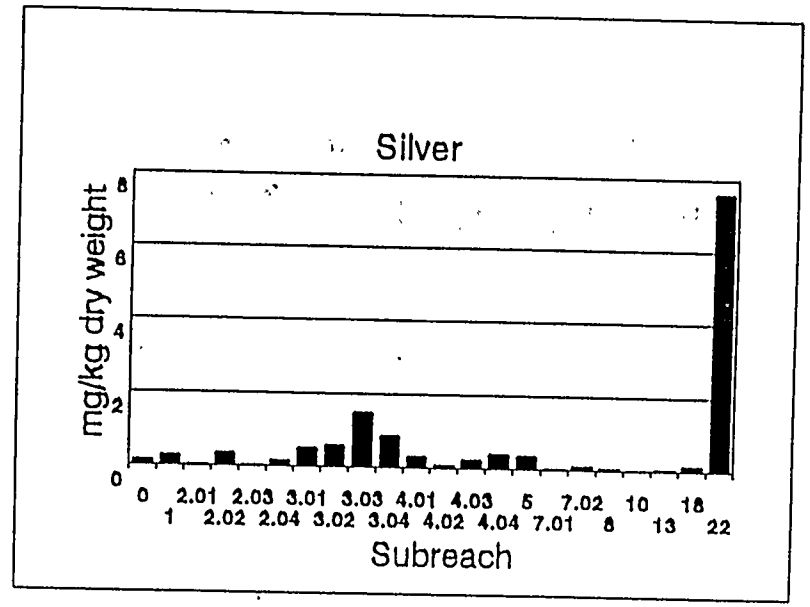
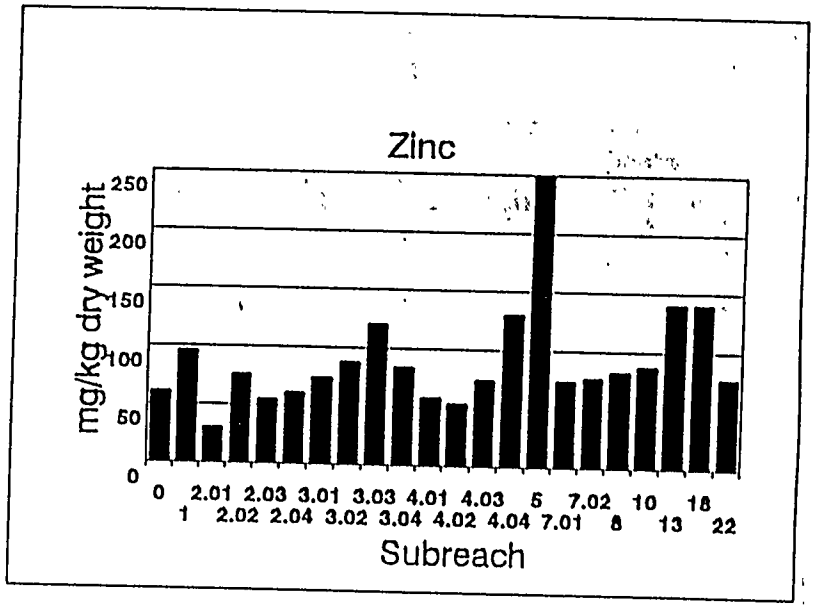
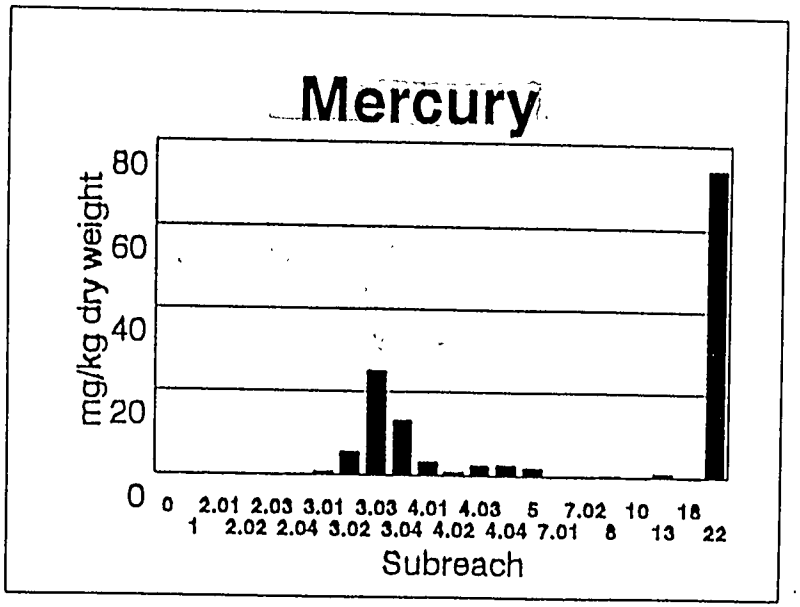
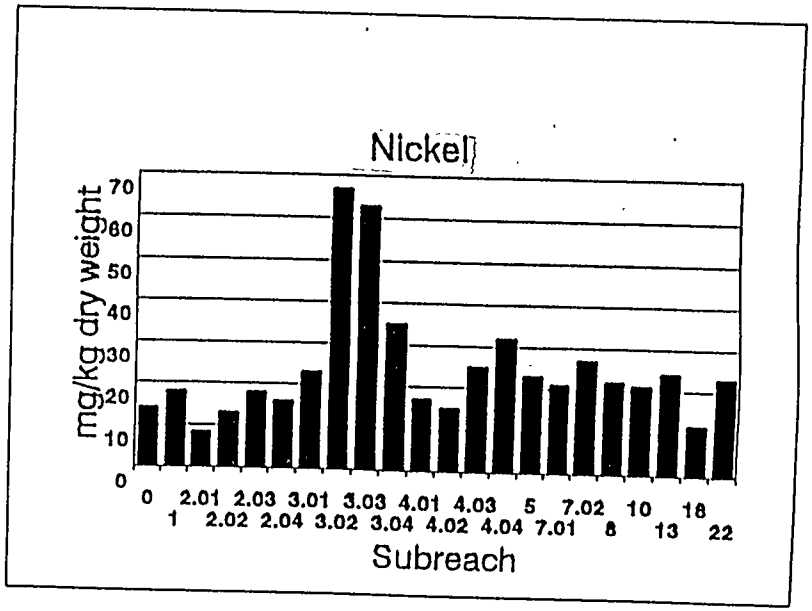


Fig. 3.37. Core-weighted mean concentrations for subreaches of inorganic contaminants.









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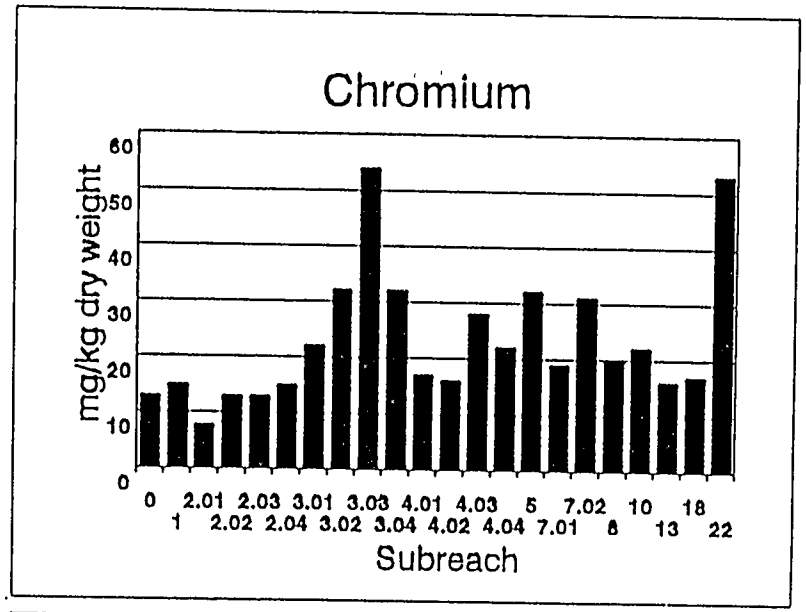

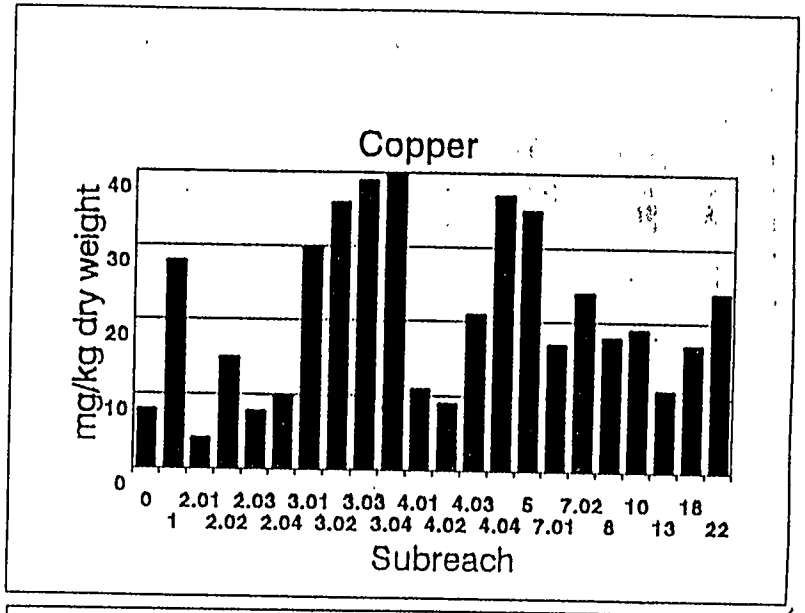

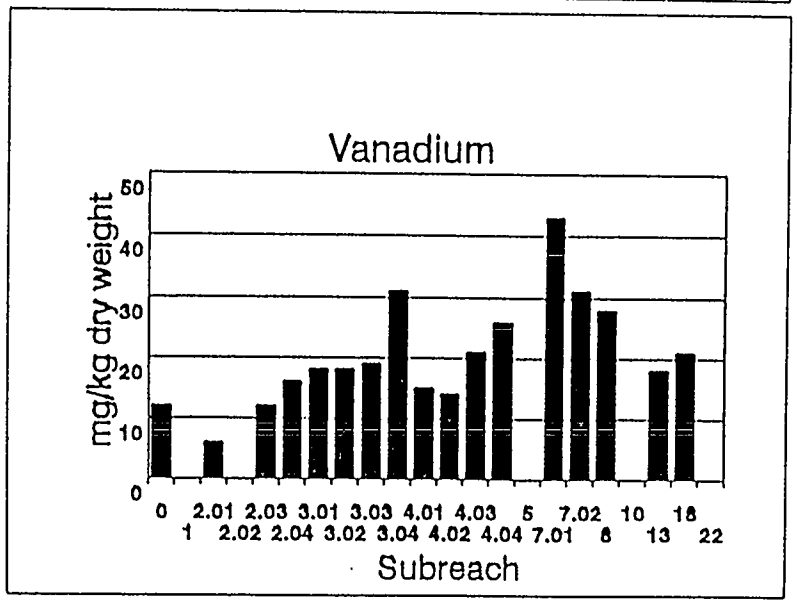

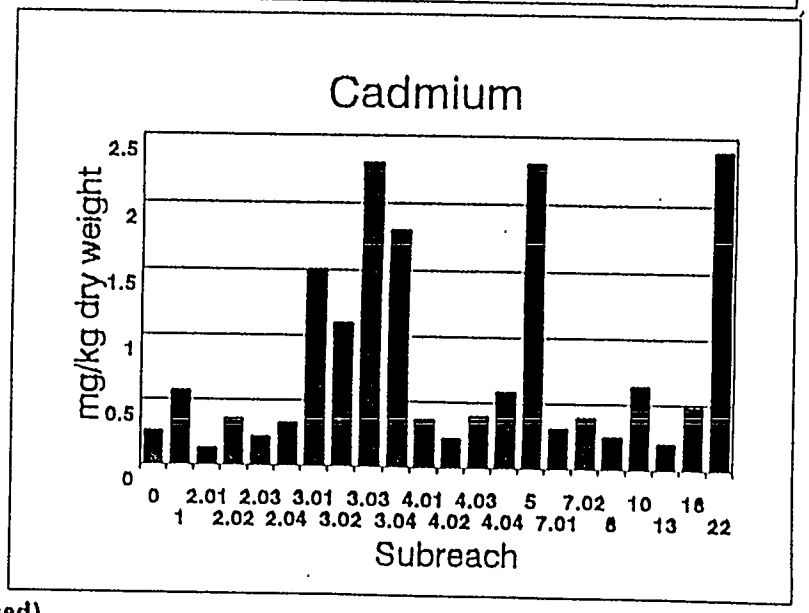

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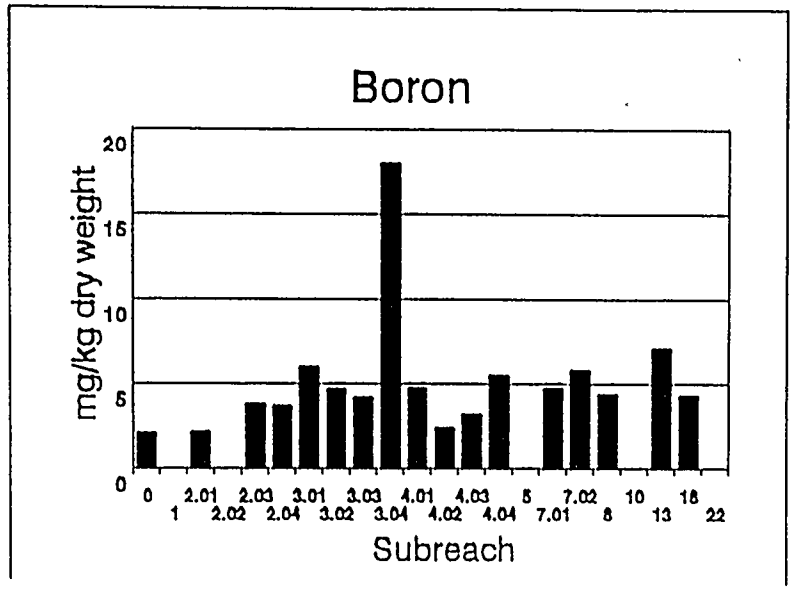

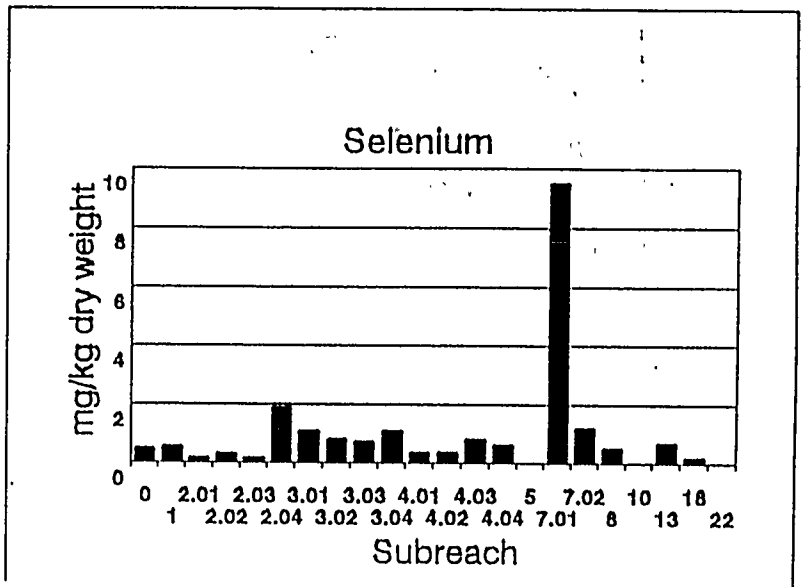

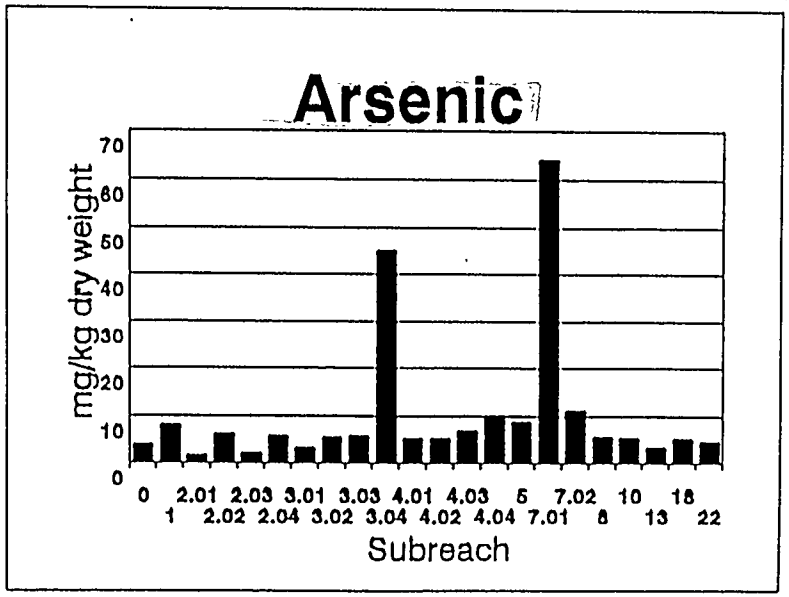

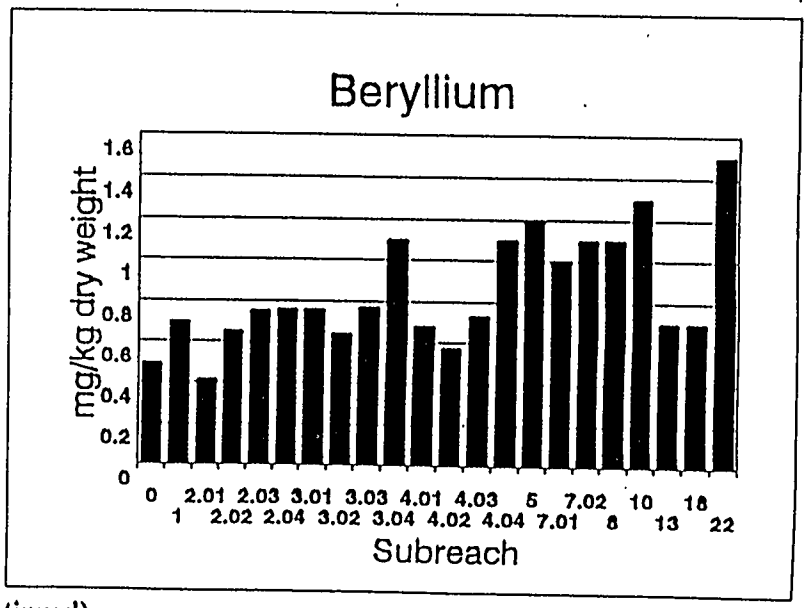

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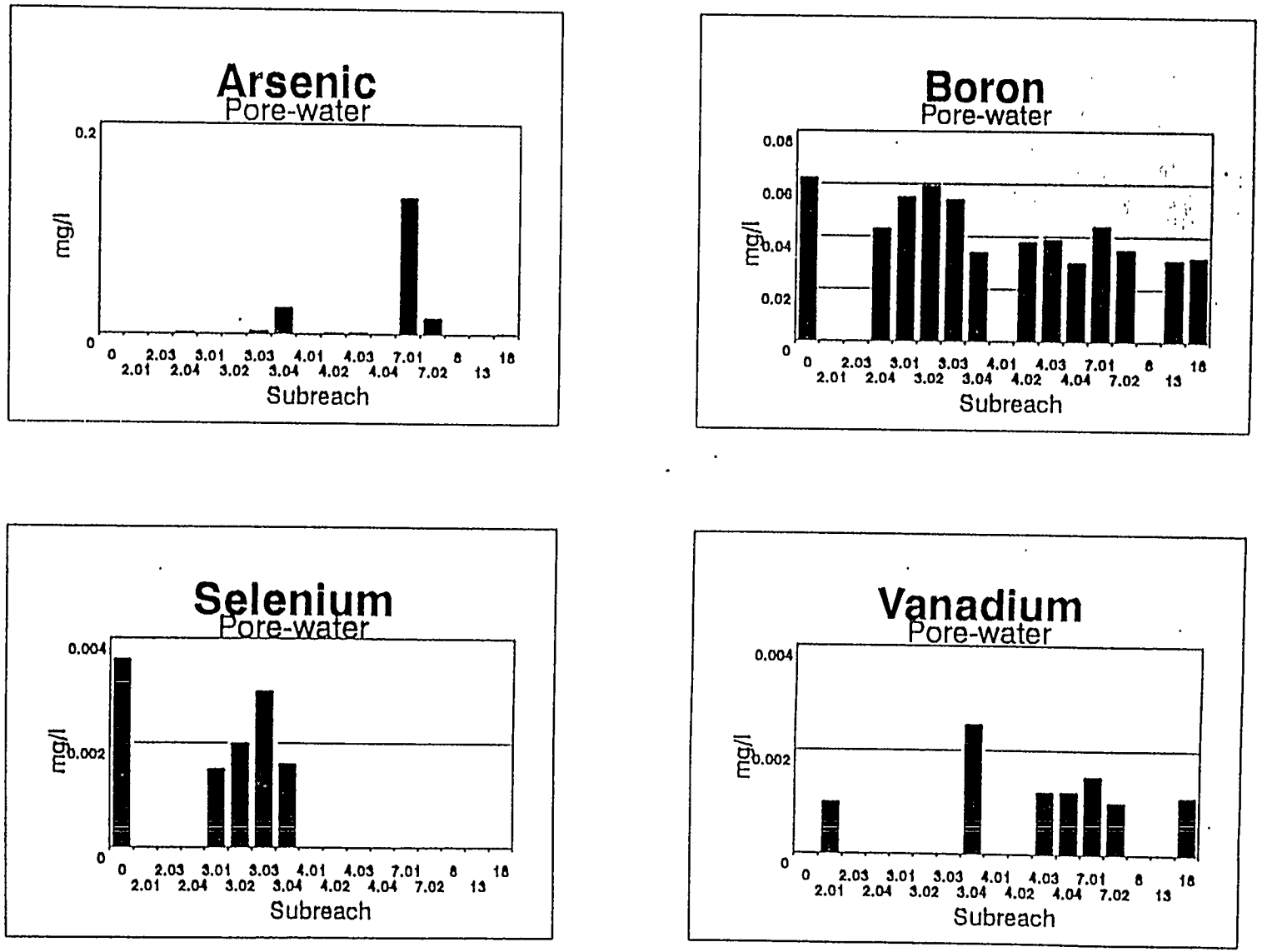
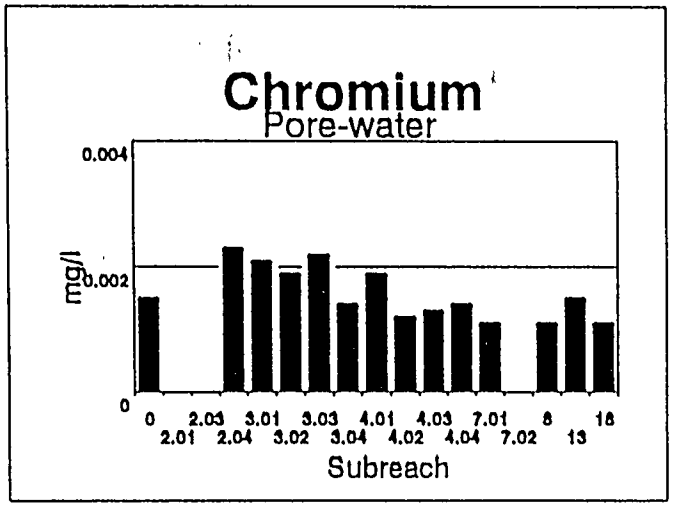
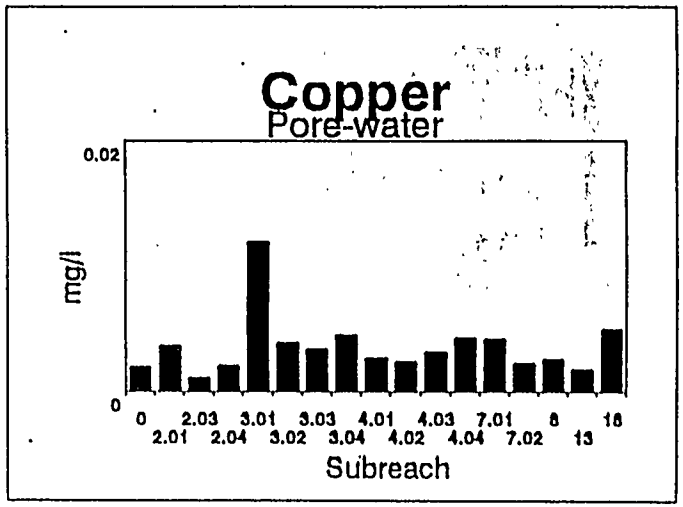
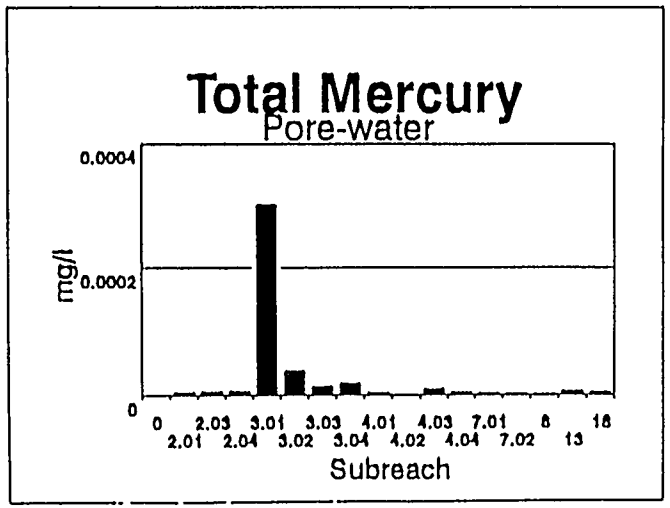
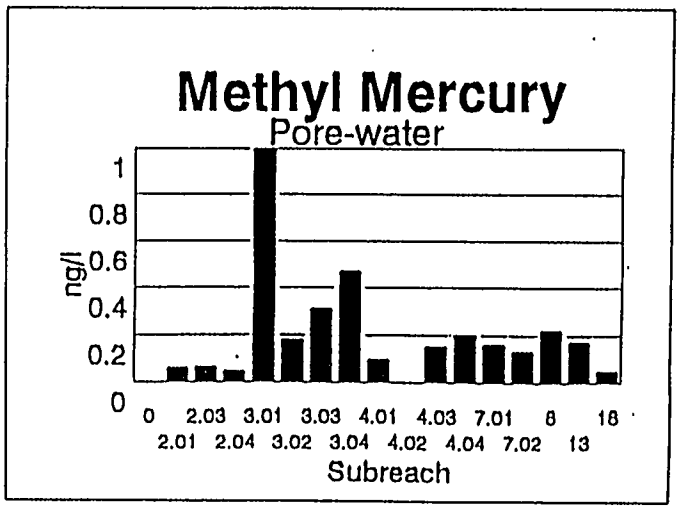


Fig. 3.38. Pore water mean concentrations for subreaches of inorganic contaminants.









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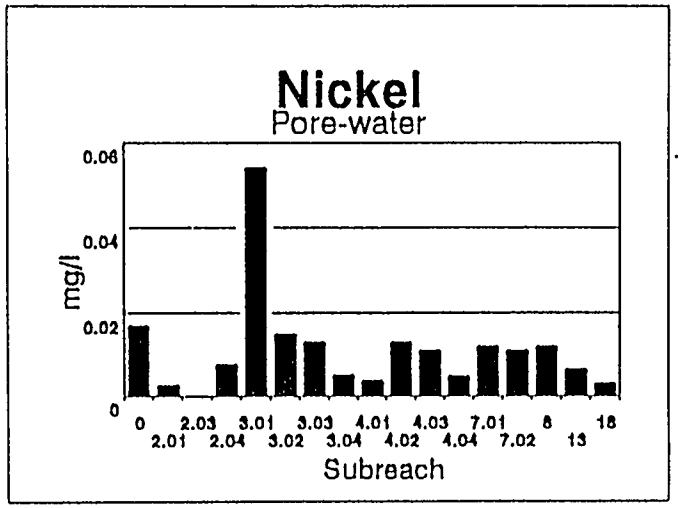

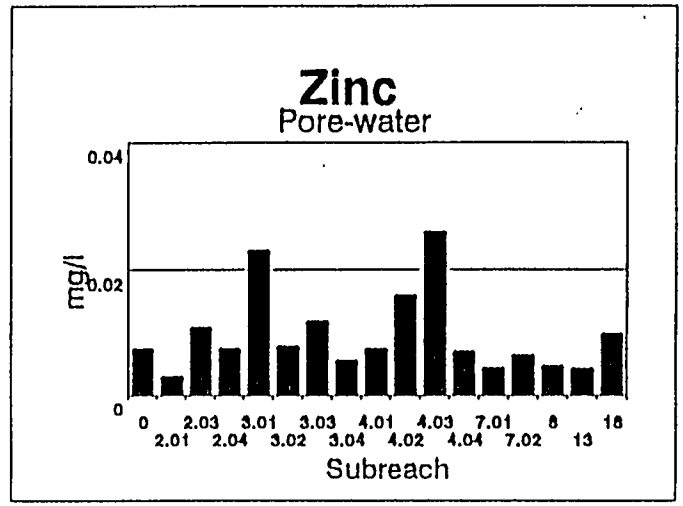

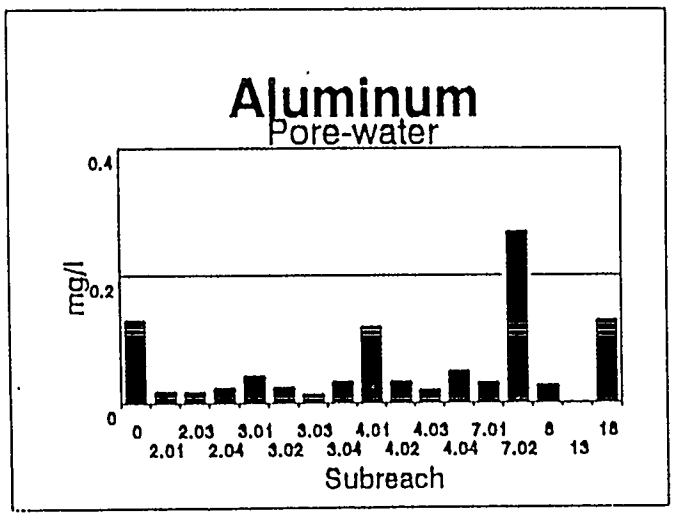

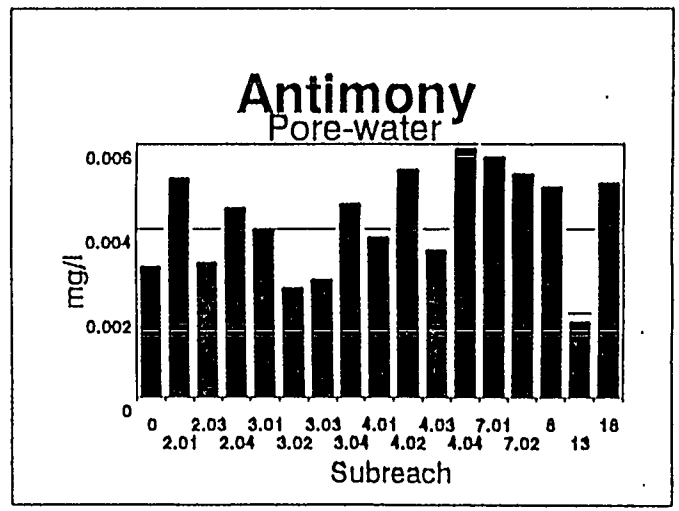

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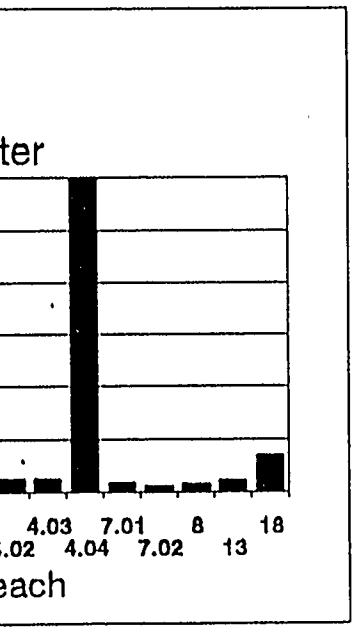

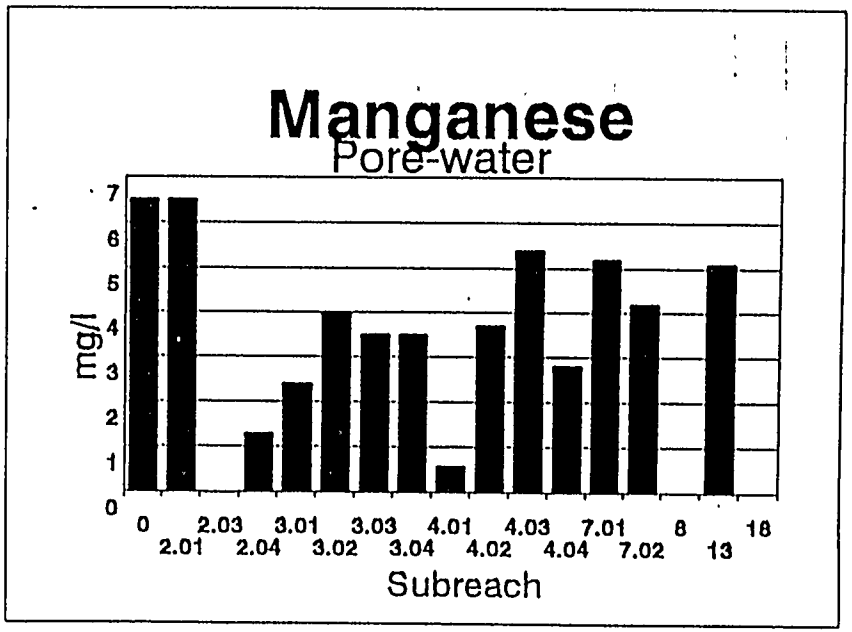

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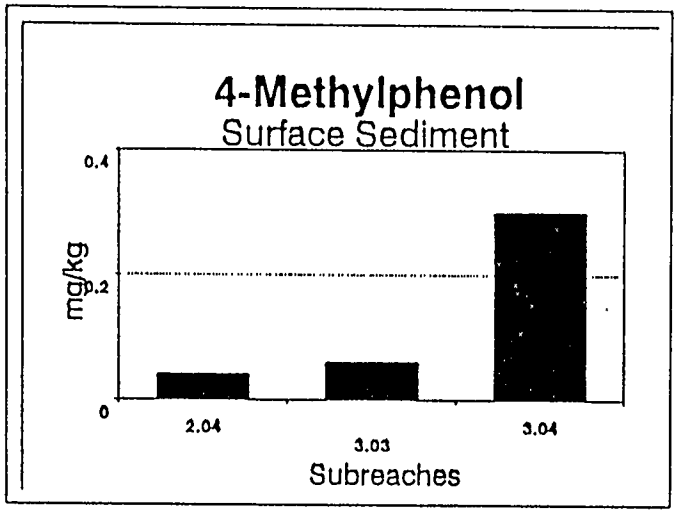
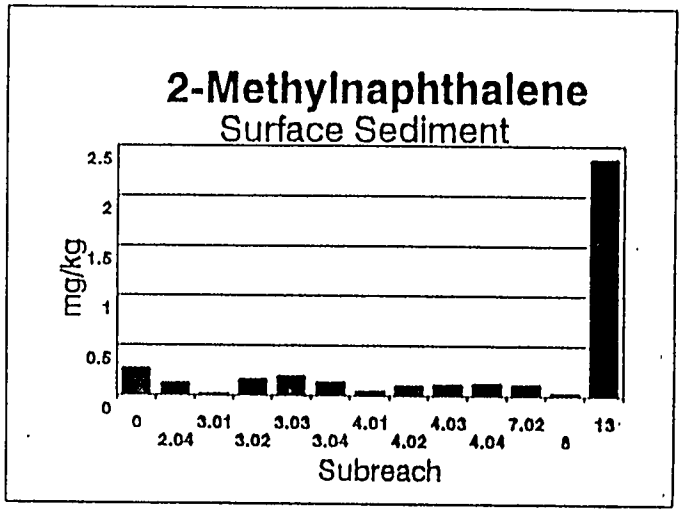
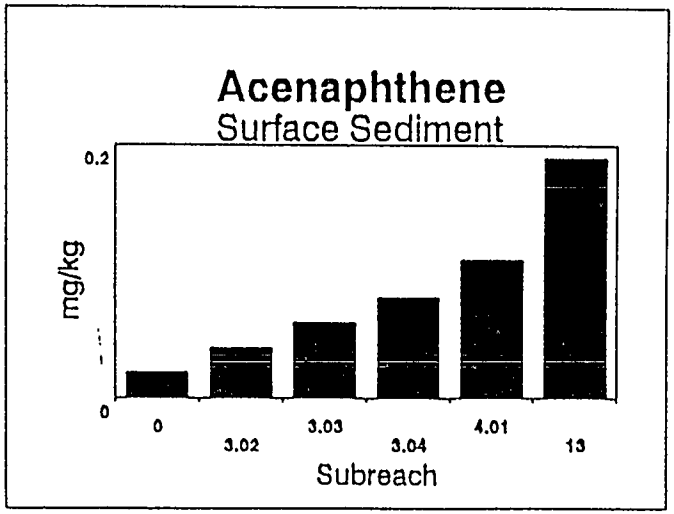






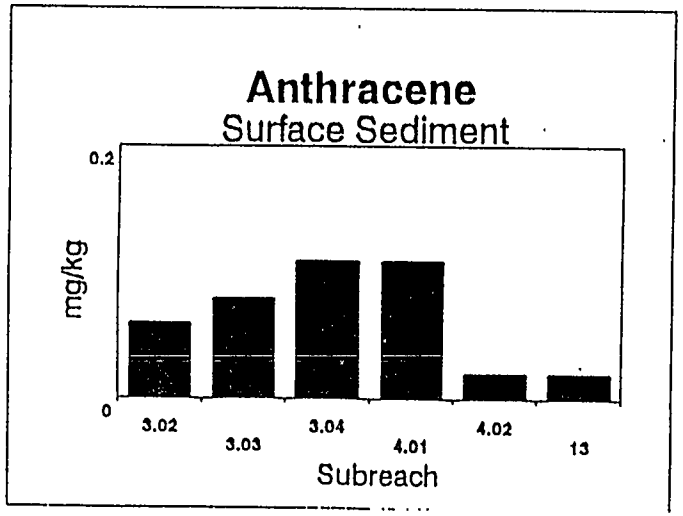
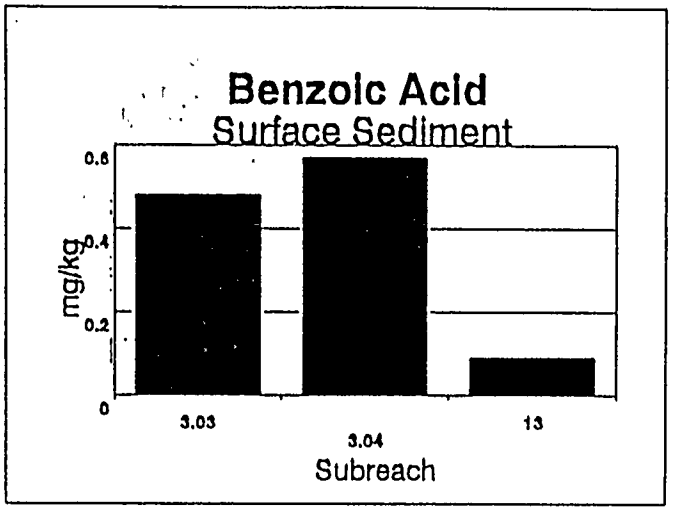
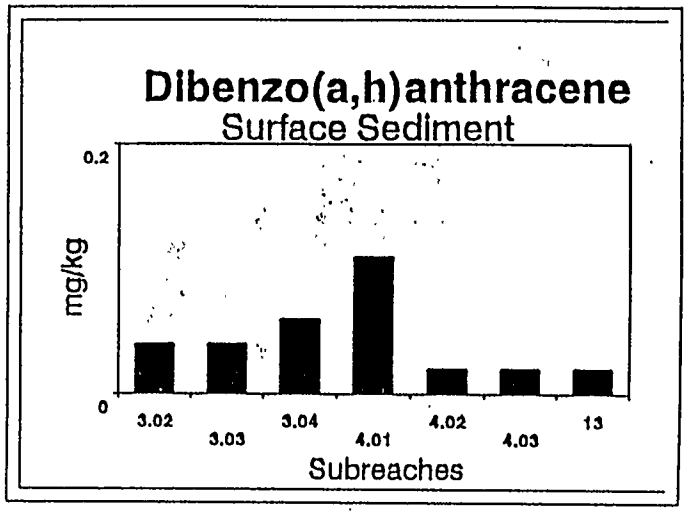
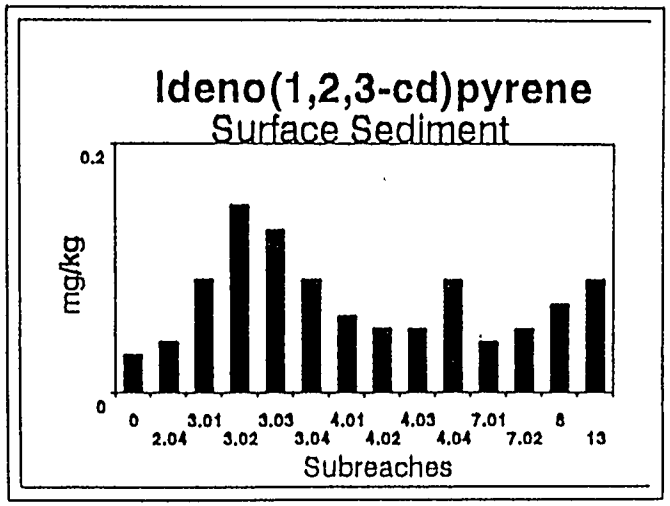
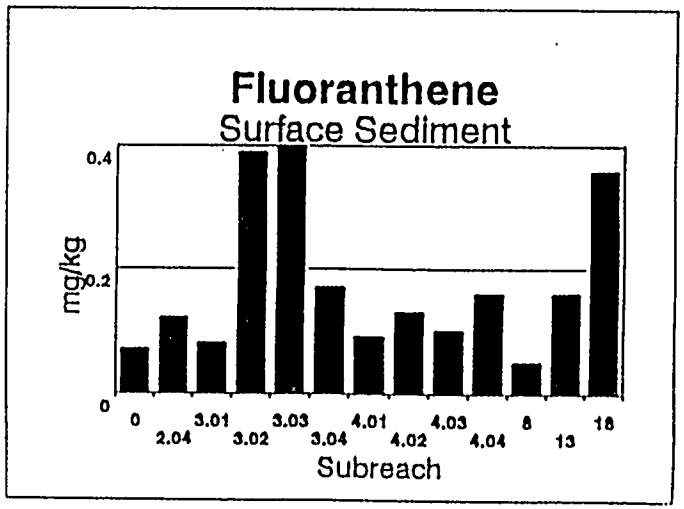


Fig. 3.39. Surface sediment mean concentrations for subreaches for organic contaminants.









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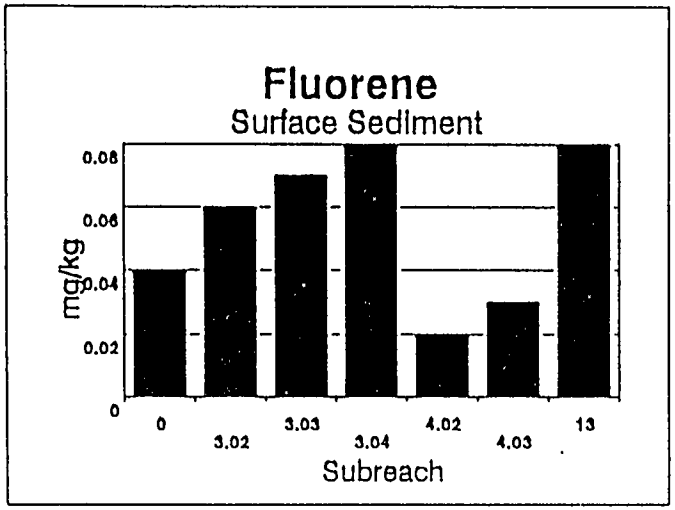

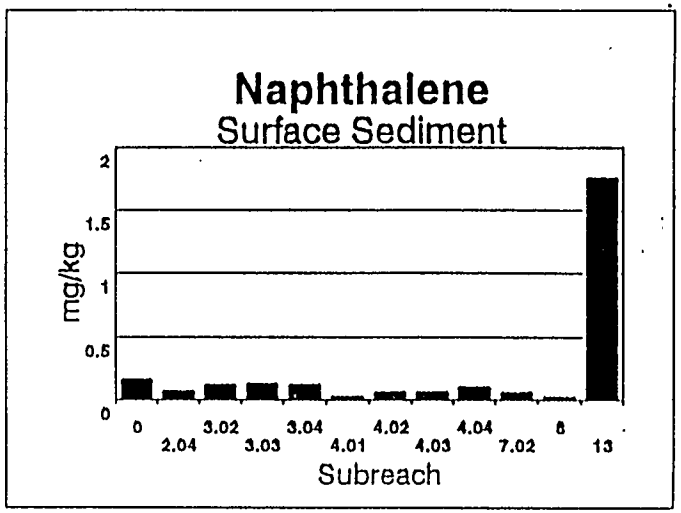

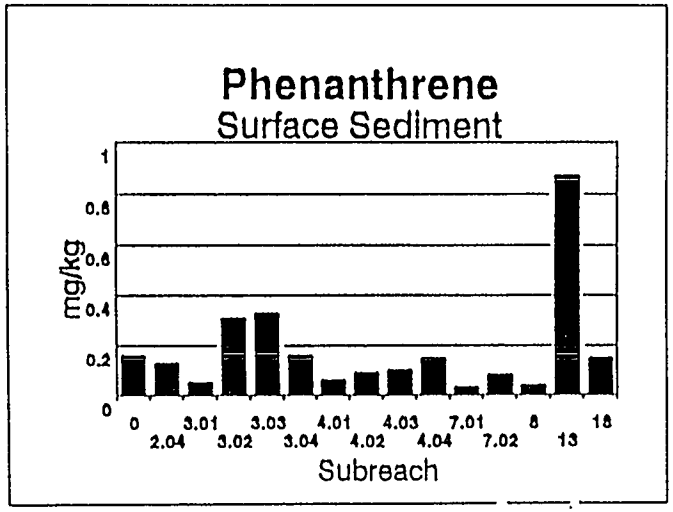

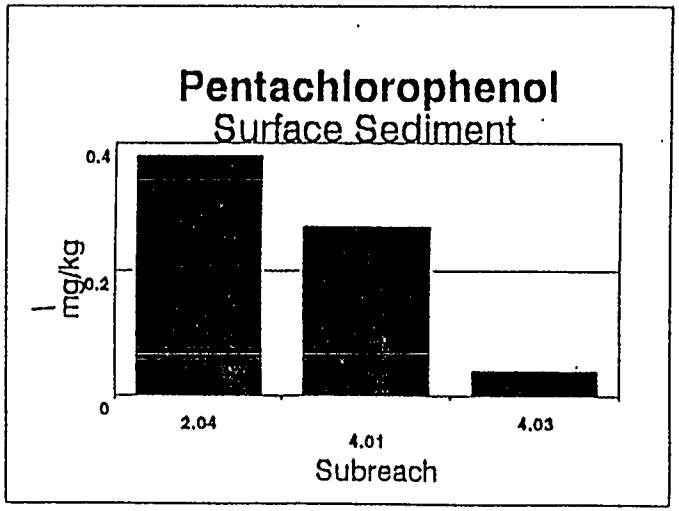

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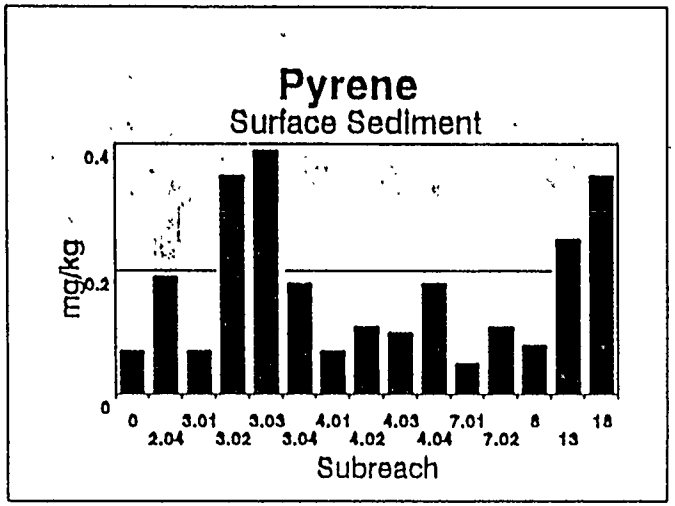

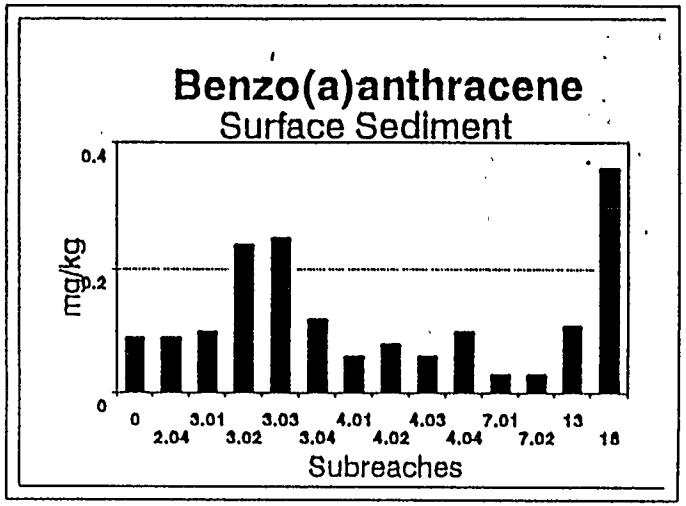

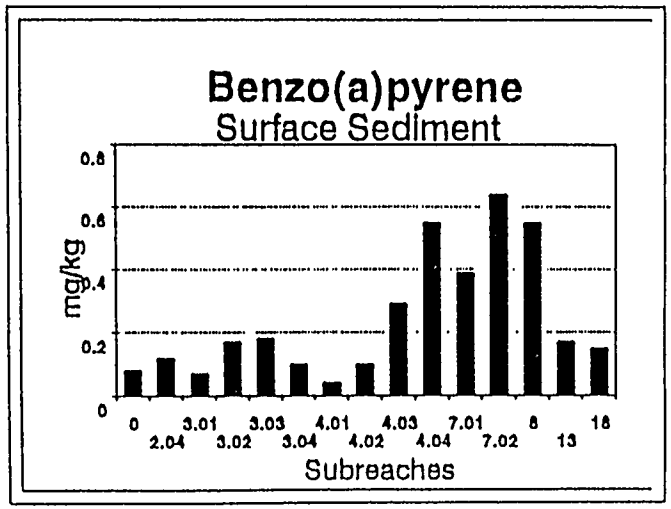

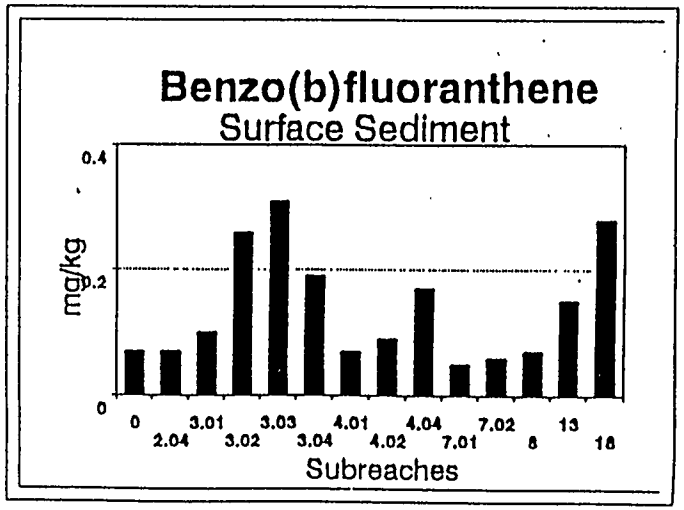

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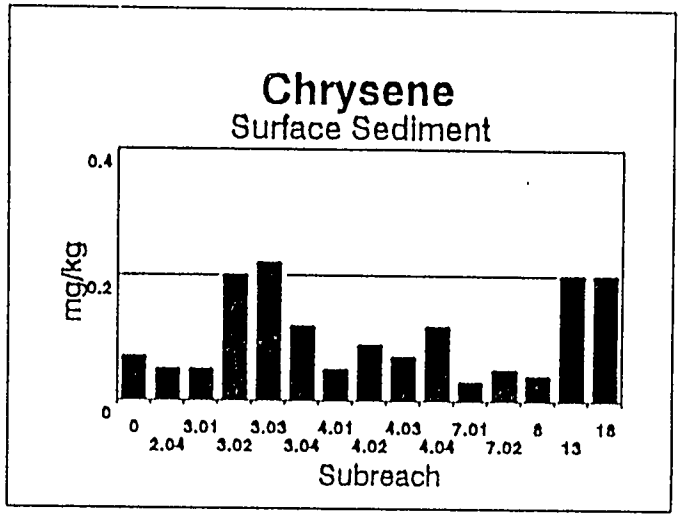

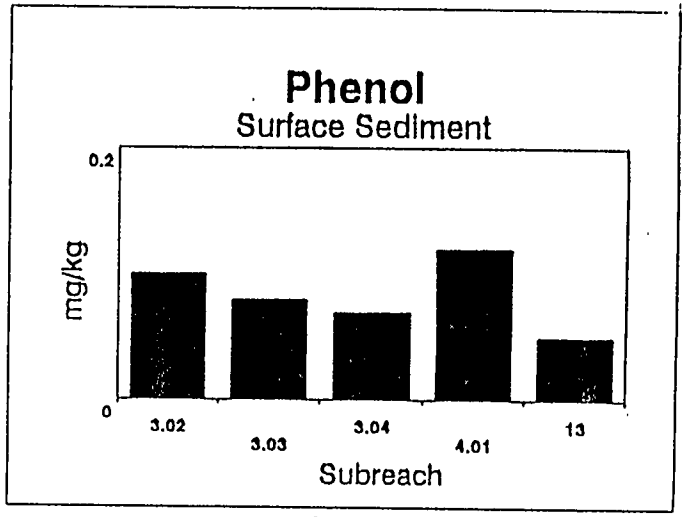

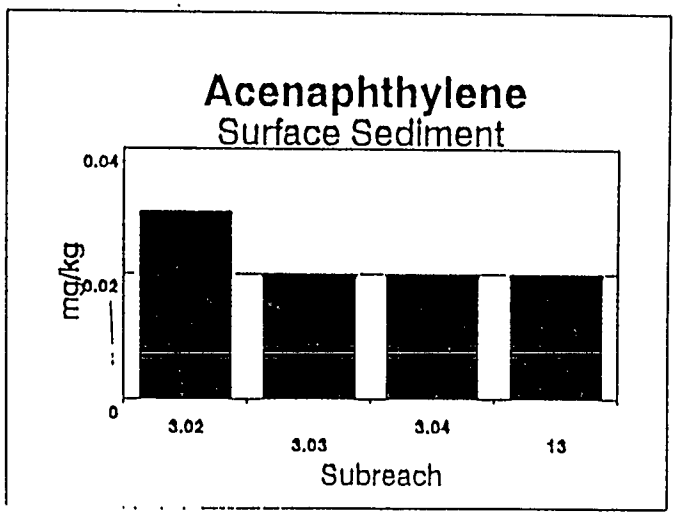

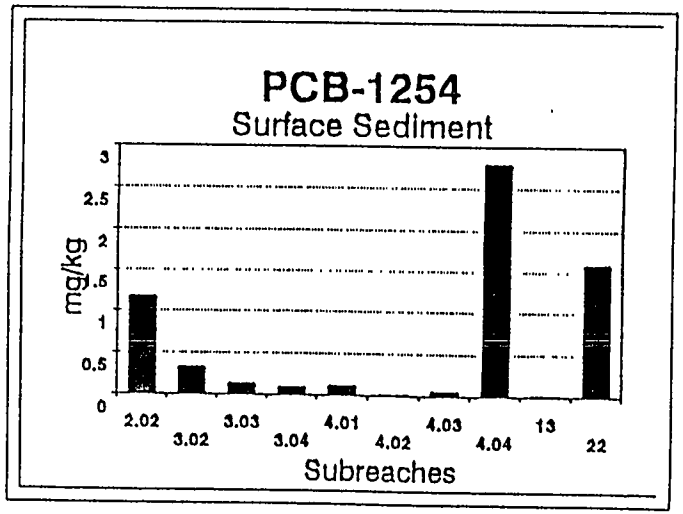

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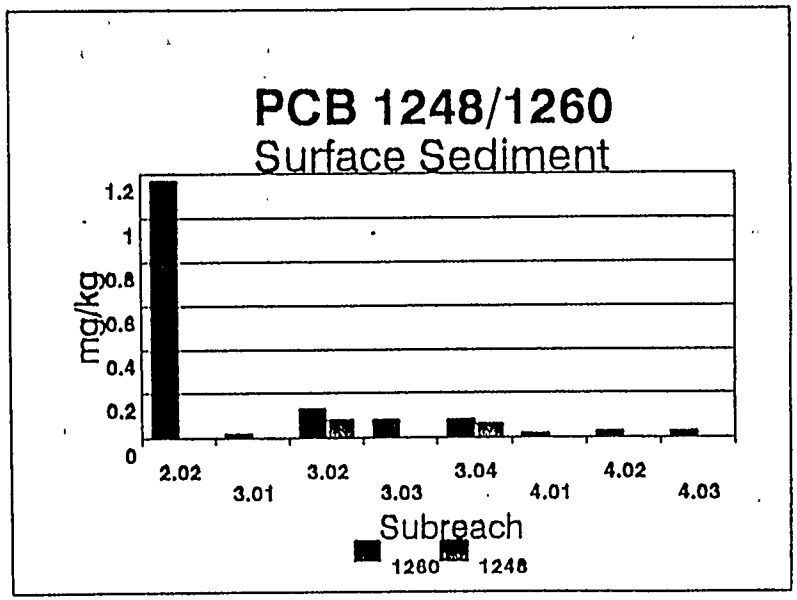

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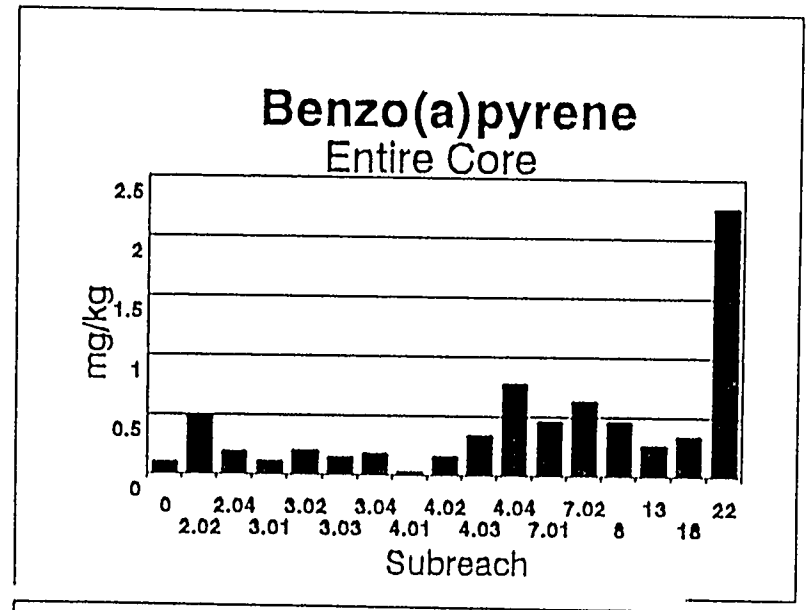
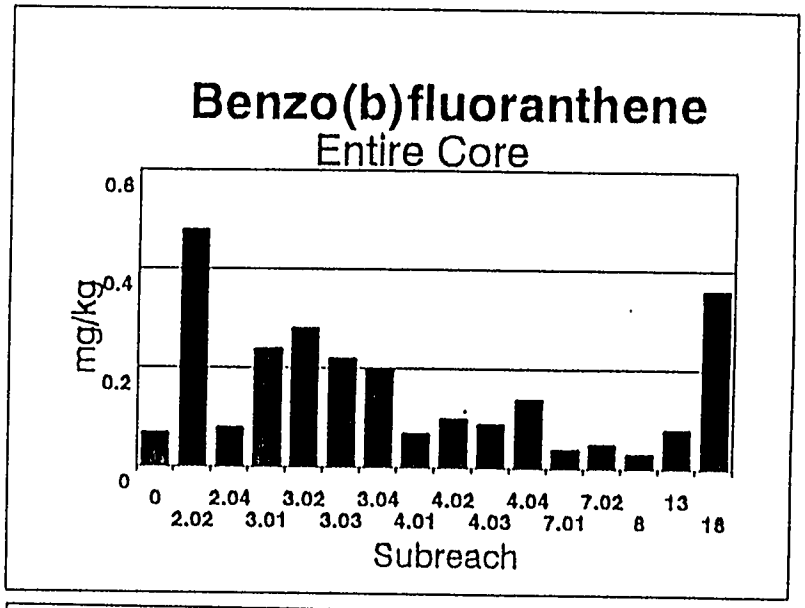
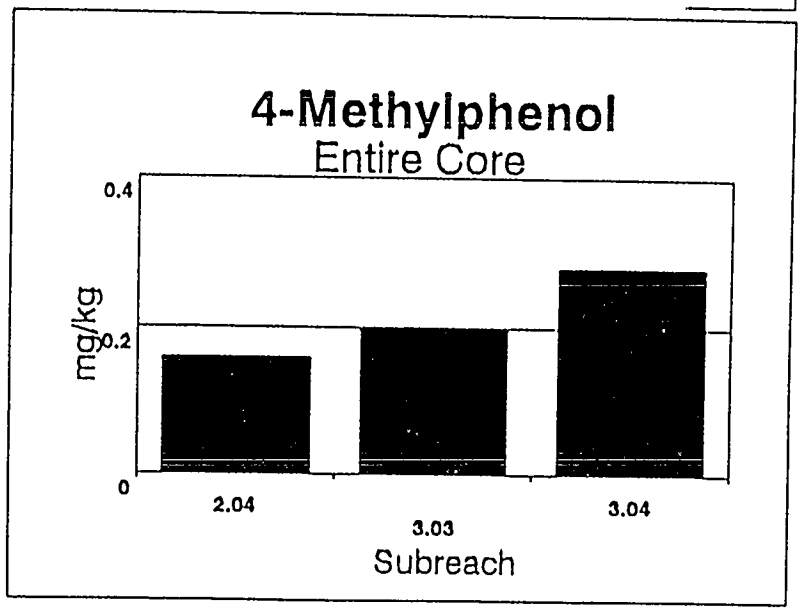






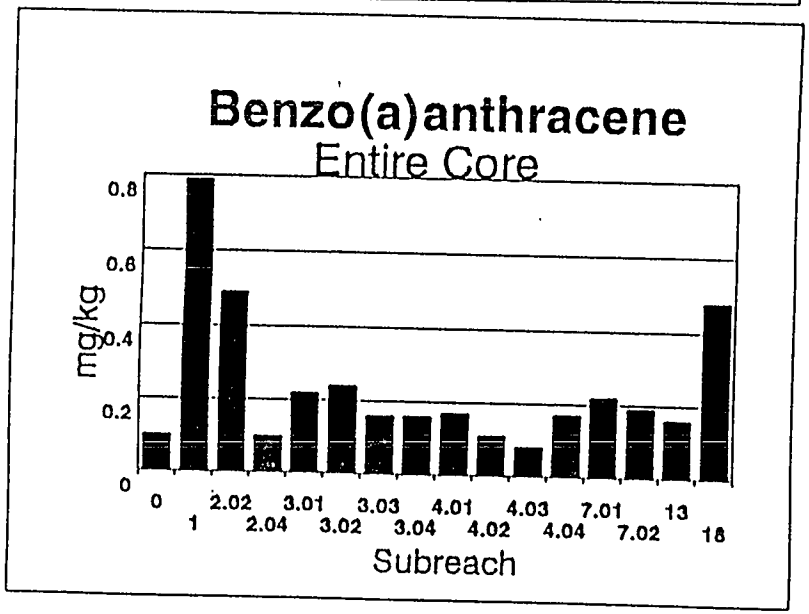
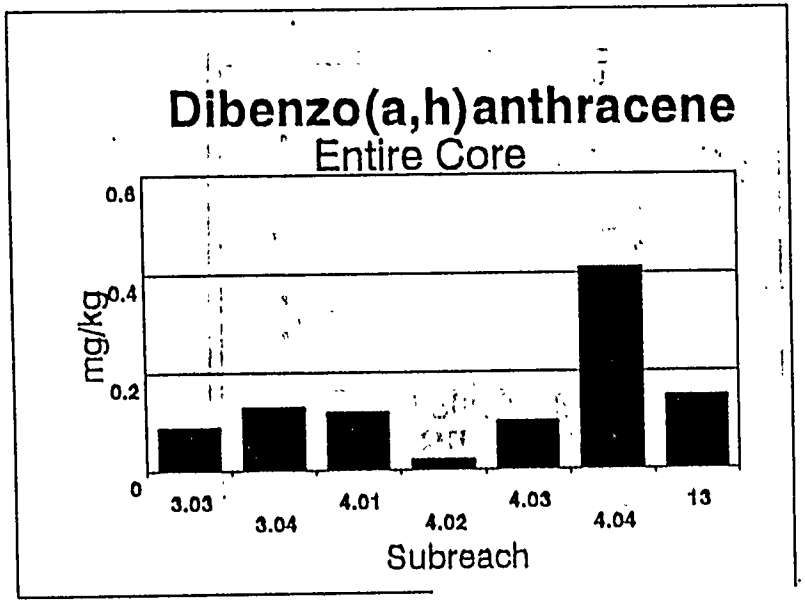
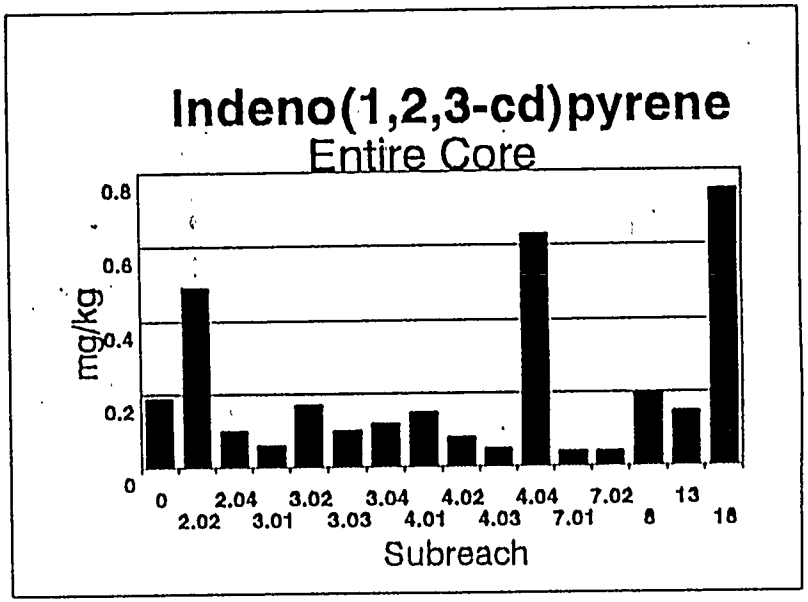


Fig. 3.40. Core-weighted mean concentrations for subreaches of organic contaminants.





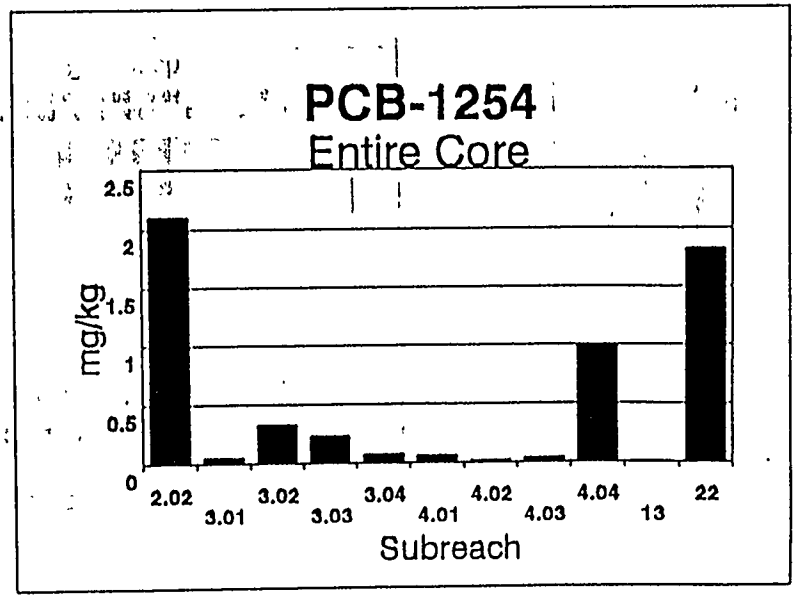


Fig. 3.40 (continued)

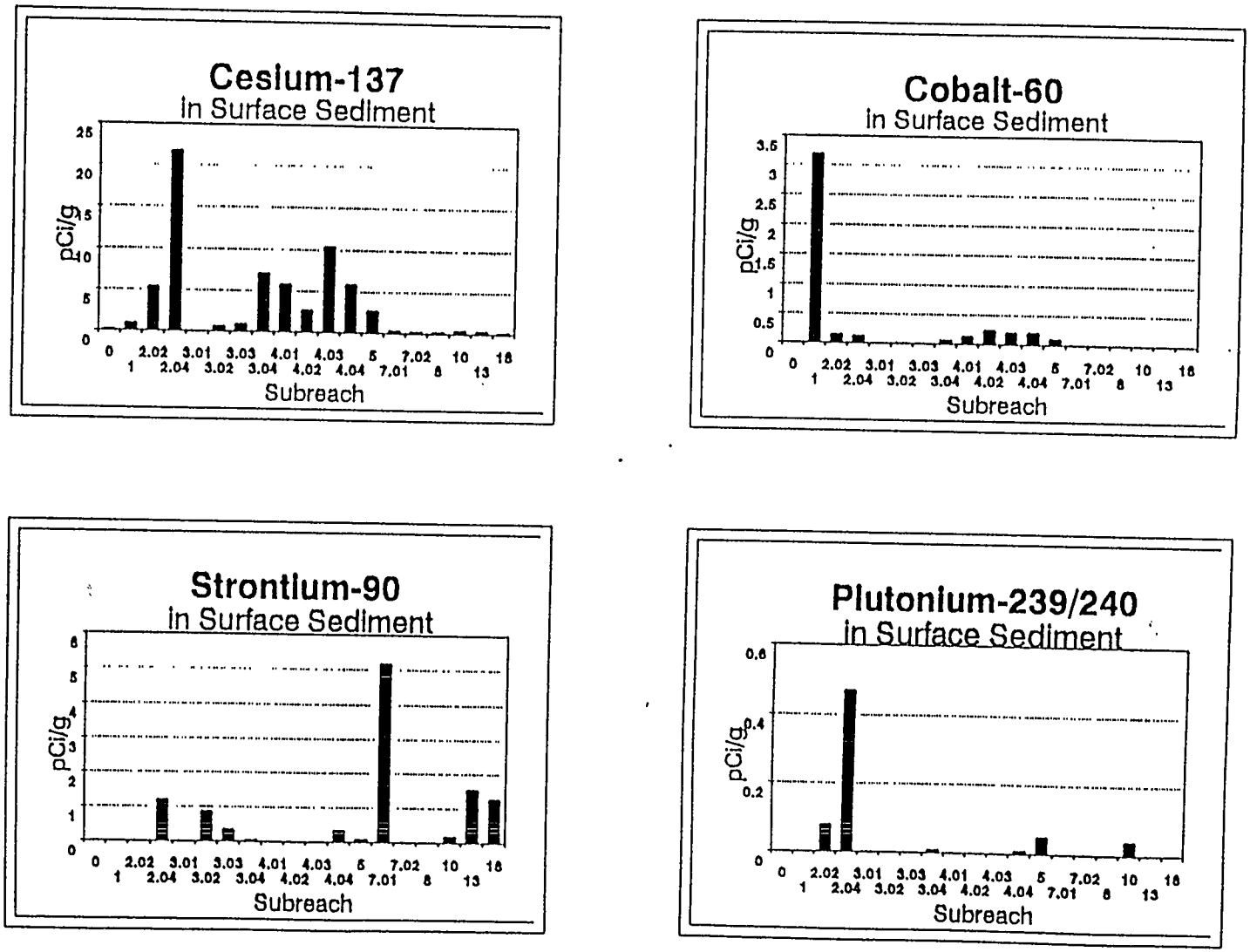
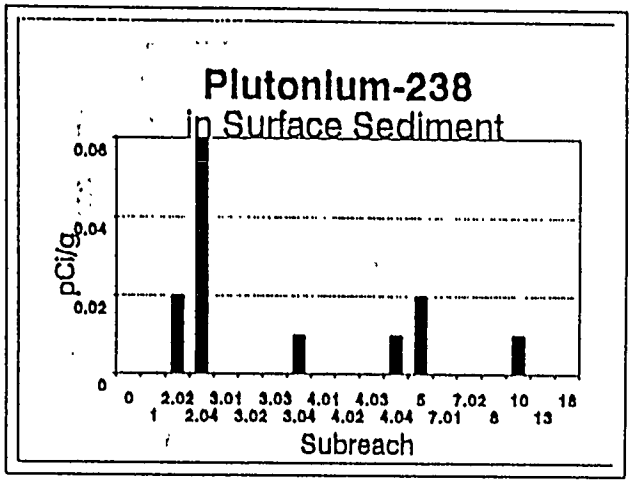
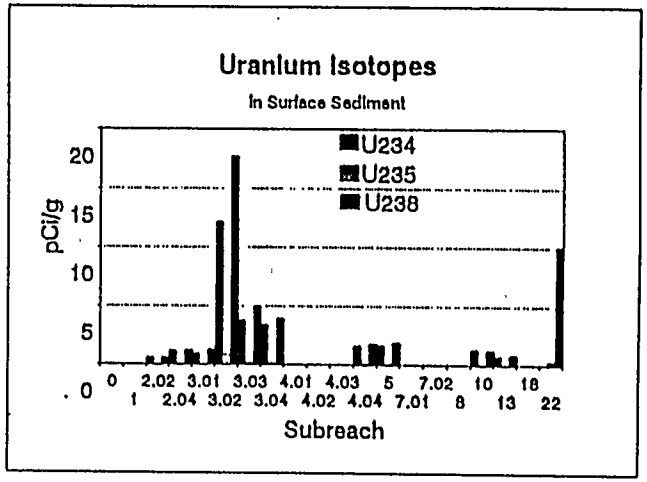
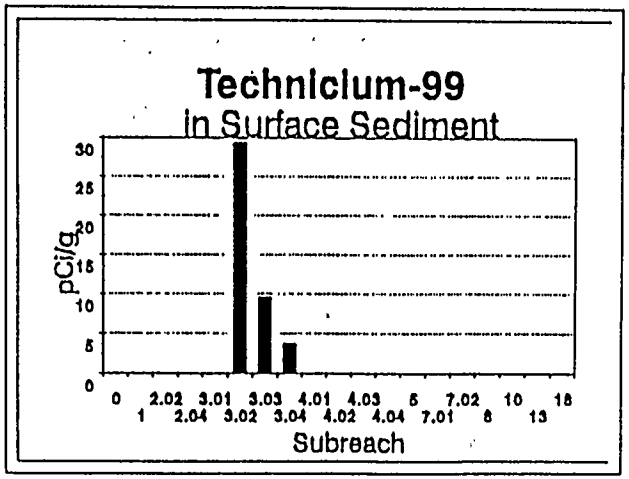


Fig. 3.41. Surface sediment mean concentrations for subreaches of radiological contaminants.







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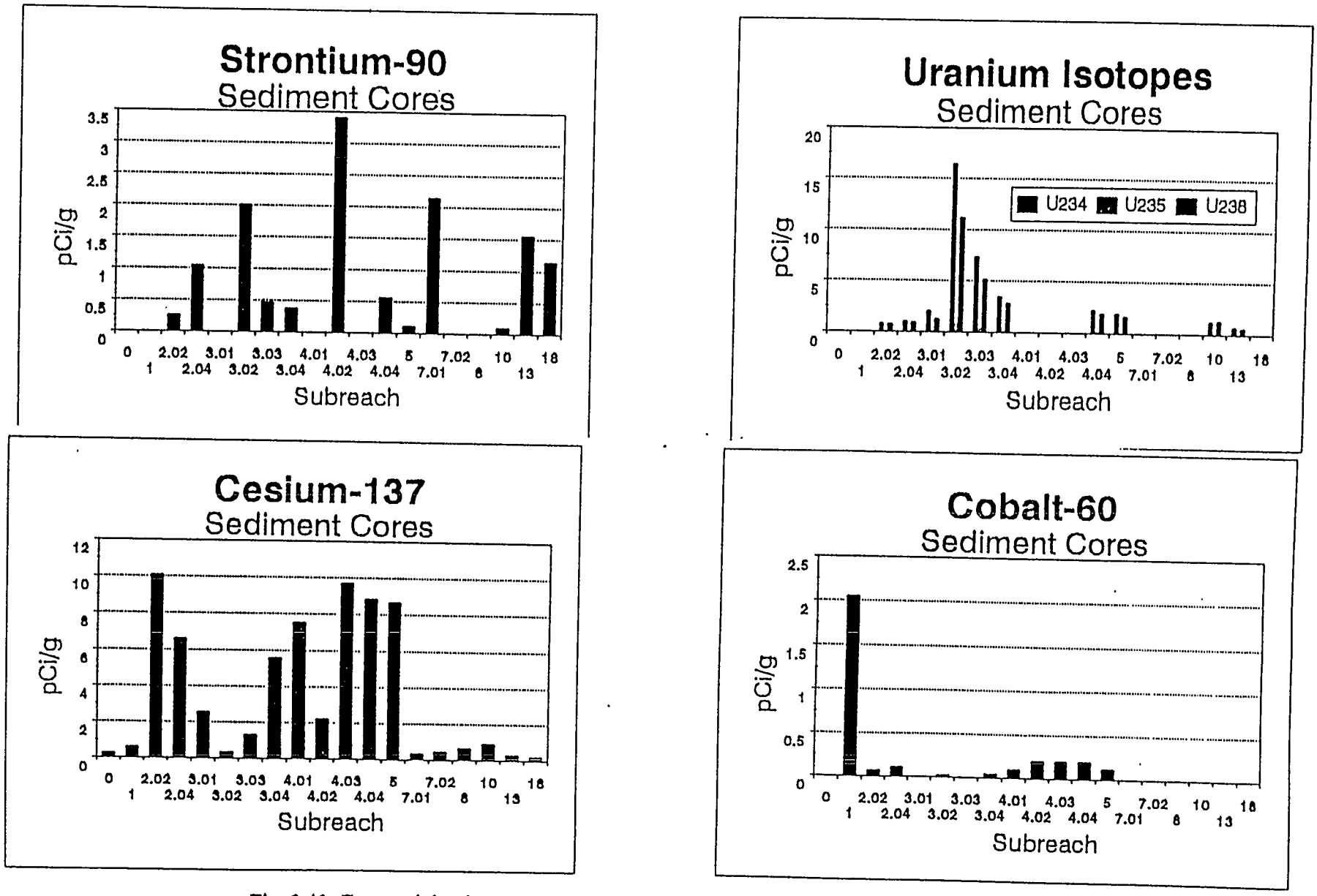
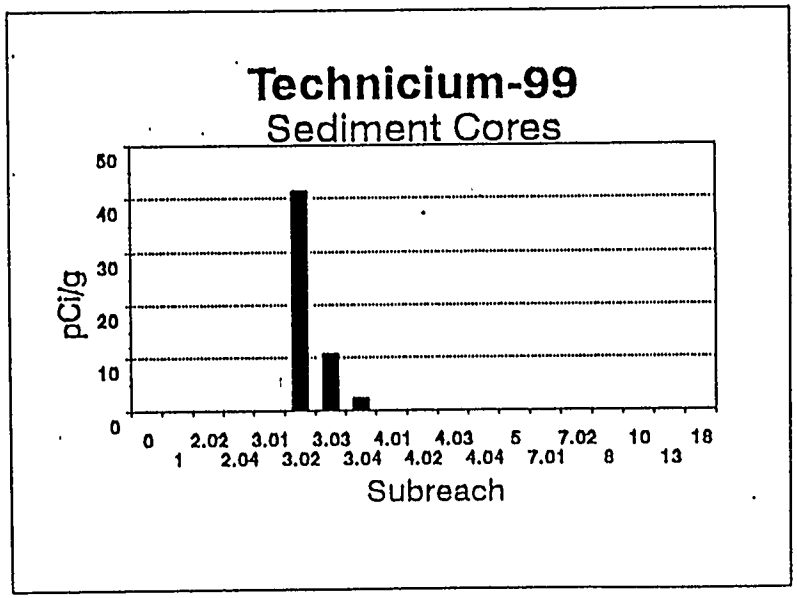


Fig. 3.42. Core-weighted mean concentrations for subreaches for radiological contaminants.



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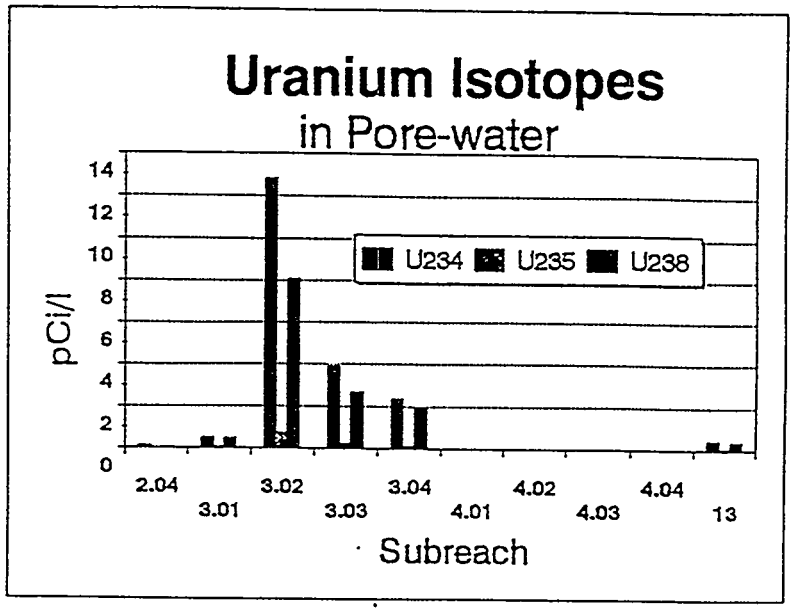


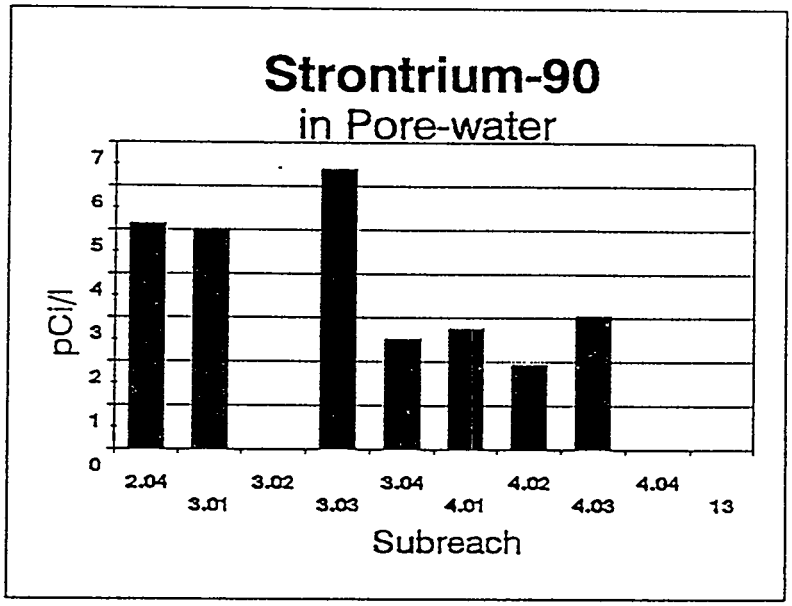


Fig. 3.43. Pore water mean concentrations for subreaches for radiological contaminants.

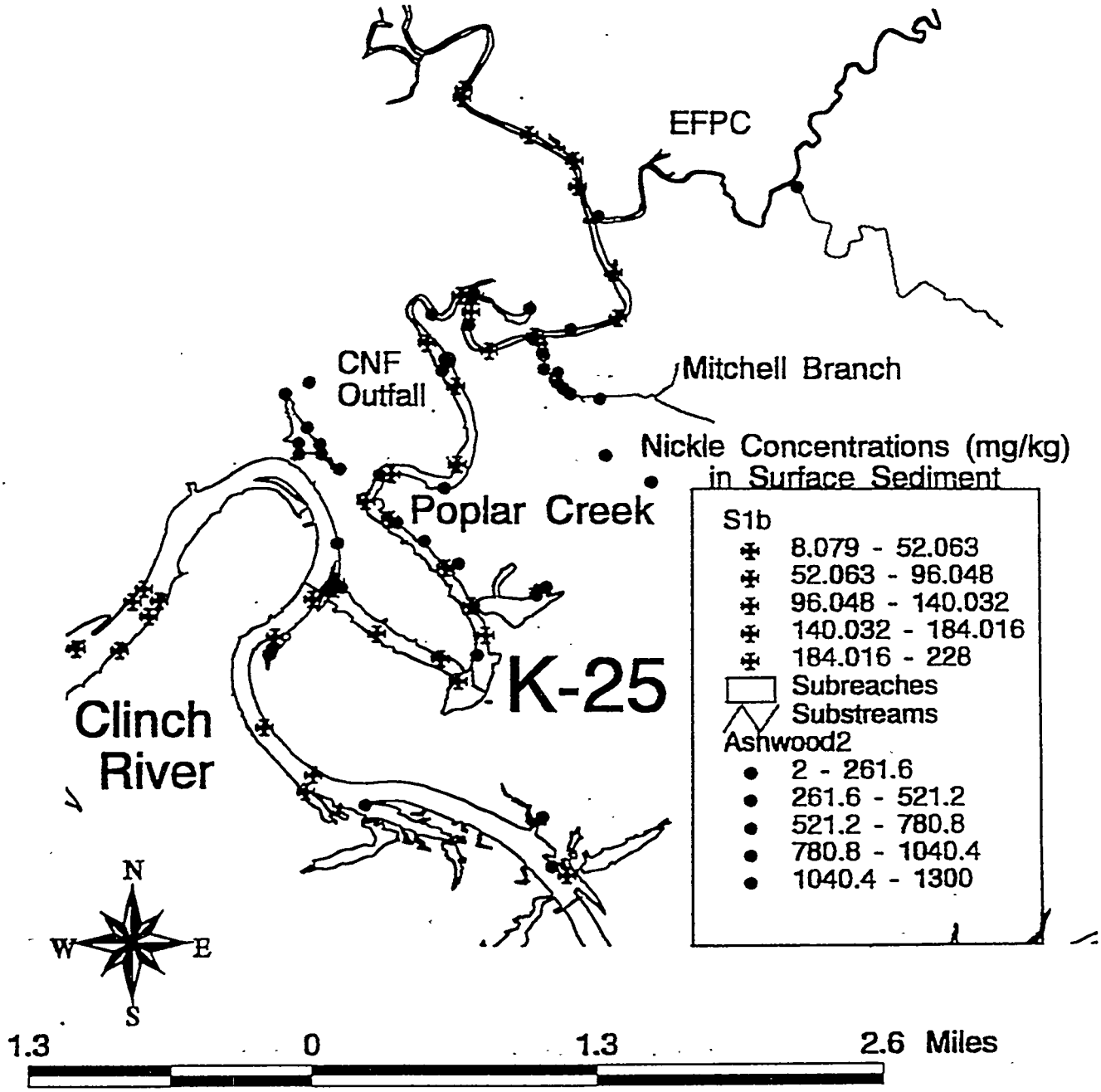


Fig. 3.44. Nickel concentrations in surface sediment in Mitchell Branch and vicinity (data from Ashwood et al. 1986 and CRRI Phase 2).

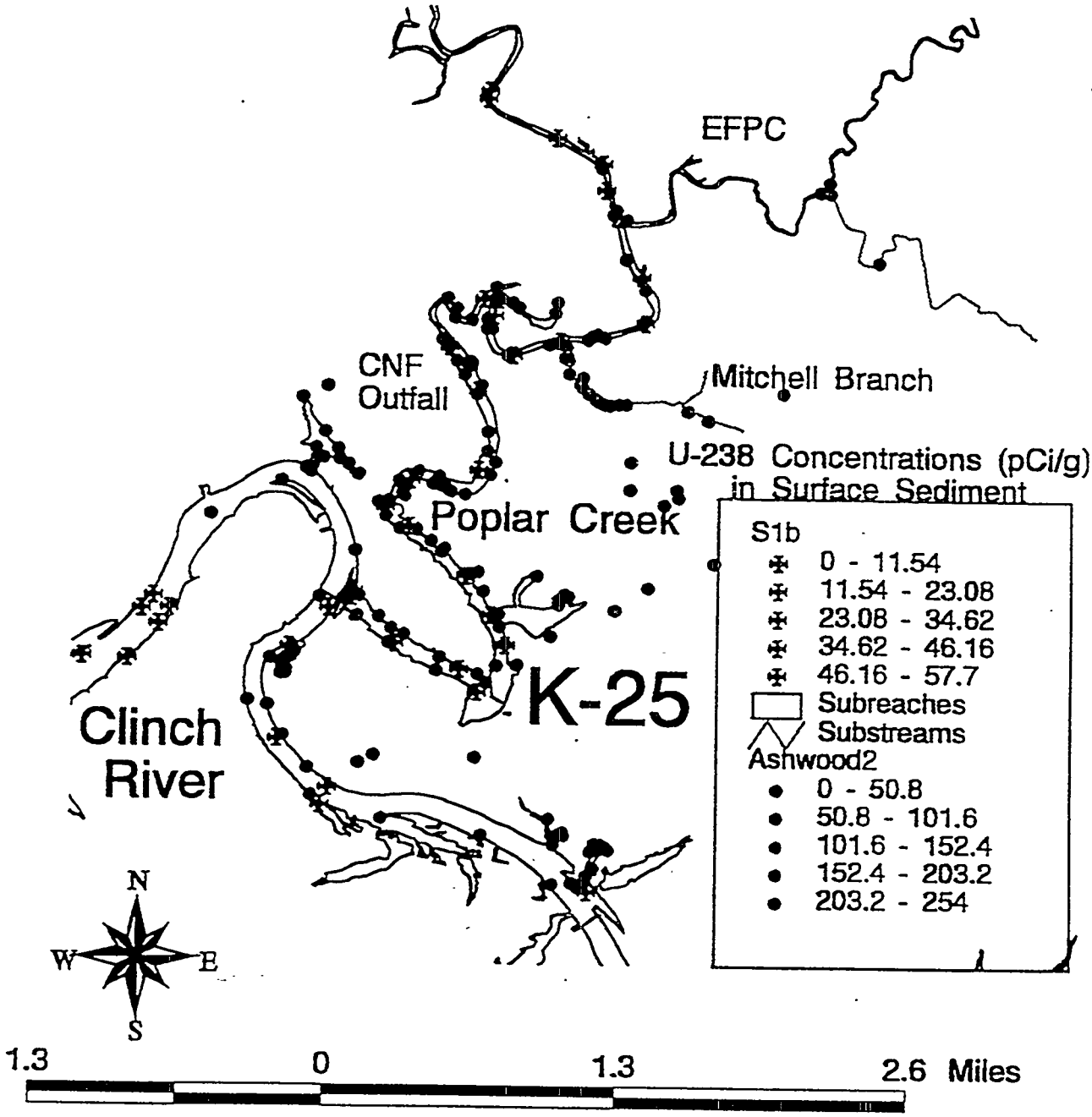


Fig. 3.45. Uranium concentrations in surface sediment in Mitchell Branch and vicinity (data from Ashwood et al. 1986).

Clinch River

This discussion considers spatial trends in contaminant distribution from upper Melton Hill Reservoir (reach 0) downstream through subreach 4.04 at the mouth of the Clinch River. Reach 0 concentrations are considered reference values for the purpose of this discussion. Organic contaminants were detected only infrequently, consisted mostly of relatively ubiquitous PAHs and phenols, were generally present at low concentrations (<1 mg/kg dry sediment), and were often present in one or more reference reaches at similar concentrations (Tables B12–B15). No clear pattern of organic contaminant distribution in the Clinch River is is evident (Figs. 3.39 and 3.40). Therefore, the discussion below will not consider organic compounds other than PCBs.

Reach 1—lower Melton Hill Reservoir. Mean concentrations of ^{60}Co were elevated in both surface and deep sediment (Figs. 3.41–3.43). This increase is attributed to known releases from the American Nuclear Corporation site on Braden Branch (see Sect. 3.1) and not the ORR. Cobalt-60 remains elevated in both surface and deep sediment at levels above reference values throughout the Clinch River, but at concentrations much lower than those observed in reach 1. Copper is also elevated in both surface sediment and core samples in reach 1; the source is unclear.

Reach 2—Clinch River between Melton Hill Dam and Poplar Creek. The upper subreaches of reach 2 are not significant zones of sediment deposition and, therefore, were sampled only sparsely in this study. As a result, it is difficult to detect trends in reach 2 with confidence. Among the most apparent trends are the expected increase in ^{137}Cs concentrations in both surface sediment and core samples collected downstream of WOC (Figs. 3.41 and 3.42). Peak values of each occur within reach 2, but remain elevated downstream throughout reach 4. Uranium-234 and ^{238}U, undetected in reaches 0 and 1, are detected at low concentrations throughout subreaches 2.02–2.04. Aroclor-1254 appears elevated in both surface and deep sediment in subreach 2.02, below WOC (Figs. 3.39 and 3.40). Although the data are derived from a single core sample, the spatial pattern is consistent with known PCB contamination in WOC sediment (subreach 22), located immediately upstream. Selenium and manganese concentrations increased significantly in both surface sediment and core samples collected from subreach 2.04, downstream of Grassy Creek (Figs. 3.36 and 3.37). Subreach 2.04 is adjacent to the the K-1770 steamplant area of the K-25 Site; increased levels of these analytes may be related to operations at this site or the nearby K-700 scrap metal pile.

Reach 4—Clinch River downstream of Poplar Creek. As expected, mean concentrations of mercury in both surface and deep sediment are elevated downstream of Poplar Creek (Figs. 3.36 and 3.37), but at levels much reduced from those within Poplar Creek itself. Mean mercury concentrations are relatively constant throughout reach 4. As noted above, ^{60}Co remains elevated throughout reach 4, but mean concentrations are low (<1 pCi/g). Cesium-137 remains elevated throughout reach 4 as well, where core values are generally highest (Fig. 3.42); surface concentrations appear slightly higher in reach 2 (Fig. 3.41).

The mean core concentration of several analytes appears to decrease in subreach 4.02, leading to an apparent increase in contaminant concentrations in subreaches 4.03 and 4.04. However, as this pattern is evident for contaminants whose sole or primary source is the ORR (e.g., ^{137}Cs and mercury), this is thought to be primarily a function of sediment transport dynamics, and is not thought to indicate a significant source of contaminant flux via the Emory River. A possible exception is copper, mean concentrations of which increased by a factor of two or more in both surface sediment and core samples collected downstream of the Emory River (subreach 4.03; Figs. 3.36 and 3.37). Aroclor-1254 was also elevated below the Emory River, but while the greatest mean core concentrations were found in

subreach 4.03, the greatest mean surface sediment concentration was found in subreach 4.04. This pattern may suggest separate releases of Aroclor-1254 from more than one source.

Reach 7—McCoy Branch. Sampling was limited to only one core sample each from subreach 7.01, 7.02, and from reach 8, the reference reach at Walker Branch. Therefore, no statistical data analysis was possible. Nonetheless, the data did show the expected elevated levels of arsenic in surface sediment, deep sediment, and pore water, particularly in subreach 7.01 (Figs. 3.36–3.38). Selenium was elevated in surface and deep sediment in subreaches 7.01 and 7.02. Vanadium appeared elevated in deep sediment and pore water and to a lesser degree in surface sediment. Each of these metals is associated with coal ash, and its presence is presumed to result from the historical disposal of fly ash from the Y-12 Plant into McCoy Branch and Rogers Quarry.

3.4.4 Sediment And Pore-water Toxicity

Laboratory sediment toxicity tests were conducted to assess the sediment quality of Poplar Creek and the Clinch River. Results of the sediment toxicity tests are used in the baseline ecological risk assessment (Chap. 6).

3.4.4.1 Introduction

The sensitivity of an organism is related to the route of exposure and the biochemical response to contaminants (EPA 1994). For sediment, three general exposures can be defined: exposure to particles (whole sediment), to pore water, and to overlying water (elutriate). A suite of organisms were chosen to assess the toxicity of each exposure route. Organisms that were chosen to evaluate exposure to whole sediment were *Hyalella azteca* (survival endpoint) and *Anodonta imbecillis* (survival endpoint); the solid phase Microtox® test was also used to evaluate toxicity of whole sediment. Two tests were chosen to evaluate exposure to pore water: the *Ceriodaphnia dubia* acute test (survival endpoint) and the liquid-phase Microtox® test. *C. dubia* is a crustacean that is commonly used to evaluate water quality (EPA 1993). Elutriate exposure was evaluated using the crustacean *Daphnia magna* (survival and reproduction endpoints). Direct exposure to *D. magna* may occur from dissolved or colloidal contaminants.

The methods used for evaluating sediment toxicity with these organisms are described in Table B22. Care was taken to avoid excessive alteration and manipulation of sediment samples during sediment storage and preparation and pore water extraction. Several common water quality parameters were analyzed in the water used in the test (alkalinity, hardness, pH, DO, conductivity, and ammonia). Except for ammonia, potentially toxic contaminants were not analyzed. All measured water quality parameters were within organism tolerances and, therefore, do not affect the sediment toxicity results.

The study period (July 1993 to September 1994) involved 9 sampling events: event 1—July 1993; event 2—August 1993; event 3—November 1993; event 4—February 1994; event 5—May 1994; event 6—June 1994; event 7—July 1994; event 8—August 1994; and event 9—September 1994. A total of 78 samples from 15 sites in 6 reaches were collected for toxicity testing (Fig. 3.46); not all sites were sampled during each sampling event. A total of 304 tests were conducted, using 5 test species and 3 endpoints.

Elutriate. A total of 54 individual tests were conducted with *D. magna*, resulting in 40 site-to-reference survival comparisons. Five of the 40 (12.5%) showed a ≥ 20% reduction in survival relative to reference sites: PCM 1.0 in events 1 and 7; CRM 9.0 in event 4; and CRM 19.0 in events 1 and 5. None of these comparisons showed statistically lower survival.

Forty site-to-reference reproduction comparisons were obtained from the same 54 *D. magna* tests. Seven of the 40 (17.5%) showed a ≥ 20% reduction in reproduction: PCM 1.0 in events 4 and 5; PCM 4.3 in event 4; PCM 5.1 in event 4; CRM 9.0 in events 4 and 5; and CRM 19.0 in event 4. Note that all significant reductions in reproduction occurred in either event 4 or 5. The reduction in reproduction was statistically significant in two of the seven tests above (CRM 9.0 and 19.0, both in event 4).

Toxicity was not suggested by either the *D. magna* survival or toxicity data. Overall survival was high, with about 85% of the tests resulting in ≥ 80% survival. Water-only reference toxicant tests and other water-only studies have demonstrated *D. magna* to be relatively sensitive to water-borne contaminants, implying that contaminants are either not present in Clinch River/Poplar Creek sediment or are not migrating into the overlying water column.

3.4.4.3 Conclusions

The results above reveal very little toxicity from sediment at the sites tested. The total percentage of tests that met either of the the significance criteria was very low, suggesting a minimal impact to test species in the Poplar Creek, Clinch River, and McCoy/Walker Branch systems.

There were no striking spatial trends in the sediment toxicity data. Of the overall low number of positive responses at test sites, the higher percentage of them were found at PCM 4.3 and CRM 9.0 and CRM 19.0. Temporal trends are difficult to determine given the minimal response detected. The greatest probability of detecting a hit appears to occur in the winter/spring, but without other data (chemistry, sediment transport dynamics, etc.), this subtle trend cannot be confirmed. No historical sediment toxicity data are available for this study area.

The most sensitive tests were the *H. azteca* and the freshwater mussel (*A. imbecillis*) whole sediment tests, where direct exposure to most contaminants is presumed greatest. The least sensitive tests were the two pore water tests (the *C. dubia* acute toxicity test and the Microtox® liquid-phase test).

3.4.5 Sediment Transport Modeling in the Clinch River

3.4.5.1 One dimensional modeling of sediment and ^{137}Cs transport

Introduction. The fate of historically released ^{137}Cs (1949–1991) was simulated using three separate one-dimensional water and sediment transport models: HEC-6-R (USACE 1993), CHARIMA (Holly et al 1990), and TODAM (Onishi et al 1980). The models were implemented independently by ORNL, by TVA in cooperation with the Iowa Institute of Hydraulic Research, and by the Pacific Northwest Laboratory (PNL). This multiple modeling approach was used to foster confidence in model predictions characterizing future scenarios (Rose et al. 1993).

The HEC-6-R (implemented by ORNL) and CHARIMA (TVA) models simulate hydrodynamic conditions, sediment deposition, erosion and transport, and contaminant fate. The TODAM model simulates sediment and contaminant fate processes, but receives hydrodynamic information from CHARIMA's hydrodynamic module. The three models were configured similarly for the total Clinch

River/WBR system, but differed in numerical solution techniques and in algorithms for calculating sediment transport and contaminant fate.

Calibration. All three models were calibrated using TVA data on historical sedimentation rates and validated using existing data on ^{137}Cs distributions (Cottrell 1960; Morton 1965; Struxness et al. 1967; Oakes et al. 1982; Olsen et al. 1991). Each model predicted sediment accumulation that generally matched the measured accumulation, even though the latter varied significantly between time periods. (e.g., TVA silt range data indicate that only 25 acre-ft of sediment accumulated in the Clinch River during the 30 year period ending 1991). TODAM tended to overpredict sediment accumulation for the periods 1951–1956 and 1961–1991.

The "known" ^{137}Cs inventory in the Clinch River in the summer of 1977 was extrapolated via a Voronoi tesselation in GRASS of the measured ^{137}Cs core data of Oakes et al. (1982). The predicted 1977 inventories were calculated by each of the modeling groups and compared to this known inventory for several segments of the Clinch River (Fig. 3.47). The extrapolated core data of Oakes et al. (1982) indicate a total of 42.5 Ci of ^{137}Cs in the river. The TODAM model predicts four-fold that amount, CHARIMA predicts a total of 40 Ci, and HEC-6-R predicts 57 Ci.

The different predictions above are due in part to differences between the models in the assumed particle size distribution of inflowing sediments. The TODAM modelling group assumed a greater quantity of relatively coarse sediment entering the Clinch River as compared to the other modelling groups. TODAM's higher predicted inventories may be partly explained by the fact that coarser sediments would deposit more quickly and closer to the source than finer sediments. The HEC-6-R assumptions were modified, after the initial calibration above, to mimic the particle-size distributions of inflowing sediment used in the TODAM and CHARIMA models. When HEC-6-R mimicked TODAM's coarse sediments, the predicted ^{137}Cs inventories increased (from 57 to 72 Ci). Similarly, when HEC-6-R mimicked CHARIMA's finer incoming sediments, the predicted ^{137}Cs inventories decreased (from 57 to 55 Ci) (Fig. 3.47). In effect, the TODAM model failed to simulate the observed erosion and downstream transport of contaminated sediment that had been deposited in the Clinch River during the periods of peak ^{137}Cs flux from WOC in the late 1950s.

Each of the models above predicts deposition over relatively large reaches of the Clinch River, and, therefore, none predicts small-scale patterns of ^{137}Cs distribution very well. The strong spatial heterogeneity in erosion and deposition in Clinch River sediment is at a much finer scale than the modeled reaches. For example, only about 25% of the over 200 cores sampled by Oakes had significant ^{137}Cs levels, and many samples collected very near each other differed significantly in ^{137}Cs inventory. In addition, the bathymetry of the Clinch was represented by only 5 silt ranges. This resulted in some necessary additional bathymetry assumptions to obtain successful hydrodynamic simulations, which might have affected the pattern of sediment deposition adversely. Nonetheless, CHARIMA and HEC-6-R predicted total ^{137}Cs inventory very well.

Simulations. Several future scenarios were simulated by each model: (1) predictions assuming no major storm events or releases of ^{137}Cs, (2) predictions following an assumed 100-year-return-period storm localized in the WOC watershed, and (3) predictions following an assumed system-wide 100-year-return-period storm. All simulations evaluated both short-term (2 week, 1 and 6 month) and long-term (1 and 10 year) responses. The increased ^{137}Cs flux from WOC was based on preliminary predictions by the HSPF watershed model (Bickwell et al. 1993) applied to the WOC Watershed. The scenarios begin on April 30, 1991, each modelling group beginning with the ^{137}Cs inventories predicted for that date by their respective models. Results are summarized in Table 3.5.

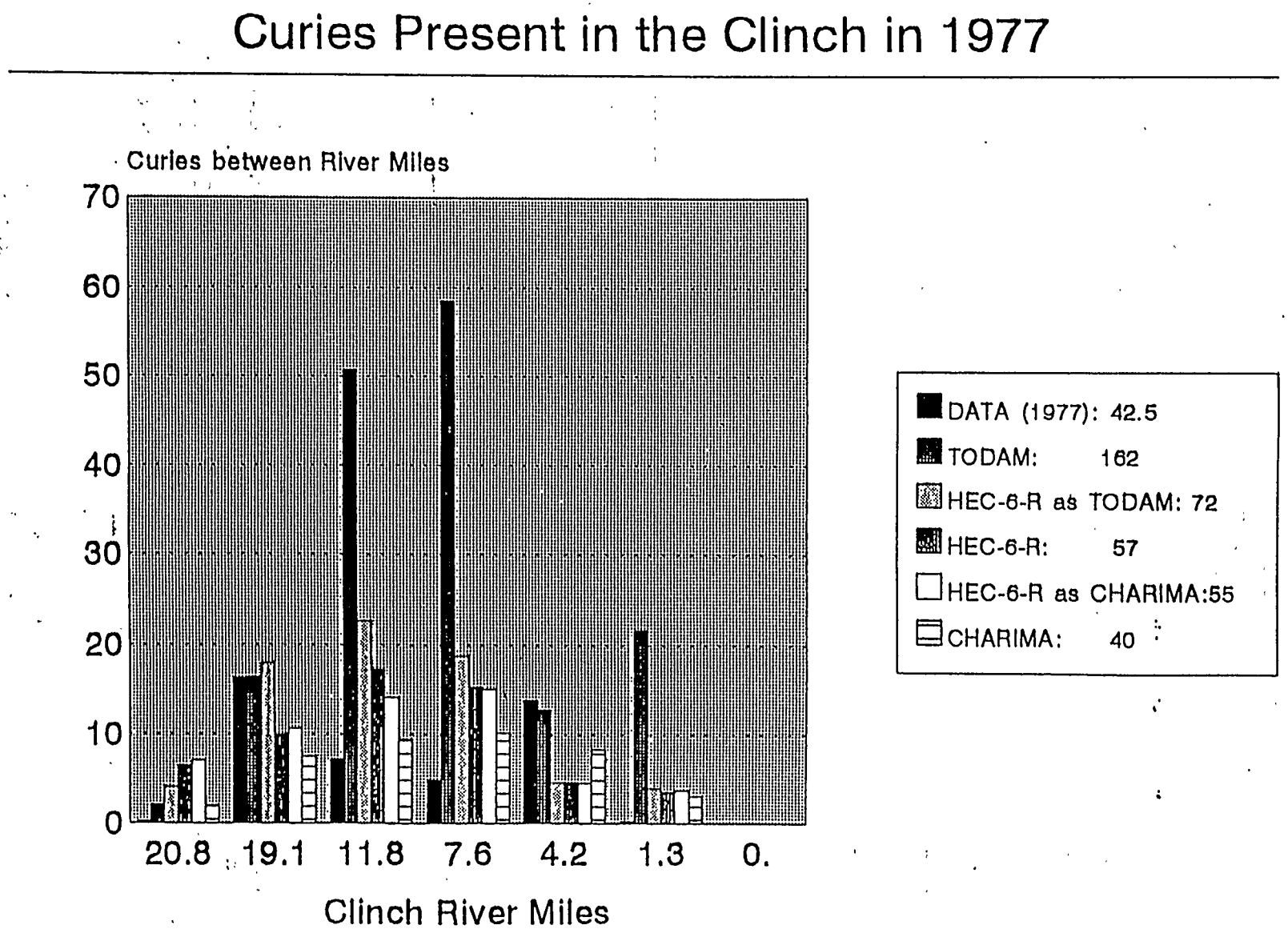


Fig. 3.47. Results of model simulations for curies within river reaches over different time periods.

HEC-6-R. When no specific storm occurs in the WOC Watershed, and, therefore, no increased release of ^{137}Cs takes place, the dominant process for loss of radioactivity is radioactive decay. Through erosion this loss is somewhat enhanced in the 1 to 6 month period. When a local 100-year-return-period storm is simulated in the WOC Watershed, 23.5 Ci are released, with 6.7 Ci accumulating in the Clinch within two weeks after onset of the storm. However, within 6 months the level in the Clinch decreases to a level lower than before the storm (i.e., the curies deposited in the Clinch reside there for a relatively short period). During the system-wide storm, in spite of increased ^{137}Cs flux from WOC, a net loss of 5.9 Ci in the Clinch occurs through erosion. Thus, 1 and 10 years after either the local storm or the no-storm scenario, the ^{137}Cs inventory in the river declines, primarily via radioactive decay. Following a system-wide storm, contaminant levels decline in the short term as a result of sediment erosion and in the long term via radioactive decay.

Table 3.5. Clinch River storm responses with regard to ^{137}Cs in bed sediments

	onset	2 weeks	1 month	0.5 year	1 year	10 years
HEC-6-R						
no storm	39.9	39.9	39.8	37.5	37.2	30.5
local storm	39.9	46.6	44.4	37.8	37.5	30.7
system storm	39.9	34.0	33.3	31.9	31.6	26.3
CHARIMA						
no storm	30.7	30.7	30.7	28.9	28.7	25.7
local storm	30.7	33.2	33.2	28.0	27.9	24.7
system storm	30.7	25.7	24.1	22.9	22.8	20.2
TODAM						
no storm	120.8	120.7	120.6	119.1	118.1	98.7
local storm	120.8	139.9	139.7	128.4	127.0	105.4
system storm	120.8	127.0	125.3	124.1	122.9	102.5

CHARIMA. Results of the CHARIMA simulations are similar to those of HEC-6-R. When no specific storm occurs, radioactive decay is the dominant process in the Clinch. Again, some erosion occurs in the short term. CHARIMA predicts less of an increase in contaminant levels than HEC-6-R as a result of the local storm (i.e., only 3 Ci) but again the increase is only temporary. As with HEC-6-R, the system-wide storm results in erosion that lowers the ^{137}Cs inventory by 5 Ci. CHARIMA's prediction of historic ^{137}Cs deposition (i.e., conditions at onset of the simulations) was lower than that of HEC-6-R, and its storm scenario response was, therefore, similarly muted.

TODAM. The TODAM scenario results differ from those of HEC-6-R and CHARIMA in a number of significant ways. To begin, the 1991 ^{137}Cs inventory in the river predicted by TODAM is three and four fold what is predicted by HEC-6-R and CHARIMA, respectively. In the no-storm scenario, both HEC-6-R and CHARIMA show roughly 5% reduction in ^{137}Cs levels between 1 and 6 months. TODAM predicts

only a 1% reduction. In other words, as compared to HEC-6-R and CHARIMA, TODAM assumes bed sediments are less erodable, which is explained by the assumption of generally coarser bed particle size distributions used in the TODAM model. The local storm scenario results differ in that a larger increase of ^{137}Cs occurs in the Clinch (+19 Ci) compared to HEC-6-R (+6.7 Ci) and CHARIMA (+2.5 Ci). TODAM, like the other models, predicts that most of the recently deposited ^{137}Cs resides there only temporarily (< 6 months), although a net increase persists longer. For the system-wide storm scenario, TODAM predicts a large increase (+6.2 Ci) in ^{137}Cs levels, while both HEC-6-R and CHARIMA showed an immediate decrease due to erosion.

Conclusions. Each model predicts that, in the absence of a significant (i.e., 100-year) storm event, the existing inventory of ^{137}Cs in the Clinch River will continue to decline, primarily through radioactive decay. The HEC-6-R and CHARIMA models predict that following a system-wide, 100-year storm, despite increased contaminant flux from WOC, contaminant levels in the Clinch River will decrease in the short-term due to erosion of existing sediment. Conversely, TODAM predicts an increased inventory under this scenario. The HEC-6-R and CHARIMA models predict that a sudden flux of contaminants from the WOC Watershed during a local storm would result in a temporary (< 6 month) increase in contaminant levels in Clinch River sediment; TODAM predicts a much larger and longer-lasting increase. The TODAM model results apparently differ because a critical underlying assumption differs; TODAM assumes a greater proportion of coarse sediment being transported, generally predicting quicker sediment deposition following storm events and less erosion subsequent to deposition. However, the coffer dam at the mouth of WOC will prevent the coarsest sediment particles from entering the Clinch River, and discharges from Melton Hill Dam can easily cause resuspension and entrainment of freshly deposited sediments. Indeed, TODAM was the least calibrated of the three models.

3.4.5.2 Simulation of sediment transport in the Clinch River using a two-dimensional, finite-element model

Introduction. A two-dimensional model of the Clinch River was used to simulate horizontal flow circulation and sediment erosion, deposition, and transport. The model is used to better understand and quantify the short-term fate of an accidental release of a sediment-reactive contaminant under baseline and high flow conditions.

The RMA2 hydrodynamic module and the STUDH sediment transport module (both from TABS-2, Norton et al. 1973; Thomas and McAnally 1991) were applied to the Clinch River. A two-dimensional model permits lateral (across river) resolution of predictions and has the advantages of being able to model unsteady flow (time-dependent), reverse and lateral flows, and complex flow patterns related to the power plant, channel islands, weirs, and tributaries. A two-dimensional finite element grid network was created to represent the bathymetry of the Clinch River system based on data previously surveyed by TVA, ORNL, and U.S. Army Corps of Engineers. Grids are formed by connecting the nodes into triangular or quadrilateral elements. Grid generation was performed using an automated algorithm and selected points from observed data. Cross-sectional areas based on generated grids differed by <5% from those estimated from measured silt range data. The grid network is composed of 4137 nodes and 1313 elements. The system receives water released at Melton Hill Dam on the upstream boundary and inflows from the tributaries including WOC, Poplar Creek, and the Emory River. The downstream boundary of the system is located at the Clinch River mouth (the confluence with the Tennessee River).

Module calibration. The RMA2 hydrodynamic module was calibrated using November 1993 flows and water surface elevation data. Because RMA2 uses observed water surface elevation at the downstream boundary and inflow values from each tributary as boundary conditions, the largest difference between simulated and observed water surface elevations generally occurs at the upstream-most boundary

(Melton Hill Dam). The regression relationship between simulated and measured stage heights at the Melton Hill Dam was

$$Y = 17.4583 + 0.92286X$$

where Y is the observed stage and X is the simulated stage. The regression R^2 was 0.9892, implying good correspondence between simulated and observed values. The simulation results also showed that reverse flow occurred several times in November 1993 around the Kingston Steam Plant.

The STUDH sediment transport module was coupled to the calibrated RMA2 hydrodynamics module to simulate deposition, resuspension, and transport of sediments (cohesive and noncohesive material). Predicted flow velocities and water depths at each node in the system from RMA2 were input to STUDH. STUDH simulates one sediment type (grain size class) at a time to simplify numerical solution. Two classes of fine-grained sediments (clay and silt) were used as a surrogate for contaminated sediments. Fine-grained sediments are a good surrogate for ^{137}Cs provided that the ^{137}Cs entering from WOC is in equilibrium between the dissolved and adsorbed phases, and undergoes negligible decay during model simulations. Field measured data indicated that approximately 90% of ^{137}Cs released was adsorbed to suspended sediments (Churchill et al. 1965). Simulated sediment transport was deemed realistic based on predicted deposition locations of clay, silt, and sand being similar to qualitative patterns of these sediment classes observed in the Clinch River (Levine et al. 1994).

Model scenarios. Six simulations using the coupled hydrodynamic and sediment transport modules were performed. The six simulations involve three flow conditions (baseline, a local storm in WOC, and a system-wide storm), each with a sudden 3-day release of clay or silt in WOC. The baseline simulation imposed the 3-day release under average flow conditions. The local storm scenario imposed the 3-day release during 3 days of high tributary inflows in the WOC basin only. The system-wide storm scenario imposed the 3-day release during 3 days of high tributary inflows for WOC and the Clinch River. The movement and distribution of the contaminated sediments suspended in the water column and newly deposited on the river bottom after the storm release were tracked for 30 days. The river bottom was assumed initially to have no sediments, and no erosion was allowed to prevent resuspension. Thus, only deposition was permitted and all deposited sediments came from the 3-day release event.

Model predictions are expressed as the percentage of the total amount of sediment introduced that deposited in the WOC Embayment (WOC dam to coffer dam), upper Clinch River region (between WOC Embayment and Poplar Creek), and lower Clinch River region (between Poplar Creek and confluence with the Tennessee River), and the percentage exported out of the Clinch River. Because of different tributary inflows, more sediment was introduced to the system under the local and system-wide storm scenarios (325,202 kg) than during the baseline scenario (20,689 kg).

Results and conclusions. Predicted percentages deposited or exported out of the system for the six simulations after 30 days are presented in Table 3.6.

The following conclusions can be drawn from the simulation results:

(a) As expected, under the same flow conditions, clay was transported further downstream than silt.
(b) A higher percentage of sediment was retained in WOC Embayment under baseline conditions compared to the local and system-wide storm scenarios; however, over 70% of the clay was exported out of the system under baseline conditions.
(c) No significant deposition occurred in the lower Clinch River in any of the simulations.

(d) Significant deposition only occurred in the upper Clinch River region under the local storm scenario.
(e) Simulations using clay and the system-wide storm using silt resulted in significant export (>27%) of sediments out of the Clinch River and into lower WBR.

Table 3.6. Predicted percentage of clay or silt deposited in regions of the Clinch River, and exported out of the Clinch River, 30 days after a 3-day release in the White Oak Creek under baseline, local storm, and system-wide storm conditions

	Clay (%)			Silt (%)		
	Baseline	Local storm	System storm	Baseline	Local storm	System storm
WOCE	29.36	4.27	4.63	85.38	39.77	46.06
Upper CR	0.00	68.17	0.53	0.00	48.50	25.97
Lower CR	0.00	0.00	0.00	0.00	0.00	0.00
Out of CR	70.38	27.57	94.65	14.62	11.73	27.92

3.4.6 Summary of Sediment Characterization

The CRRI Phase 2 data confirm much of what was known about sediment contamination in the Clinch River and Poplar Creek from earlier investigations. In general, organic contaminants are found infrequently and at very low concentrations, and consist almost exclusively of compounds that are relatively ubiquitous at low concentrations in the environment.

In Melton Hill Reservoir, contaminant levels are generally at or near background except for ^{60}Co, which originates from a non-DOE source in Braden Branch. The historical practice of disposing of fly ash from the Y-12 Plant into McCoy Branch has resulted in elevated concentrations of several metals (As, Se, and V) in sediment of the McCoy Branch Embayment of Melton Hill Reservoir.

The primary radionuclide found at elevated levels in the Clinch River downstream of WOC is ^{137}Cs. Peak concentrations are found in areas of significant sediment accumulation, primarily downstream of Poplar Creek and are buried under as much as a foot of cleaner sediment. Near-shore areas, as a result of less sediment contamination, have average ^{137}Cs concentrations that are lower than sediment accumulation zones in and along the river channel. Mercury is also elevated in the Clinch River downstream of Poplar Creek, where peak concentrations are found coincident with those of ^{137}Cs due to concurrent release histories.

Several metals and radionuclides are elevated in Poplar Creek sediment. Mercury, copper, chromium, and cadmium are elevated below the mouth of EFPC. Mitchell Branch is an apparent source of several contaminants, as evidenced by increased levels of Ni, Ag, Cr, Cu, U, and ^{99}Tc downstream of its mouth. In lower Poplar Creek, the historical disposal of fly ash from the K-25 steam plant has resulted in increased levels of arsenic, boron, and vanadium in both surface and deep sediment. Levels of ^{137}Cs and ^{60}Co are also slightly elevated here as compared to upper subreaches of Poplar Creek, possibly a result of backflow from the Clinch River.

Tests were conducted to evaluate the toxicity of whole sediment, sediment elutriate, and sediment pore water to several different test organisms. Overall, toxicity was very low in all tests and across all

sites. Few tests indicated statistically significant toxic effects as compared to the appropriate reference tests, and no meaningful pattern of toxicity could be discerned.

One-dimensional sediment transport modelling was conducted to predict future contaminant (^{137}Cs) fate and distribution under a variety of hydrological conditions. In general, barring any significant additional release to the Clinch River, existing levels of ^{137}Cs will continue to decline, primarily via radioactive decay. In the event of a local 100-year storm in the WOC Watershed, sediment and ^{137}Cs flux would result in temporarily increased levels in the Clinch River, but subsequent scouring and transport downstream of these recently deposited sediments would occur within 6 months. A regional 100-year storm would result in the immediate scour and transport downstream of existing contamination, such that levels decline immediately as a direct result of the storm.

3.5 CHARACTERIZATION OF BIOTA

The characterization of biota consists of five interrelated tasks. The fish contaminant study (Sect. 3.5.1) characterizes the nature and extent of organic and heavy metal contaminants in key fish species of the CR/PC system. An analysis of contaminants in the aquatic foodweb is presented in Sect. 3.5.2. Section 3.5.3 investigates contaminant dynamics and biological effects of other important biota of the CR/PC system such as mink and the great blue heron. The biological indicators component (Sect. 3.5.4) and the reproductive effects study (Sect. 3.5.5) are designed to evaluate the effects of contaminants and other environmental stressors on fish health and fish reproductive function, respectively. Information from these five tasks are used not only to characterize the nature and extent of contamination in biota and to evaluate the effects of this contamination on important ecological species, but they also provide information that is used in the human health and ecological risk assessments.

3.5.1 Contaminants in Sportfish

3.5.1.1 Historical studies of contaminants in fish

Clinch River Study. Fish were collected from the Clinch River downstream of ORNL during the period 1960–1963 and analyzed for several radionuclides for the purpose of estimating potential risk to humans via fish consumption (Cowser and Snyder 1966). Several species of bottom feeders (carp, carpsucker, buffalo, and catfish) and several species of "sight feeders" (white crappie, bluegill, white bass, largemouth bass, sauger, and drum) were collected.

Results are presented in Table C1. Bottom feeders were analyzed in two ways: flesh only and as whole fish. Results are presented for each bottom feeder species. Sight feeders were analyzed flesh only; because of limited sample size, no interspecific or year-to-year results are presented.

The greatest radionuclide intake was calculated to result from the consumption of whole (i.e., bones and flesh) bottom feeders. It was estimated that, as a result primarily of ^{90}Sr in the bones of such fish, an individual could receive up to 7% of the maximum permissible intake in effect at that time (Cowser and Snyder 1966). The authors noted that approximately 45% of the ^{90}Sr and 20% of the ^{137}Cs measured in fish tissues were attributable to atmospheric fallout from nuclear tests.

TVA Instream Contaminant Study. In preparing for this study, TVA (1983) conducted an extensive review of existing data. These data led TVA to expect levels of mercury, chromium, nickel, and PCBs in Clinch River and Poplar Creek fish that were above background in at least one species (Tables C2 and

C3). In both the Clinch River and in Poplar Creek, mean mercury concentrations, while elevated, were below the Food and Drug Administration (FDA) action level of 1 mg/kg.

During the study, TVA (1985) collected fish (primarily bass and bluegill) from several sites in the Clinch River, one site in Poplar Creek, from several streams on the ORR, and from reference areas. TVA concluded that the concentrations of metals other than mercury were within the range of background levels. Mean mercury concentrations in the Clinch River and Poplar Creek ranged from 0.03 mg/kg (in bluegill at CRM 2.0) to 0.93 mg/kg (in smallmouth buffalo at PCM 0.2). Considering all species combined, mean mercury concentrations in Poplar Creek and the Clinch River were elevated above background but were below the FDA action level of 1.0 mg/kg, confirming the historical data.

Organic contaminants other than PCBs were detected only rarely during the study. Mean PCB concentrations in channel catfish (fillets) were greatest at WOC Mile 0.2 (3.1 mg/kg). Concentrations in Clinch River catfish decreased with distance downstream of WOC, but appeared elevated relative to catfish from Melton Hill Reservoir. Mean concentrations (<1.0 mg/kg) in the Clinch River were below the FDA action level of 2.0 mg/kg (Table C4).

Of several radiological parameters that were measured, only gross beta and ^{137}Cs appeared elevated in Clinch River fish as compared to historical values for fish from the Tennessee River (Table C5).

CRRI Phase 1. Three fish species (bluegill, channel catfish, and largemouth bass) were collected from locations in Watts Bar, Melton Hill, and Norris reservoirs and analyzed for metals, organic compounds, and radionuclides (Cook et al. 1992). Compared to the Norris reference site, the concentrations of several analytes were significantly elevated at one or more Poplar Creek or Clinch River stations. However, only mercury and ^{137}Cs exhibited a spatial pattern that could clearly be attributed to releases from the ORR. Mean mercury and PCB values in Clinch River and Poplar Creek fish were again below FDA action levels.

TVA Fish Tissue Studies. The TVA monitors contaminant concentrations in fish tissue throughout the Tennessee Valley. Elevated levels of PCBs have been found in fish from Fort Loudon, Watts Bar,and Melton Hill reservoirs since the late 1980s. As a result, the TDEC (1992) issued fish consumption advisories for these waters, including a "no consumption" advisory for Melton Hill catfish and "limited consumption" advisories for catfish and sauger in the Clinch River below Melton Hill Dam. Recent data collection efforts have focused on PCBs in catfish, results for which are summarized in Figs. 3.48–3.49.

3.5.1.2 Introduction

Both water-soluble and particle-reactive contaminants can accumulate in WBR biota. The extent to which this has occurred in WBR fish has been under investigation since the mid 1980s (TVA 1985; Dycus and Hickman 1988, 1989, 1990; Meinert 1991; Cook et al. 1992; Meinert and Fehring 1992; Fehring and Meinert 1993). The upper Tennessee River arm of the reservoir was the first area of the reservoir to be investigated, but eventually, investigators realized that a problem extended throughout the reservoir. Phase 1 of the CRRI identified seven contaminants of concern to human health in fish — As, Be, Hg, Se, PCBs (Aroclors 1254 and 1260), and chlordane (Cook et al. 1992). Radionuclides occurred at relatively low levels in fish tissue and none were listed as a contaminant of concern via the fish consumption pathway. The ecological risk assessment did not identify any additional contaminants of concern.

The Phase 1 sampling and analysis left many questions unanswered, however. Some important sport species (i.e., largemouth bass, *Micropterus salmoides*, and striped bass, *Morone saxatilis*) were

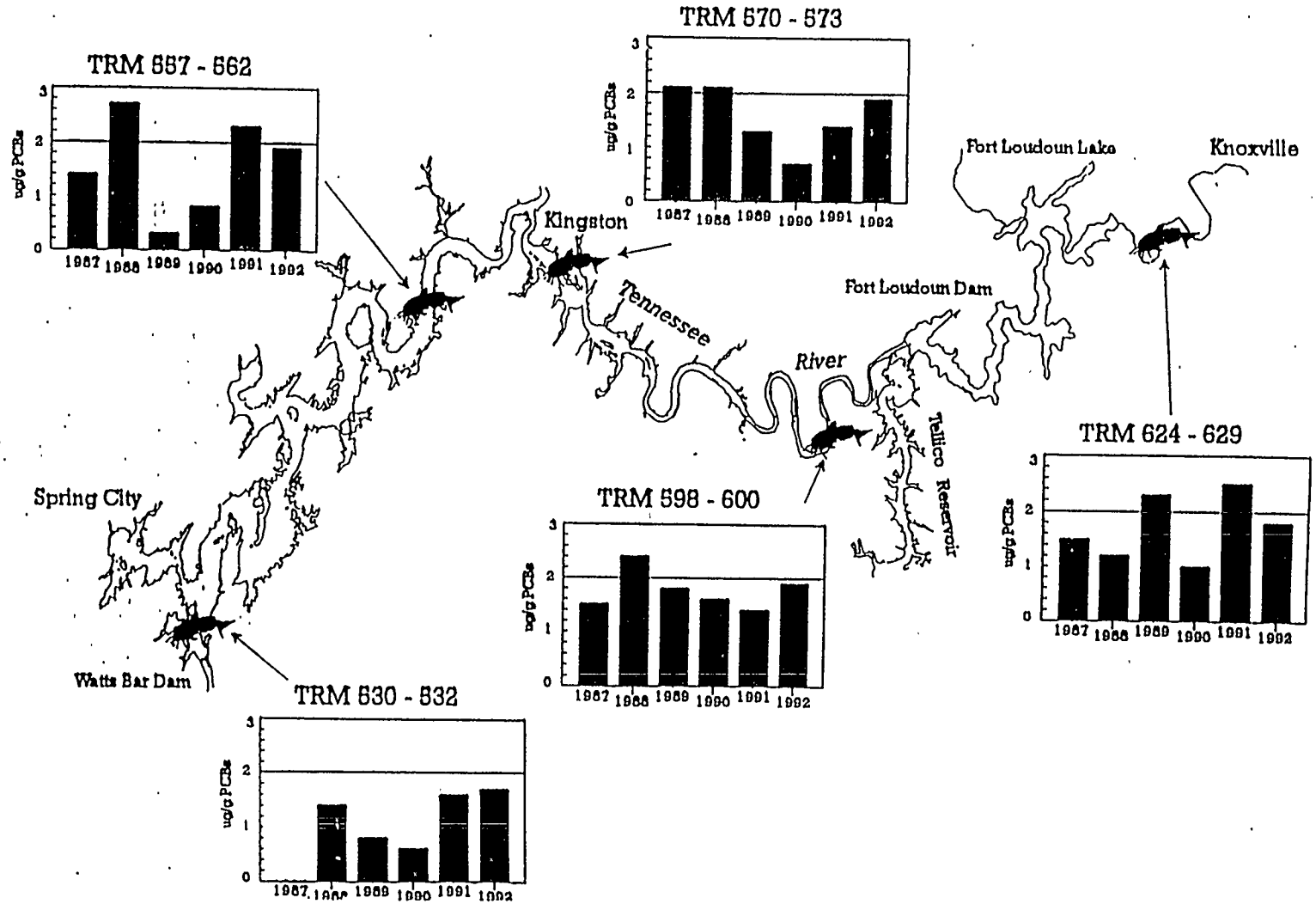


Fig. 3.48. Mean total PCB concentrations (mg/kg) in catfish at various sites throughout the Tennessee River section of Watts Bar Reservoir from 1987 to 1992.

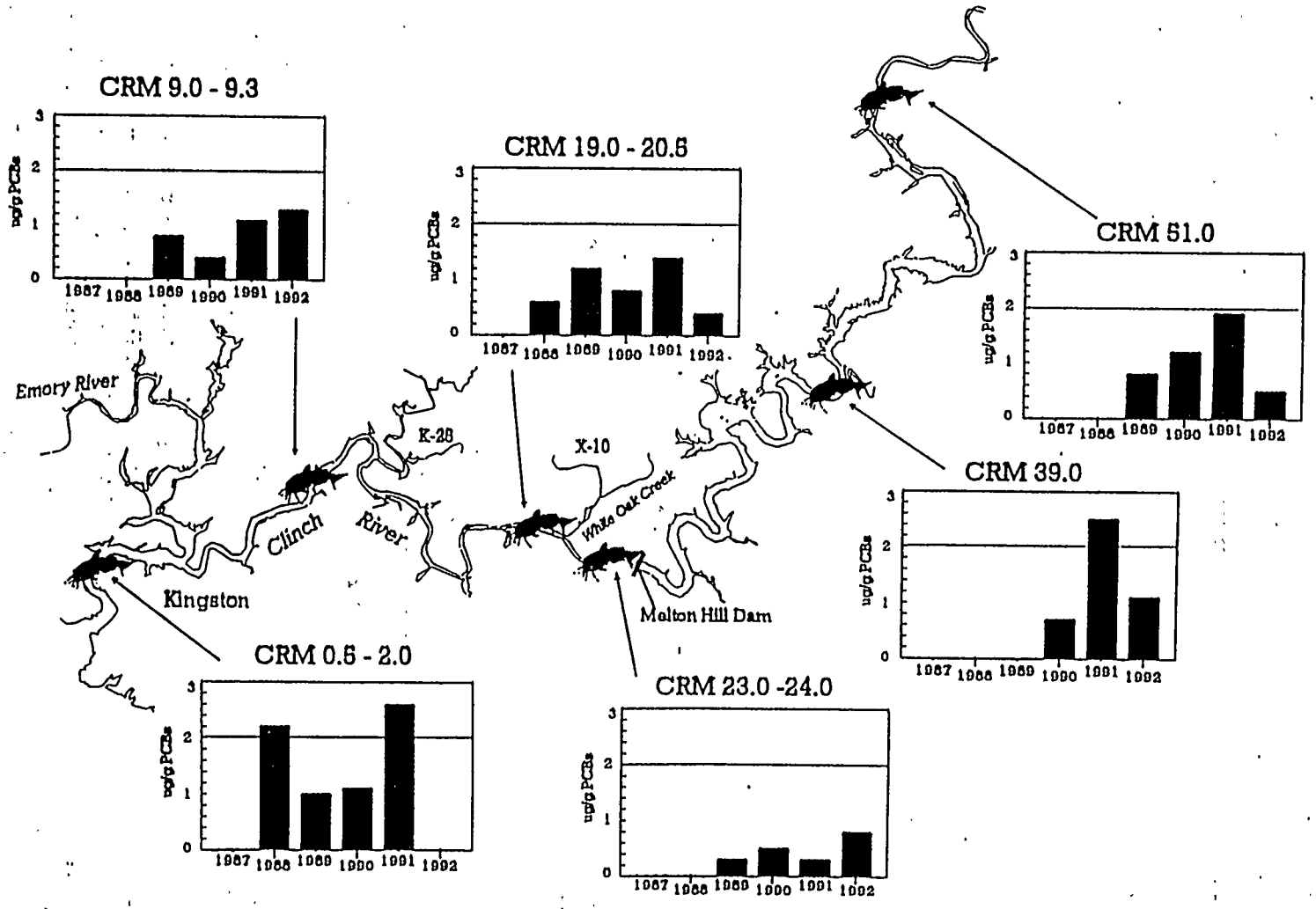


Fig. 3.49. Mean total PCB concentrations (mg/kg) in catfish at various sites throughout the Clinch River arm of Watts Bar Reservoir and Poplar Creek embayment from 1988 to 1992.

either not sampled or sampled in inadequate numbers to address among- and within-site variability and differences among species. Possible temporal trends were difficult to identify given the single collection period (fall 1989) and the limited historical data set. In addition, a detailed evaluation of the PCB problem was not possible since PCB concentrations in fish tissue were expressed as mixtures of several PCBs (e.g., Aroclor 1260 or 1254) and not as individual PCB congeners. For these and other reasons, the sampling and analysis of fish were continued during Phase 2 of the CRRI.

The primary objective of this task was to determine the extent to which key fish species in the CR/PC OU are contaminated by past and present releases from the ORR. This information will be used in the human health and ecological risk assessments and will also provide supportive data for other biota tasks. Key fish species from selected sites throughout the CR/PC system, including reference areas, were sampled and analyzed for contaminants identified in Phase 1 as those of potential human health or ecological concern. This sampling, while concentrated in the Poplar Creek embayment and the Clinch River arm of WBR, also included sites in the Tennessee River and Norris Reservoir for comparison.

3.5.1.3 Sampling and analysis

Several species of fish were collected from 1989 to 1994 at sites throughout WBR and from upstream "reference" reservoirs. Species were selected based on angling popularity, desirability for consumption, contaminant assimilation properties, and diversity (e.g., different sizes and trophic levels). Catfish (channel, *Ictalurus punctatus*, and blue, *I. furcatus*) are a popular food fish particularly for subsistence fishers and are omnivorous bottom-dwelling fish with relatively high lipid content. Fish with higher lipid contents generally accumulate higher concentrations of hydrophobic contaminants such as PCBs. Largemouth bass are an extremely popular sport fish and are mid-sized piscivores with a somewhat limited home range. Striped bass (including the striped bass X white bass hybrid, *Morone saxatilis* X *M. chrysops*), popular as a sportfish but less so as a food fish, are large piscivores that are known to range throughout the reservoir on a seasonal basis (Cheek et al. 1983). Bluegill sunfish (*Lepomis macrochirus*), also a popular food fish, are small invertivores with a relatively small home range. The contaminant body burden of fish with small home ranges should be more representative of conditions at the capture location compared to fish with larger home ranges. A limited number of carp (*Cyprinus carpio*) and white crappie (*Pomoxis annularis*) were also collected. The lengths of fish collected were within the range of the typical harvestable size for each species.

During Phase 2 (1991–1994), fish were collected by electroshocking, gill-netting, and trapping (slat-baskets) at 13 sites in WBR, at two reference sites in Norris Reservoir, in Melton Hill Reservoir, and in Chickamauga Reservoir (Fig. 3.50). Sites were selected such that all areas of the reservoir were represented, particularly those close to potential sources of contamination. Bluegill and largemouth bass were collected in the spring, while the other species were, with a few exceptions, collected in the fall.

Fish were usually analyzed as individual samples, but in some cases, five fish were combined into a composite sample. Fillets were removed from all sportfish species for analysis. Catfish were skinned, while other species were scaled and analyzed with the skin on. Samples were homogenized and analyzed by standard analytical methods identified in the sampling plan (DOE 1993). Catfish, largemouth bass, striped bass (which includes some hybrids), and a single composite sample each of carp and white crappie were analyzed for PCBs (Aroclor mixtures and individual congeners) and pesticides (primarily chlordane). Bluegill, largemouth bass, and a few catfish were analyzed for several inorganics (As, Be, Cu, Hg, and Se). In addition, catfish at one site were analyzed for a suite of semivolatile organics to confirm the general absence of this class of contaminants as documented during Phase 1.

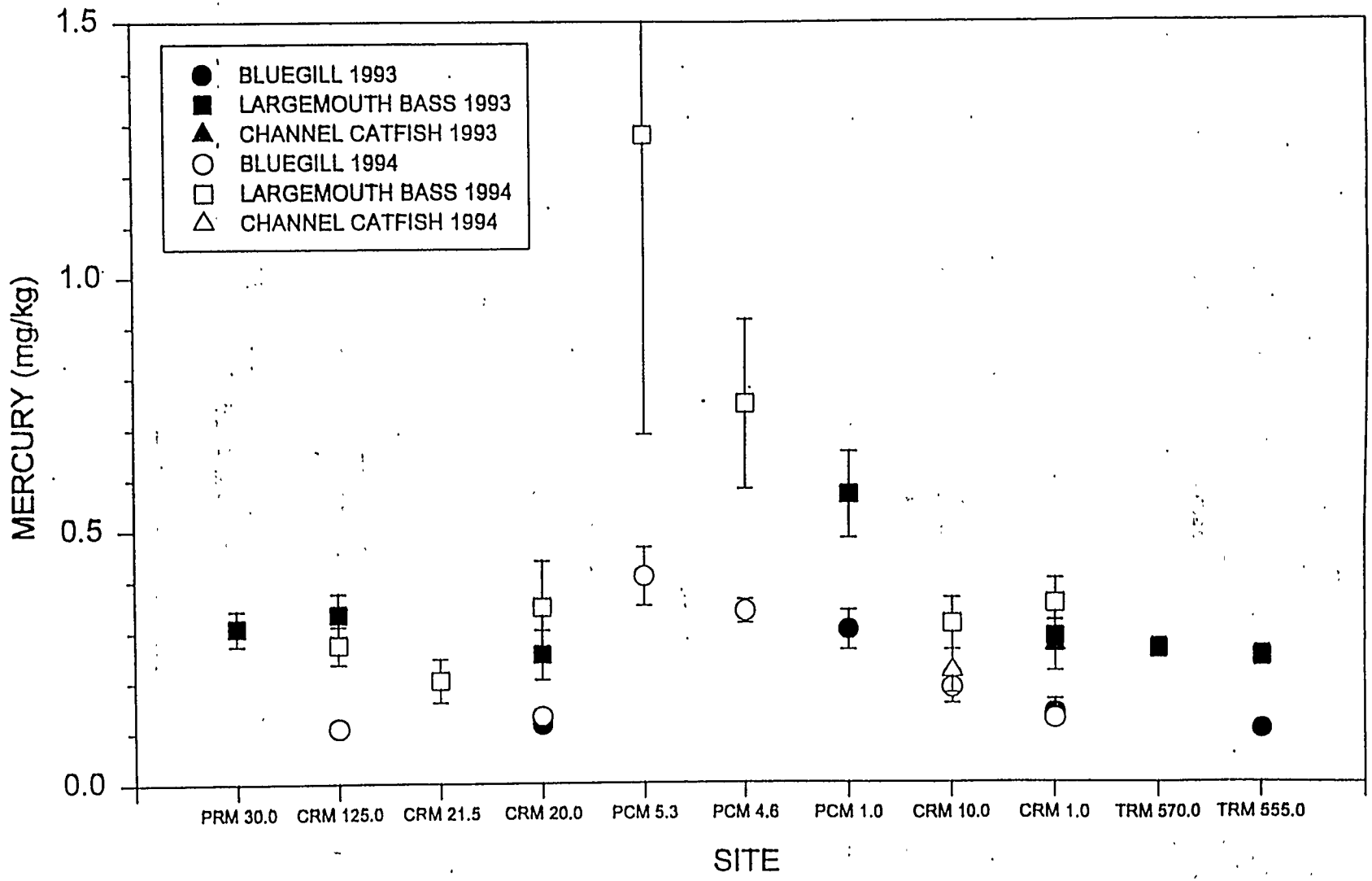


Fig. 3.51. Mercury in largemouth bass, bluegill, and catfish fillets collected from Watts Bar Reservoir and reference sites during Phase 2 sampling, 1993–1994.

Selenium was detected in 94, 48, and 87% of the 159 bluegill, 25 catfish, and 135 largemouth bass samples, respectively, collected from WBR (Table C6). The ANOVA indicated significant site and species effects, but also significant interaction effects. The three sites with the highest concentrations (PRM 30.0, PCM 5.3, and CRM 21.5) are not near each other, suggesting that surface water sources of selenium are multiple or that the primary source is atmospheric.(Table C6). The ANOVA indicated significant site and species effects, but also significant interaction effects. The three sites with the highest concentrations (PRM 30.0, PCM 5.3, and CRM 21.5) are not near each other, suggesting that surface water sources of selenium are multiple or that the primary source is atmospheric.

PCBs/Pesticides

PCBs were reported as both Aroclor mixtures and individual congeners for most samples. As initially manufactured, each Aroclor mixture (e.g., 1254 or 1260) included different combinations of the 209 possible individual PCB compounds or congeners. The higher numbered Aroclors contain a larger proportion of the highly chlorinated congeners that are suspected to be generally more toxic. Due to the degradation and transformation of PCBs in the environment as a result of natural biological processes, what the analytical laboratory quantifies as a specific Aroclor mixture likely has a substantially different composition from the Aroclor as originally manufactured. Although the amount of information from a toxicological standpoint contained in an Aroclor value is less than that obtained in measures of individual congeners, Aroclor concentrations were included in this investigation for two reasons—(1) to maintain comparability with prior years of PCB data for WBR and (2) risk assessment factors have not yet been developed for individual congeners. The analysis of individual PCB congeners was initiated to provide additional information regarding (1) the relative contribution of the most toxic PCBs to the total PCB mixture, (2) differences among species, (3) temporal variability, and (4) site differences and similarities relative to possible sources.

Analyses were conducted for PCB Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260, but only Aroclors 1254 and 1260 were detected (Table C6). Excluding samples collected from Norris Reservoir (CRM 125 and PRM 30), where PCB levels are low and the incidence of non-detects is high, Aroclors 1254 and 1260 were detected in 96% of the samples. The 1254 and 1260 values were summed (with non-detects assigned a value of one half the detection limit) to estimate the total PCB concentration.

The FDA action level for PCBs of 2.0 mg/kg was exceeded by only one sample mean (catfish at CRM 1 in 1991), but was exceeded in 48 individual fish from the Clinch River (23 catfish), Poplar Creek (6 catfish), the upper Tennessee River (6 catfish), the Emory River (1 catfish), and lower Watts Bar (12 catfish and 1 striped bass). Mean total PCBs exceeded 1.0 mg/kg in 15 instances (Table 3.7).

Table 3.7 CRRI sampling events and locations in which mean total PCB concentrations in catfish exceeded 1.0 mg/kg

Site	Catfish	Striped bass	Largemouth bass
CRM 20	1993		1994
PCM 1.0	1992		
ERM 1	1993		
CRM 1	1991–1993	1992	
TRM 570	1991–1992		
TRM 561	1991		
TRM 545	1992	1992	
TRM 530	1991, 1993		

An unbalanced ANOVA was performed to evaluate the effects of sample location, species, and year on the total PCB concentration in fish (Table C8). The results suggest significant site and species effects, but significant interaction effects cast some uncertainty on this conclusion. Figure 3.52 clearly indicates that mean PCB levels in WBR catfish are higher than those at the two reference sites in Norris Reservoir. Several sites downstream of the ORR (such as CRM 20, PCM 1, CRM 1, TRM 561) have elevated levels of PCBs, as do two sites (TRM 570 and ERM 1) located upstream of the influence of ORR operations, suggesting there are numerous sources of PCBs to WBR. Similar among-site differences and similarities are seen in the data for the other species (Figure 3.53).

The among-species differences identified in the ANOVA (Table C8) are confirmed by a closer look at the means for each species by site and year. A comparison of mean PCBs among catfish and the other species at sites where both were sampled suggests catfish are likely to have among the highest PCB concentrations in the fish community. In 13 cases where both largemouth bass and catfish were sampled at a given site in the same year, the largemouth bass mean PCB concentration ranged from 19 to 84% that of catfish (mean=37%). In 3 cases where both striped bass and catfish were sampled, the striped bass mean PCB concentration ranged from 54 to 105% that of catfish (mean=78%). A composite sample of five carp at CRM 1 had a PCB concentration that was 45% of the mean concentration of catfish collected at the same time and place. Similar composites of bluegill and white crappie had PCB concentrations that were 38 and 17%, respectively, of the concentration in catfish. Some of the variation among species may be explained by differences in lipid content of the fish although there are obviously other factors as well. The average lipid content of the sportfish collected during Phase 2 was 9.7% for striped bass, 5.9% for catfish, 1.7% for largemouth bass, 6.9 for bluegill, 24.0% for carp, and 0.6% for white crappie.

No year effect was found in the ANOVA (Table C8) even when the analysis was performed on catfish data only. There appear to be significant year-to-year differences within some sites, but these trends are not consistent among sites. These local temporal effects may be the result of local short-term changes in PCB loading to the system, remobilization of PCB-laden sediments, or changes in the aquatic community and food-chain dynamics. An evaluation of PCB data collected since 1987 by several agencies shows no consistent trends in PCB concentrations throughout WBR (Figs. 3.48 and 3.49).

PCB congeners were measured in samples collected from fall 1992 through spring 1994. Forty-four different congeners were selected for analysis based on their occurrence in other aquatic-related samples (water, sediment, or biota), from other studies throughout the country, or on their supposed high toxicity. The list included those congeners with a co-planar configuration that are geometrically similar to dioxin molecules and are suspected to be more toxic than many of the other PCB congeners.

All of the 44 congeners were found in at least one of the samples from the CR/PC OU (Table C9). Twenty congeners were found in more than 50% of the samples, and eight were found in more than 90% of the samples. Those congeners with the highest mean concentration across all samples were PCB numbers 153, 180, 138, 118, and 99 (Table C9).

One reason for analyzing congeners was to provide more detailed information on those congeners with suspected greater toxicity. The proportion of the total PCB (sum of the congeners) that can be attributed to coplaner congeners (PCB congeners 37, 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189) averaged about 27% for all samples from the CR/PC OU, with little variation among sites or species.

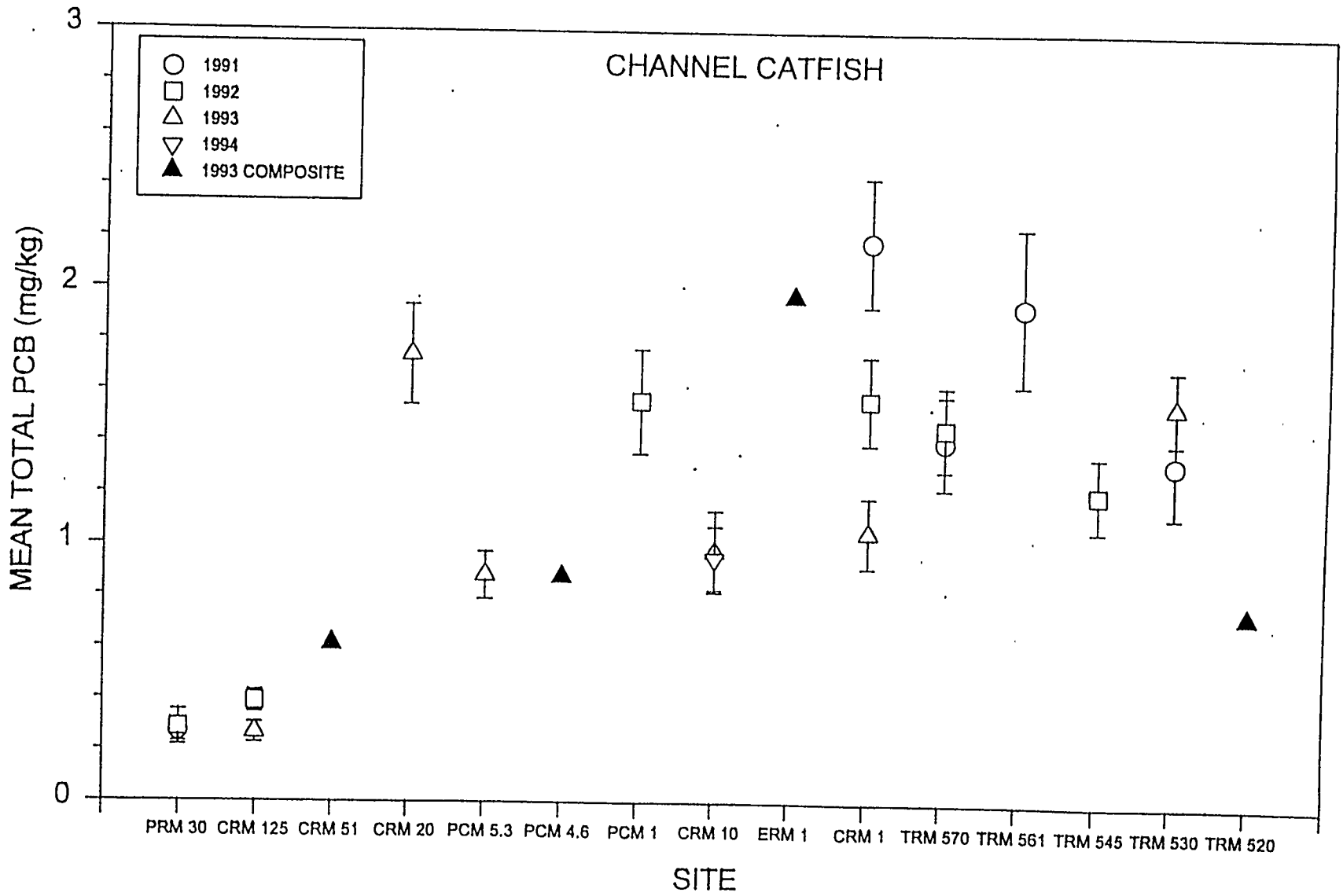


Fig. 3.52. Mean total PCB concentrations (mg/kg) in catfish collected from Watts Bar Reservoir and reference sites during Phase 2 sampling, 1991–1994.

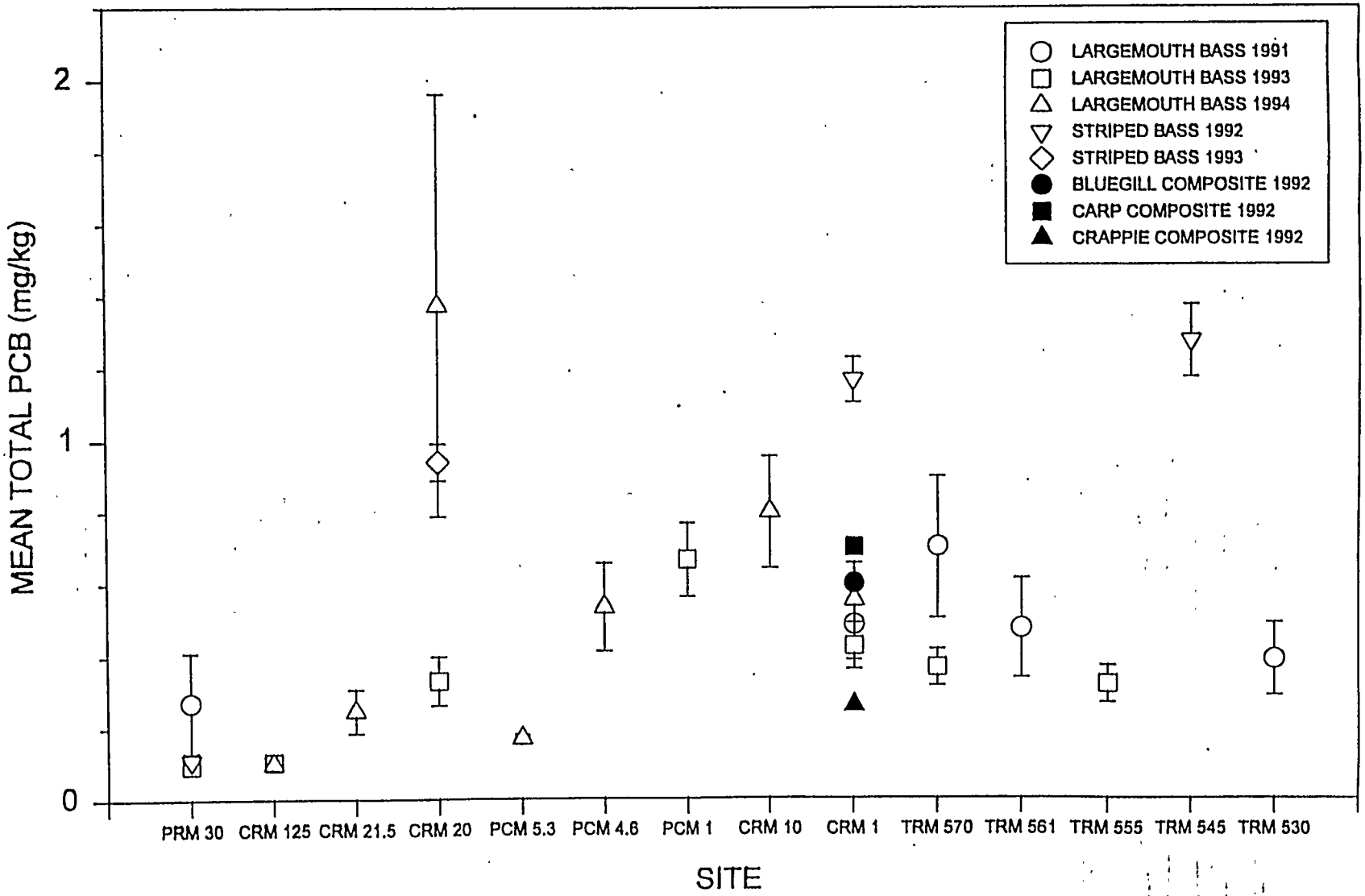


Fig. 3.53. Mean total PCB concentrations (mg/kg) in striped bass, largemouth bass, other species collected from Watts Bar Reservoir and reference sites during Phase 2 sampling, 1991–1994.

The temporal variation in PCB concentrations in WBR that has been observed in Aroclor and total PCB data over the last several years is also evident in the congener data. Table C10 shows how the incidence of detection of each congener changed from fall 1992 to spring 1994. For example, the detection of PCB congeners 28, 31, 99, and 170 decline noticeably during this time. Conversely, the detection of congeners 101 and 105 increased since the first sample in fall 1992. Some congeners, such as 153, had a high incidence of detection throughout the study, but showed a noticeable increase in concentration in catfish tissue in the second year of sampling (Fig. 3.54). This increase in the concentration of congener 153 was also observed in largemouth bass and shad samples. Figure 3.54 illustrates not only the year-to-year variation in congener concentrations (fall 1992 versus fall 1993), but also shows a marked difference between spring and fall samples of the same species from the same site.

Differences among species are also obvious in the congener data (Fig. 3.55). Differences in the magnitude of the contamination among species are similar to those observed in the Aroclor data, but there is little difference in the congeners present among the various species. Most of the congeners detected in those species with the highest PCB concentrations (i.e., catfish and striped bass) are also detected in the less contaminated species.

Total chlordane is calculated as the sum of six chlordane constituents (gamma-chlordene, alpha-chlordene, gamma-chlordane, cis-nonachlor, trans-nonachlor, and chlordane). Non-detects were not included in the sum. At least one of these constituents was detected (and thus a total chlordane value calculated) in 95% of the catfish, 95% of the striped bass, and 2% of the largemouth bass samples from WBR (Table C6). The incidence of detection for total chlordane was 85 and 77%, respectively, for catfish and largemouth bass at the reference site, Norris Reservoir.

The ANOVA indicated significant species and site effects, but also significant interaction terms (Table C8). The concentration of total chlordane in catfish is roughly twice that in largemouth bass. Site means for catfish in WBR ranged from 0.08 to 0.22 mg/kg, with the highest concentrations at CRM 20, CRM 1, TRM 570, and TRM 561 (Table C6). Largemouth bass means ranged from 0.06 to 0.085 mg/kg with little difference among sites; striped bass means were similar to catfish means, ranging from 0.10 to 0.14 mg/kg.

3.5.1.5 Semivolatile organics

During Phase 1, over a hundred samples were analyzed for a total of 65 semivolatile organic compounds. Many of the analyses were rejected due to quality control (QC) problems, but of those that were acceptable, very few had detectable levels of any compound. During Phase 2, the concentrations of semivolatile organics were measured in ten catfish from Poplar Creek to confirm these low levels. As in Phase 1, very few semivolatiles were detected (Table C6). Diethylphthalate, di-n-butylphthalate, and naphthalene were detected in three samples each, and bis(2-ethylhexyl)phthalate was detected in six.

3.5.1.6 Summary

The only metal for which a meaningful spatial pattern was identified was mercury; concentrations were highest in fish from Poplar Creek. However, mean values in Poplar Creek were below the FDA action level of 1 mg/kg for all species. Concentrations were highest in largemouth bass, second highest in catfish, and lowest in bluegill.

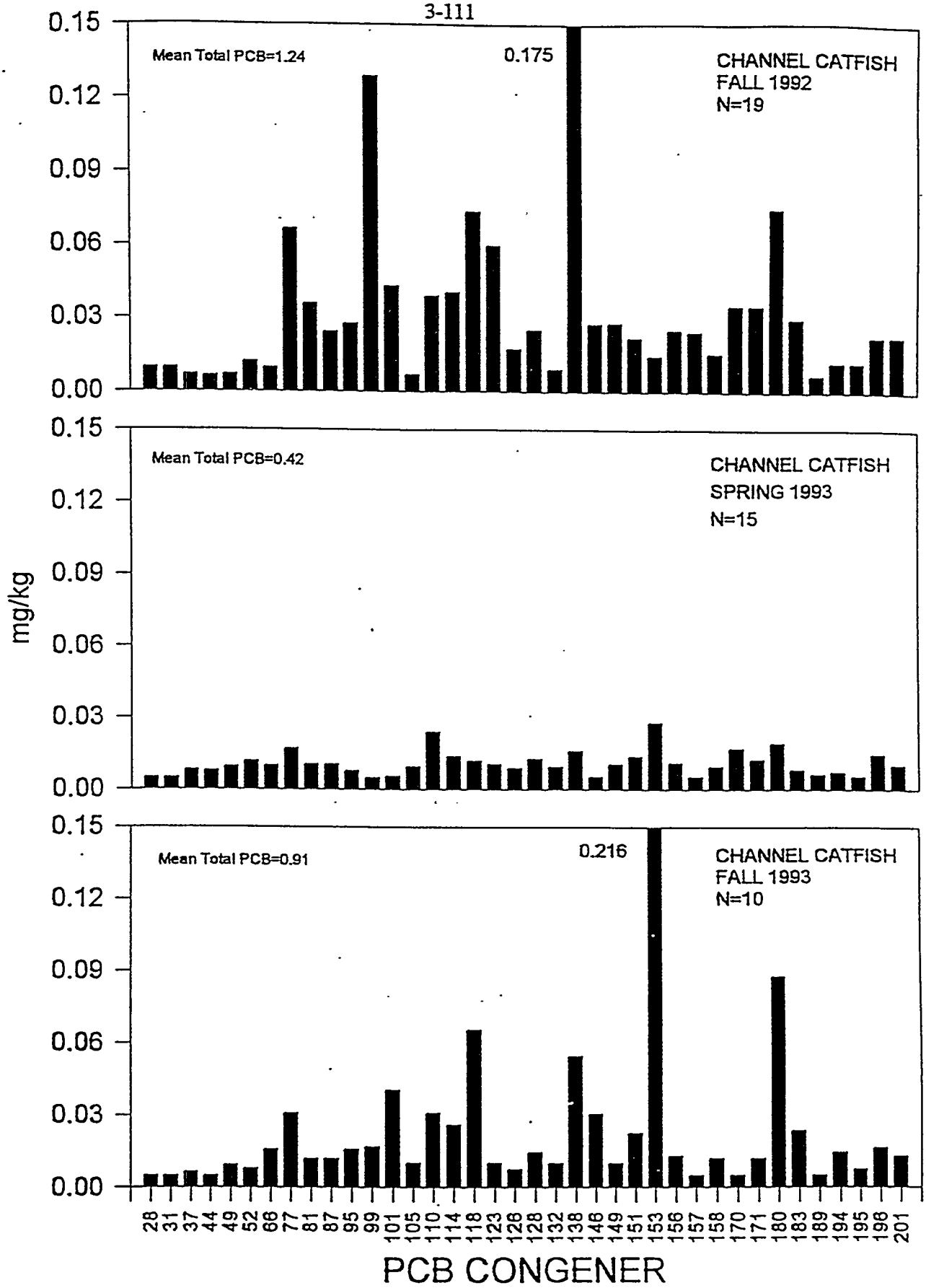


Fig. 3.54. Congener concentrations in catfish, fall 1992 to fall 1993.

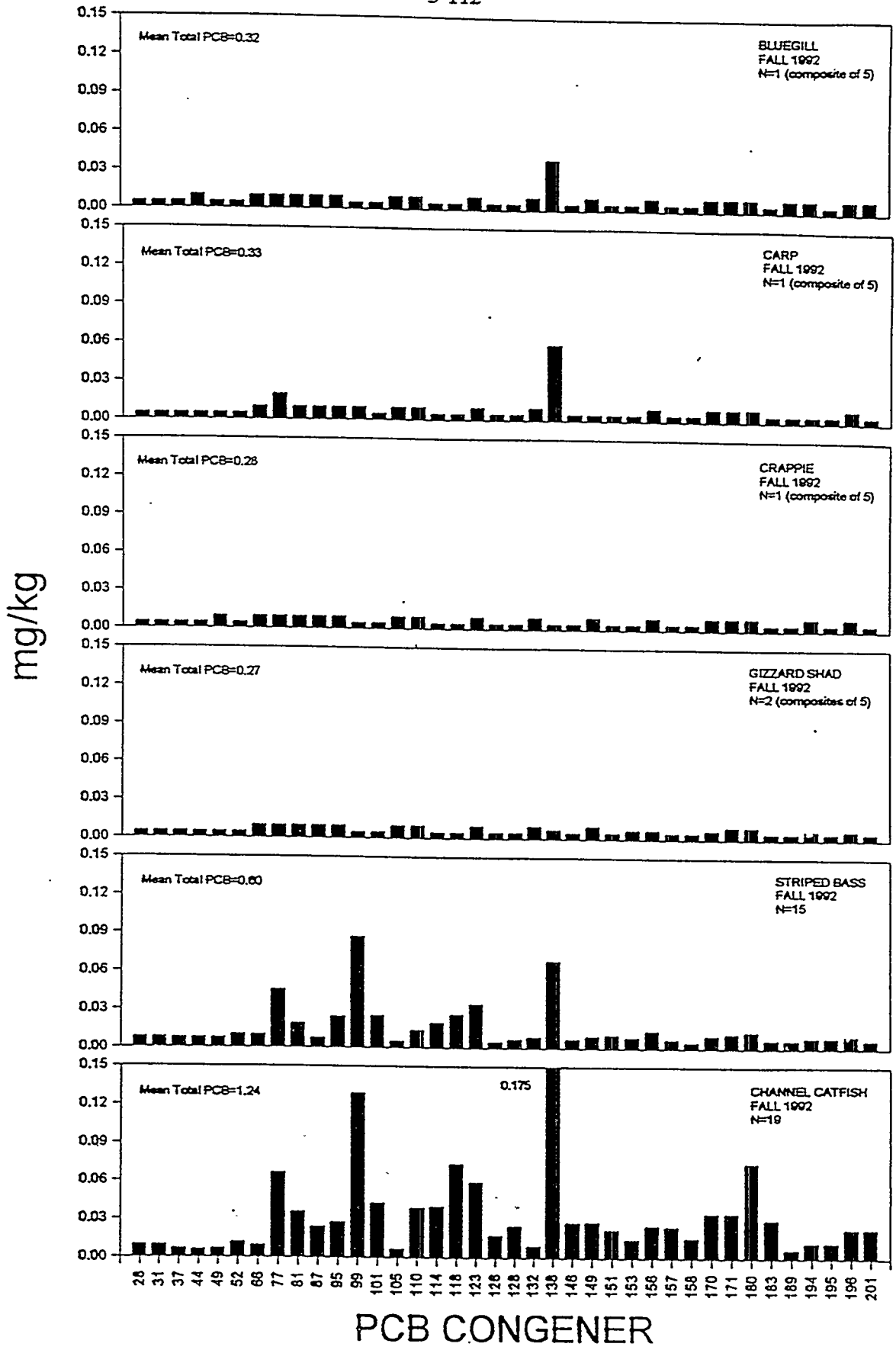


Fig. 3.55. Congener concentrations in sportfish.

Aroclors 1260 and 1254 were detected in 96% of all fish sampled from the study area (excluding the Norris reference site); no other Aroclors were detected in any sample. In only one case (catfish collected from CRM 1.0 in 1991) did the mean total PCB concentration exceed the FDA action level of 2.0 mg/kg. Concentrations were highest in catfish and lowest in bluegill and crappie. Spatial patterns suggest several sources of PCBs to the river system. No temporal pattern was evident, as mean values of both Aroclors and individual congeners varied widely over time.

Chlordane was detected in most fish from the study sites. Concentraions were highest in catfish, but mean levels were well below the FDA action level of 1.0 mg/kg. No meaningful spatial patterns were evident.

The analyses of catfish from Poplar Creek confirmed the expected low levels of other semivolatile organic compounds in fish flesh. The only compounds detected were several phthalates and one PAH, all of which are commonly detected in environmental samples.

3.5.2 Contaminants in the Food Web

3.5.2.1 Introduction

The goal of this task was to identify important sources and pathways of contaminant transport, movement, and bioaccumulation within the Clinch River/Poplar Creek food web. These data are also used in the ecological risk assessment.

3.5.2.2 Sampling and Analysis

Original plans called for the collection of crayfish and dragonfly larvae at three sites in WBR (DOE 1993). Due to their greater abundance and ease of collection, adult emergent mayflies (*Hexagenia* sp.) were collected instead of dragonfly larvae. Mayflies were collected at three locations—PCM 2, just upstream of the K-1007B pond outfall (1993 and 1994); CRM 1, at the Kingston hardware store (1993 and 1994); and TRM 570, at the Riley Creek recreation center boat dock (1993). Several dozen mayflies were composited to produce three samples from each site. The samples were analyzed for five metals (As, Pb, Hg, Ag, and Zn) and a suite of pesticides and PCBs. Several methods were attempted to collect crayfish in the reservoir, including baited traps and electroshocking, but none were successful.

Shad (gizzard, *Dorosoma cepedianum*, or threadfin, *D. petenense*) are most likely the primary food item for striped bass and largemouth bass in Watts Bar, but are not consumed by humans. Shad were collected at nearly all the same sites and times as were catfish and analyzed whole for PCBs/pesticides. Most (114; 72 individual and 42 composite samples) of the 119 shad samples were of yearling fish about 1.5 years old, though there were five samples that were composites of young-of-year fish about 0.5 years old.

3.5.2.3 Results and Interpretation

No pesticides (including DDT, DDD, DDE, aldrin, dieldrin, total chlordane, and others) were detected in mayfly samples, and of the PCB Aroclors, only 1254 was detected (Table C11). The mean values at all sites were less than 0.15 mg/kg, with concentrations in the Poplar Creek samples being slightly lower than the other two sites. Total PCB concentrations (with non-detects added at half the detection limit) in mayflies are less than in the fish species at the same sites except when compared to shad at TRM 570 in 1993 (Fig. 3.56).

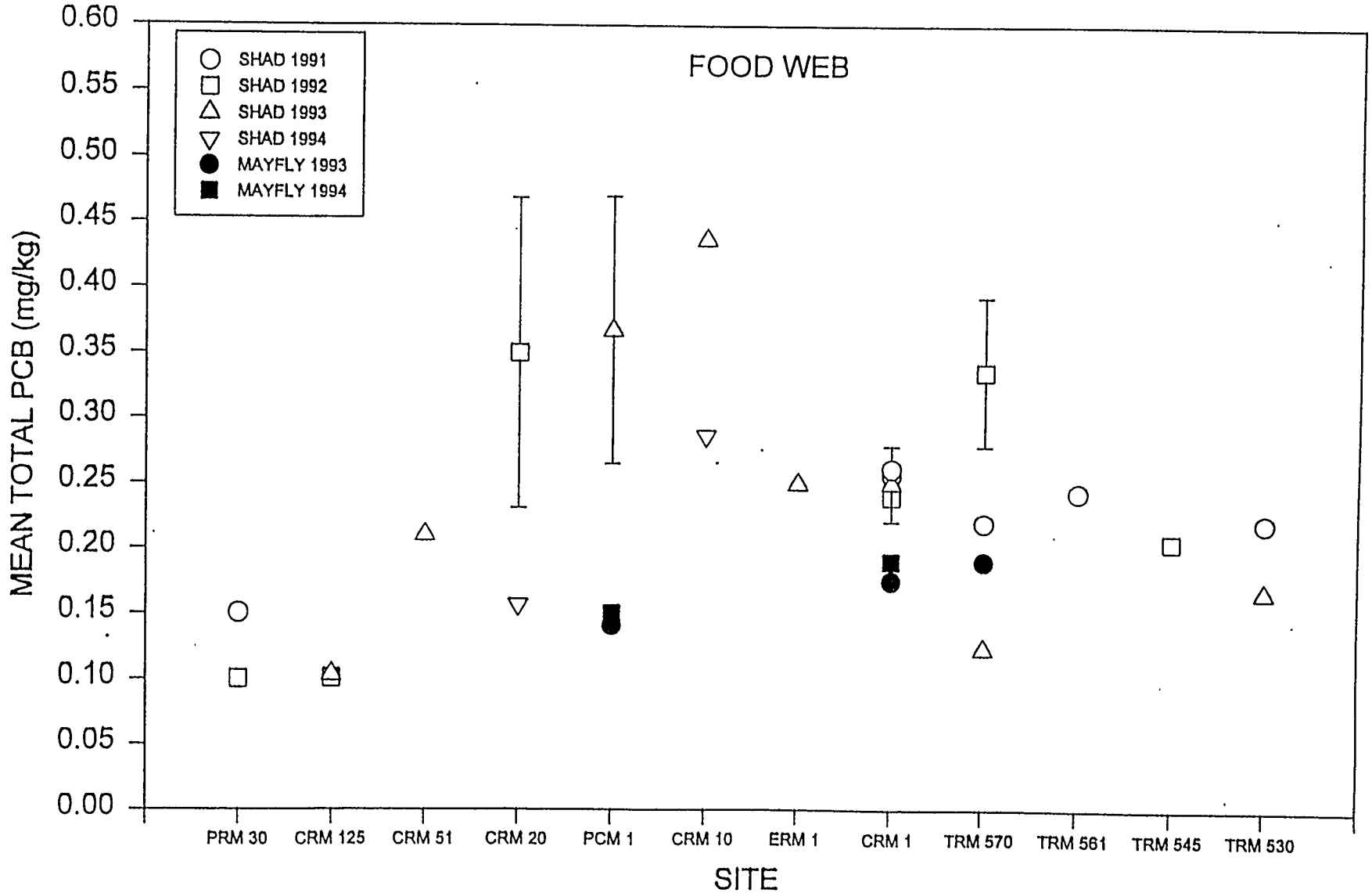


Fig. 3.56. Mean total PCB concentrations (mg/kg) in shad and mayflies collected from Watts Bar Reservoir and reference sites during Phase 2 sampling, 1991–1994.

Of the five metals for which mayflies were analyzed, As, Hg, and Zn were detected in all nine samples, Pb in seven of nine, and Ag in none (Table C11). Mercury concentrations in mayflies are roughly 10–20% of that found in bluegill fillets at the same sites and about 5–10% of that found in largemouth bass fillets (Table C6). Likewise, arsenic concentrations in mayflies are roughly 30 and 15% of the levels found in bluegill and largemouth bass filets, respectively. Zinc concentrations in mayflies are roughly 10 times greater than those found in fish during Phase 1 sampling, while lead was not detected at all in fish during Phase 1.

PCBs were detected in three of the five young-of-year composite samples. Total PCBs at CRM 1, TRM 561, and TRM 570 ranged from 0.13–0.19 mg/kg, while PCBs were not detected at PRM 30 and TRM 530.

As with the other fish species (Sect. 3.5.1), total PCB concentrations in shad exhibit a great deal of among-year and among-site variability (Fig. 3.56). At only one site (PCM 1.0, 1992) did total PCBs exceed 1.0 mg/kg; the next highest mean was only 0.44 mg/kg. On average, shad PCB concentrations were roughly 25% that of catfish and striped bass fillets, and 70% that of largemouth bass fillets.

3.5.2.4 Summary

Mayflies were found to contain several of the contaminants found in the sediment and in fish (particularly, arsenic, mercury, zinc, and PCBs) and are likely to provide one of many mechanisms for transport of these contaminants into fish from the sediment. Shad (even young-of-year fish) had detectable levels of PCBs and are likely the most important pathway for PCB contamination of piscivorous fish.

3.5.3 Contaminants in Piscivorous Wildlife (Great Blue Heron and Mink)

Suter (1990) identified piscivorous wildlife along the Clinch River as being potentially at risk from toxicant releases from the ORR. This section evaluates the potential for biological effects in great blue heron and mink, two piscivorous species known to occur along the Clinch River.

3.5.3.1 Contaminant accumulation and effects in great blue heron

Introduction. This study seeks to assess the general health and fecundity of the ORR great blue heron population and document any contaminant-induced effects, particularly with respect to mercury and PCB exposure. Reproductive health is of particular concern, and the potential for off-site transportation of contaminants through heron body burdens is addressed.

Monitoring of great blue heron (*Ardea herodias*) was begun in 1991. The great blue heron was chosen as an indicator species because it (1) is predominantly piscivorous, foraging along the major waterways on and downstream of the ORR; (2) is at the top of the aquatic food chain; (3) has been suggested to be a good indicator of aquatic health; (4) is well represented in the scientific literature, including toxicological literature; and, (5) satisfies necessary logistical sampling considerations. Important logistical considerations were the presence of study and reference colonies on or in close proximity to ORR and population densities to meet sampling requirements. In addition, great blue heron are highly visible, facilitating direct observation and site location.

Study Sites

Four colonies were used for heron chick and egg collection. Two colonies (K-25 and Melton Hill colonies) are located within 1.8 miles of the ORR, and herons using these colonies are potentially exposed to contaminants occurring on the reservation. The remaining two colonies (Long Island and Looney Island colonies) are located >6 miles from the ORR, and heron using these colonies are assumed not to be exposed to contaminants that occur on the ORR. In general, there has been an increase in heron colonies in eastern Tennessee resulting from recent range expansion of the great blue heron in the upper Tennessee Valley (Pullin 1990).

The K-25 colony is located within the boundaries of the K-25 Site, on the west bank of Poplar Creek approximately 1.2 miles from its confluence with the Clinch River. Areal surveys by the TVA documented nesting activity at K-25 in 1986, and an estimated 31 nests were active in 1988 (Pullin 1990). The number of nests at this colony have remained at 25 to 50 during the 4 years of this study.

The second colony is located among three small islands in Melton Hill Lake approximately 1.2 miles above Melton Hill Dam. This colony has been active for at least 4 years (personal communication, Jim Evans, TWRA, Oak Ridge National Laboratory), and is composed of approximately 40 active nests.

Colonies on Long Island and Looney Island are each greater than 6 miles from the ORR and serve as off-site reference locations. Long Island is approximately 1.8 miles from the confluence of the Tennessee and Clinch rivers in the Tennessee River arm of WBR. The colony has been active since at least 1983, and 141 great blue heron nests were active in 1988 (Pullin 1990). Approximately 200 active nests have been observed during each year of the current study.

Looney Island is located in the Tennessee River approximately 18 miles upstream of Long Island in Fort Loudon Reservoir. The colony has been active since at least 1992, and an estimated 100 active great blue heron nests were observed on the island during the 1993 and 1994 nesting seasons. Black-crowned night herons also were found nesting on this island during both seasons.

Methods

For three years (March to June, 1992–1994) eggs and chicks were collected from great blue heron colonies. Egg and chick collection and processing techniques are described in ER/CR-SOPs 2180 and 2190.

To assess heron food preference and availability, crop contents were examined, and fish regurgitated from chicks or found beneath nests were collected. Recognizable fish samples were archived prior to PCB and mercury analysis. Abnormalities were noted and organ somatic indices were computed.

Results of contaminant analyses, physiological measurements, and reproductive parameters were statistically evaluated for differences between colonies located on and off the ORR. Aroclor 1260 and individual congener differences were evaluated when concentrations in at least one location (on or off ORR) were greater than 30 ppb. For congeners that were evaluated, any concentrations below detection limits were assigned a value equal to half the detection limit. Differences between locations were evaluated using a Student's t-test and, when appropriate, differences among colonies were evaluated using an ANOVA or Kruskal-Wallis test.

Results

Contaminant concentrations in fish collected from heron colonies

Mercury and chromium concentrations were significantly greater in fish collected from colonies located on the ORR than in colonies located off the ORR (Table C12). No significant differences in Aroclor 1260 concentrations existed between on- and off-ORR colonies and all PCB congener concentrations were less than 20 μg/kg.

Egg and chick metal concentrations

Thirty-three and 34 eggs, and 38 and 35 chicks, respectively, were collected from heron colonies on and off the ORR. Extreme mercury concentrations were quantified in one egg from the Melton Hill colony (KE022, Hg concentration = 0.601 mg/kg) and one egg from the Long Island colony (LE513, Hg concentration = 0.596 mg/kg). The egg from the Melton Hill colony was collected from a nest with 2 chicks approximately 2 weeks of age and this egg did not show signs of development. Egg LE513 was collected from a nest that contained 3 eggs and was in an early stage of development. Both concentrations were rejected as outliers by the Dixon and Grubbs test for outlying observations and were eliminated from the data set (Taylor 1987).

No difference existed between mean mercury concentrations in eggs collected from the Long Island and Looney Island colonies (Table C13); therefore, data from both colonies were used in calculating differences between on- and off-ORR mercury concentrations in eggs. However, mean mercury concentration in eggs collected from the K-25 colony ($\bar{x} \pm SE = 0.17 \pm 0.02$, mg/kg) was significantly greater ($P < 0.001$) than the mean concentration in eggs collected from the Melton Hill colony ($\bar{x} \pm SE = 0.07 \pm 0.01$, mg/kg). Therefore, only mercury data from eggs collected from the K-25 colony was used to test for differences between on- and off-ORR mercury concentrations in eggs.

Mean mercury concentration in eggs collected on the ORR was significantly greater than the mean concentration in eggs collected off the ORR (Table C13). Mean concentrations were greatest in eggs collected from the K-25 colony and least in the Melton Hill colony.

Mean chromium concentration in eggs collected on the ORR was significantly greater ($P = 0.046$) than the mean concentration in eggs collected off the ORR (Table C13). Concentrations were greatest in eggs collected from the Melton Hill colony ($\bar{x}$ = 0.22 mg/kg) followed in decreasing order by concentrations in the K-25 ($\bar{x}$ = 0.15 mg/kg), Long Island ($\bar{x}$ = 0.11 mg/kg), and Looney Island ($\bar{x}$ = 0.11 mg/kg) colonies. Arsenic was quantified in only one egg and the concentration was below the contract required detection limit.

Mean mercury concentrations were significantly greater ($P < 0.05$) in feathers and liver tissue of chicks collected on the ORR compared to those collected off the ORR (Table C14). Mean feather mercury concentration was significantly greater in chicks collected from the K-25 colony ($\bar{x}$ = 2.02 mg/kg) compared to feathers from chicks collected from the Melton Hill ($\bar{x}$ = 1.02 mg/kg), Looney Island ($\bar{x}$ = 0.97 mg/kg), and Long Island ($\bar{x}$ = 0.87 mg/kg) colonies. Mean liver mercury concentration was not significantly different between chicks collected from the K-25 colony ($\bar{x}$ = 0.29 mg/kg) and the Looney Island colony ($\bar{x}$ = 0.25 mg/kg). However, mean liver mercury concentration was significantly greater in chicks collected from the K-25 colony compared to chicks collected from the Melton Hill ($\bar{x}$ = 0.15 mg/kg) and Long Island ($\bar{x}$ = 0.12 mg/kg) colonies. No significant differences existed in mean muscle concentrations between colonies located on or off the ORR. Mean muscle mercury concentration was significantly greater in chicks collected from the K-25 colony ($\bar{x}$ = 0.09 mg/kg) compared to chicks

collected from the Melton Hill colony ($\bar{x}$ = 0.05 mg/kg). No significant differences in mean liver, muscle, or feather concentrations of arsenic or chromium were detected between chicks collected on and off ORR, or among colonies (Table C14).

Egg and chick PCB concentrations

Mean concentrations of Aroclor 1260 and 76% of the quantified PCB congeners were significantly greater ($P < 0.05$) in eggs collected from the K-25 colony compared to those collected from the Melton Hill colony. No significant differences were detected in Aroclor 1260 or congener concentrations between Long Island and Looney Island eggs. Therefore, for statistical analysis between on- and off-ORR colonies, PCB concentrations in K-25 eggs were compared to concentrations in Long Island and Looney Island eggs combined. Mean concentrations of Aroclor 1260 and 10 congeners were significantly greater in eggs collected on the ORR compared to concentrations in eggs collected off the ORR (Table C15). Concentrations of 47% of the 30 congeners evaluated in egg homogenates were below 30 μg/kg. Concentrations of congeners 123 and 167 were the only coplanar congeners that differed between eggs from colonies located on and off the ORR.

Aroclor 1260 and a majority of congener concentrations were significantly greater ($P < 0.05$) in fat, liver, and muscle tissue from heron chicks collected from the K-25 colony compared to those collected from the Melton Hill colony. No differences existed between chicks collected from the Long Island and Looney Island colonies. Therefore, comparison of PCB results between on and off ORR was between the K-25 colony and the Long Island and Looney Island colonies combined. Aroclor 1260 concentration was significantly greater ($P < 0.05$) in fat, liver, and muscle tissue from chicks collected on the ORR compared to concentrations in chicks collected off the ORR. Although concentrations of all congeners were greater in fat tissue from chicks collected on the ORR, this difference was significant in only 30% of the congeners quantified (Table C16). Congener 156 was the only coplanar congener that was significantly different in fat tissue between on and off ORR colonies.

Of the 30 congeners evaluated, 77 and 73% of the concentrations in chick muscle and liver tissue, respectively, were below 30 μg/kg. In chick liver tissue, concentrations of congeners 110, 118, 151, 153 and 180 differed significantly between on and off ORR colonies (Table C17). In chick muscle tissue, concentrations of congeners 110, 118, 138, 153, and 180 differed significantly between on- and off-ORR colonies (Table C18). Congener 110 and 118 were the only coplanar congener that differed between on- and off-ORR colonies in liver and muscle tissue, although concentrations of coplanar congeners ranged from below detection to 18 mg/kg in chick fat tissue.

Physiological and reproductive effects

No significant differences were observed in the number of eggs or chicks per nest between on- and off-ORR colonies (Table C19). The mean weight of eggs collected from colonies on the ORR was significantly heavier than eggs collected off the ORR; however, there was no difference in shell thickness.

Chick weight/length ratios, liver somatic indexes, and hematocrit measurements were not different in chicks collected on and off the ORR. However, liver EROD activity and DNA F values (fraction of double stranded DNA) were significantly greater ($P < 0.05$) in chicks collected from colonies off the ORR compared to those collected on the ORR (Table C19).

Summary

Although herons occupying the K-25 colony have elevated body burdens of mercury and PCBs compared to herons occupying colonies off the ORR, the contaminant levels in tissues do not appear to affect the number of eggs laid or survival of chicks to fledging. Effects on chick survival from fledging to reproductive maturity were not determined. Contaminant data from one adult heron collected on the ORR in August 1992 suggest that body burdens are much greater in adults than in chicks.

3.5.3.2. Reproductive performance of mink

Introduction

Mink (*Mustela vison*) have been shown to be one of the mammals most sensitive to PCB exposure (Aulerich and Ringer 1977). They are also sensitive to other toxicants, including mercury (Calabrese et al. 1992).

Because mink are sensitive to PCB and mercury toxicity and inhabit wetland areas, they are potentially good indicators of environmental effects of these chemicals in aquatic habitats. However, mink are secretive and population densities tend to be low, making assessment of environmental contaminant effects in natural populations difficult. The objectives of this study were to evaluate contaminant bioaccumulation and correlated reproductive effects in mink fed fish collected from three locations: (1) on the ORR (Poplar Creek), (2) the Clinch River above the ORR, and (3) the ocean.

Materials and Methods

Fish collection and diet preparation

Fish used in mink diets were collected from (1) Poplar Creek between its mouth and the mouth of EFPC and (2) the Clinch River above Melton Hill Dam (above the ORR). Ocean fish (mackerel) were obtained from a commercial supplier. Fish from each location were homogenized and ten aliquots of homogenate collected for contaminant analyses.

Five diets composed of 75% fish and 25% normal mink diet (eggs, liver, vitamin and mineral premix, d-biotin, and cereal) were prepared. All diets were formulated to meet the nutrient requirements of the mink (NRC 1982). The fish portion of two reference diets contained ocean fish only (Diet A) and fish from the Clinch River only (Diet B). The fish portion of the remaining 3 diets (C, D, and E) contained 33, 67, and 100% fish collected from Poplar Creek and 67, 33, and 0% ocean fish, respectively. Diet proximate analyses were determined by MSU. Ten aliquots of each diet were collected for contaminant analyses.

Mink feeding experiment

Fifty adult, natural dark mink from the MSU Experimental Fur Farm were uniquely identified and randomly divided into 5 groups of 2 males and 8 females per group. Mink were housed individually in wire cages (61 x 76 x 46 cm) with attached nest boxes (38 x 28 x 27 cm). Cages were suspended above the ground in open-sided sheds. Throughout the study, mink were provided food and drinking water *ad libitum* and exposed to ambient temperature and photoperiod. Mink were immunized against canine distemper, viral enteritis, infectious pneumonia, and botulism, and provided thiamine daily to prevent thiamine deficiency resulting from thiaminase in fish. Mink were acclimated to the test facilities for at least 1 week prior to the definitive test.

Each mink group was fed one of the prepared diets from December 1, 1993 (approximately 3 months prior to breeding) through approximately June 30, 1993 (6 weeks postpartum). Mink were weighed at the beginning of the feeding trials and at monthly intervals thereafter (except during the gestation period). They were observed daily and any behavioral changes or clinical signs of toxicity recorded.

Mating began March 1, 1994, and was confined within the respective groups. Females were given an opportunity to mate every fourth day until a confirmed mating (presence of motile spermatozoa in vaginal aspirations) was obtained. The mated females were given an opportunity for a second mating the day following the initial mating or eight days later (a standard commercial mink ranch practice). The bred females were checked daily during gestation for evidence of whelping. The gestation period of mink averages 51 days but is highly variable (42 to 65 days) due to delayed implantation. Whelped kits were counted, sexed, and weighed on the day of birth and at 3 and 6 weeks of age. Mink kits begin to consume solid feed at 21 to 24 days of age and are weaned at 6 weeks. Thus, kit body weight at 3 weeks of age provides a good indication of the lactational performance of the female. Reproductive indices measured included number of females mated; number of females whelping; length of gestation; number of kits whelped (alive, dead); kit sex ratio; average kit body weight at birth, 3, and 6 weeks of age; and kit survival to 3 and 6 weeks of age.

Adult mink with > 30 % decrease in original body weight and all adults at the termination of the study were euthanized (CO_2). All adult mink were necropsied, organ (brain, liver, kidneys, heart, lungs, gonads, and adrenal glands) weights were recorded and samples of adipose, liver, kidney, and hair collected for residue analysis. At 6 weeks of age, 3 kits each from 3 randomly selected females from dietary groups A, B, C, and E were euthanized; liver, spleen, and kidneys weighed; and samples (liver, kidney, and remaining carcass) collected for residue analyses. Tissue samples (brain, liver, kidney, heart, lungs, and adrenal gland) also were collected from adult mink and preserved in 10% formalin for histopathologic examination.

Ten aliquots each of homogenized fish and mink diets and the collected mink tissues were analyzed for PCB congeners, Aroclors, and mercury. Adult liver and fat tissues were analyzed for PCBs; the kidney, liver, and hair tissues were analyzed for mercury. Liver tissue was also analyzed for ethoxyresorufin-o-deethylase (EROD) activity. Kit whole carcasses were analyzed for PCBs and mercury, liver tissue for PCBs only, and kidney tissues for mercury only. Lipid concentration (% lipid) was determined for all samples analyzed for PCBs.

PCB results were adjusted for lipid concentration (tissue concentrations divided by the % lipid) prior to statistical analysis. Results of contaminant analyses, physiological measurements, and reproductive parameters were statistically evaluated for differences among diet groups and between diet groups A or B and E using non-parametric (Wilcoxon or Kruskel-Wallis) and gausian (t-test or ANOVA) tests.

Results

Mercury concentrations in fish, diets, and mink

The species composition of fish collected from the ORR and the Clinch River above Melton Hill Dam were similar and consisted mostly of benthic species (Table C20). Mean mercury concentrations were significantly different among fish collected from the ORR, Clinch River, and the ocean (Table C21). Mean mercury concentrations in mink diets increased progressively from diet A through diet E (Table C21). Correspondingly, mercury concentrations in liver, kidney, and hair of adult female mink

increased progressively in mink fed diets A through E (Table C22). Mercury concentrations in kit kidney tissue and homogenized carcass were not significantly different in offspring of mink fed diets A, B, or C, but were significantly greater ($P < 0.05$) in offspring of mink fed diet E (Table C22).

PCB and congener profiles in fish and mink diets

Aroclor 1260 was the dominant Aroclor detected in aliquots of homogenized fish, mink diets, and tissues of adult mink and kits, although Aroclor 1254 also was quantified in several tissue samples. Aroclor 1260 was quantified in aliquots of all diets except for diet A (75% ocean fish), in fat tissue from mink in all diet groups except group C, and in liver tissue of mink from diet groups D and E. Twenty-three specific congeners, including 8 coplanar congeners (non-ortho or mono-ortho congeners), were evaluated in homogenized fish, diets, liver and fat tissues of adult mink, and liver tissue and carcass of kits. Ninety-six percent of congener concentrations were significantly different among ocean, ORR, and Clinch River homogenized fish, including all but one coplanar congeners (Table C23). In all cases where significant differences existed in homogenized fish congener concentrations among collection sites, the greatest concentrations were in fish collected from the ORR. Aroclor 1260 and 87% of the congener evaluated also were quantified in mink diets (Table C24). Mean Aroclor 1260 concentration was significantly greater ($P < 0.01$) in diet E compared to concentrations in other diets. Coplanar congeners 126 and 189 were not detected in any diets; congener 156 was detected in low concentrations in diets B, C, and D; congeners 77 and 81 were quantified in low concentrations in diets C, D, and E; and congener 167 was only quantified in diets D and E. Concentrations of coplanar congener 118 were significantly greater ($P < 0.01$) in aliquots of diet E compared to aliquots of the other diets. Mean concentrations of congener 123 progressively increased from diet C to D, however, quantified concentrations in diet E were surprisingly lower than concentrations in diet C. Low concentrations of this congener in diet E are thought to result from matrix interference in this diet. Similarly, lower than expected concentrations were quantified for congeners 99, 101, 156, and 171 in diet E. The remaining non-planer congener concentrations were generally greatest in aliquots from diet E (Table C24).

PCB and congener profile in mink tissues

Mean Aroclor 1260 concentration was significantly greater in liver tissue of female mink fed diet E (Table C25). Coplanar congener 189 was quantified at low concentrations (<21 μg/kg) in liver tissue from all mink fed diet E, 50% of those fed diet D, and less than 10% of those fed diets A, B, or C. Liver concentrations of congener 126 were significantly greater ($P < 0.01$) in samples collected from female mink fed diet E. Low concentrations (<32 μg/kg) of congener 126 also were quantified in liver tissue from female mink fed diets B and D. Mean liver concentrations of coplanar congeners 77 and 81 were ≤ 6 μg/kg in all female mink regardless of diet. Mean concentrations of congeners 156 and 167 increased progressively in liver tissue from female mink fed diets A–E and were significantly greater ($P < 0.01$) in mink fed diet E compared to those fed diets A or B. Mean concentration of coplanar congeners 118 and 123 were significantly greater in liver tissue from female mink on diet E compared to concentrations in liver tissue from mink fed diets A or B. There were significant differences ($P < 0.05$) in all female mink liver tissue non-planar congener concentrations among diet groups. For all non-planar congener in female liver tissue, concentrations were significantly greater ($P < 0.05$) in tissues from diet E mink compared to diet A mink, except for concentrations of congeners 195 and 196, which were not significantly different. Similarly, mean female mink liver concentrations of all non-planar congeners were significantly greater in female mink liver from diet group E mink compared to diet group B mink, except for congeners 146, 153, 170, 180, 183, and 201, which were not significantly different between these diet groups.

Mean Aroclor 1260 concentration in fat tissue from female mink fed diet E were significantly greater than mean concentrations from female mink fed diets A or B (Table C26). Mean concentrations of all coplanar congeners were significantly greater ($P < 0.05$) in fat tissue from female mink fed diet E compared to mean concentrations in mink fed diets A or B, except that there was no difference in congener 126 fat concentration between female mink fed diets E and B. Non-planar congener mean concentrations were significantly greater ($P < 0.05$) in fat tissue from female mink fed diet E compared to mean concentrations in mink fed diets A or B, except congeners 170, 194, and 195. There was no difference between congener 170 or 194 mean fat concentrations between female mink fed diets B or E, and mean fat concentration of congener 195 in female mink was significantly greater ($P < 0.05$) in female mink fed diet B compared to diet E.

Concentrations of coplanar congeners 77, 81, 123, 156, and 189 were < 20 μg/kg in liver tissue from kits in all diet groups (Table C27). Concentrations of coplanar congeners 118, 126, and 167 were significantly greater ($P < 0.05$) in liver from diet E kits compared to those from diets A, B, or C. Concentrations of non-planar congeners 101, 151, 171, and 195 were less than 15 μg/kg in liver tissue from kits in all diet groups. Concentrations of the remaining non-planar congeners quantified were greater in liver tissue of diet E kits. The pattern of concentrations of coplanar congeners in kit carcasses homogenates from the various diets were similar to those observed in kit liver tissue (Table C28), except that the concentration of coplanar congener 126 was less than 25 μg/kg in kit carcass homogenates and the concentration of congener 156 was significantly greater ($P < 0.05$) in kit carcass homogenates from diet group E compared to other diet groups. Concentration patterns of non-planar congeners in the various diet groups also were similar in carcass homogenates compared to concentrations in liver tissue, except concentrations of congeners 151 and 196 were the only congeners with concentrations less than 25 μg/kg. Concentrations of all other congeners quantified were greater in homogenized carcasses of kits from diet group E.

Physiological and reproductive effects

Two mink from diet group A, one male and one female, died during the experimental period. The male died on March 18, 1994, from hemorrhagic and necrotizing cystitis, and the female died on April 24, 1994, due to complications during parturition. In addition to these adult mink, kits from one female in diet group B developed staph infections, and all but one died prior to 6 weeks of age.

One, 2, and 4 females did not whelp in diet groups A and B, D, and C, respectively (Table C29). Two females that did not whelp (1 from diet group A and 1 from diet group C) had cysts in the reproductive tracts that probably interfered with normal reproduction. Two females that did not whelp (1 from diet group C and 1 from diet group D) had no placental scars in the uterus, and, therefore, probably were not pregnant. The reason that the remaining four females did not whelp is unknown.

Mean whole body weights of female mink were not significantly different among diet groups at the beginning of the experimental period; however, mean weights of females in diet group E were significantly less ($P=0.03$) than mean weights of females in diet group A at the end of the experimental period (Table C29). Mean female relative organ weights (organ weights/body weight) were not significantly different among diet groups. At 6 weeks of age, mean whole body weights were significantly lower ($P=0.004$) in male kits from diet group E compared to those from diet group A. A similar trend was observed in 6 week old female kits, although differences were not statistically significant. Mean relative kidney weights were significantly lower ($P=0.003$) in kits from diet group B ($\bar{x}=1.0$ g) compared to those from diet group E ($\bar{x}=1.3$ g). Kit mean relative liver and spleen weights were not significantly different among diet groups. No histological lesions were attributed to diets.

Mean litter size was significantly reduced (P=0.01) in diet group E compared to diet groups A, B, and C but not diet group D (Table C29). Liver EROD activity was significantly increased in adult female mink from diet groups D and E compared to those from diet group A (Table C29).

Summary

Although concentrations of mercury and PCBs were greater in fish collected from streams located on the ORR and these contaminants were higher in diets fed to mink with increasing percentage of ORR fish, reproductive effects were only noted in mink fed 75% ORR fish. Liver EROD activity, a sensitive biomarker of exposure to PCBs, increased in mink fed diets containing 50% and 75% fish collected from the ORR. Although fish are a major food item in the diet of wild mink, the proportion of fish in their diets normally does not exceed 4–60%. However, in addition to fish, concentrations of contaminants in other food items (crayfish, frogs, muskrat, ducks, and rodents) need to be evaluated in assessing effects of contaminants on mink living on the ORR.

3.5.4 Bioindicator Analysis

In this task, bioindicator analysis was conducted on largemouth bass and bluegill to (1) determine if the health of these species is being adversely affected by contaminants in the Clinch River/Poplar Creek system, (2) establish baseline conditions for evaluating the effectiveness of any future remedial actions, and (3) provide information to be used in the ecological risk assessment. The health status of these two species was evaluated by both a functional response group approach (individual response parameters) and an analysis of integrated site responses.

3.5.4.1 Methods and approach

Field collection and processing methods and laboratory processing approaches are described in the sampling and analysis plan (DOE 1993). Histopathological analyses were based on procedures provided in Hinton and Lauren (1990) and Hinton and Couch (1984). Detoxification enzyme analysis and blood chemical analysis involving indicators of contaminant exposure and organ dysfunction, respectively, were performed according to Adams and Ryon (1994) and Adams et al. (1990). Indicators of overall condition (condition indices) and bioenergetic and nutritional status were determined based on the methods given in Adams and Ryon (1994), Adams et al. (1992a), and Adams et al. (1992b). The health assessment index (HAI) was also applied to individual bluegill and largemouth bass collected at each site (Adams et al. 1993). This index is a field necropsy method that provides a health profile of a fish population based on the incidence of anomalies observed in tissues and organs of individual fish. This method is used to detect gross changes in the health of fish populations but is not diagnostic in character.

An ANOVA was used to determine statistical significance of variables among sites, including detoxification enzymes, indicators of organ dysfunction, histopathological responses, condition indices, and indicators of bioenergetic and nutritional status. If the ANOVA rejected a multisample null hypothesis of equal means ($P<0.05$), then Dunnett's test (Zar 1984) was used to determine significance for individual variables among sites. Tests for homogeneity of variance of individual response variables between sites were conducted with Levene's test (Sokal & Rohlf 1981).

To determine the integrated (multivariate) response of fish to the environmental conditions at each sampling site, all the bioindicator variables were considered jointly within a multivariate context using a canonical discriminant analysis procedure (SAS 1985; Adams et al. 1994). This method provides a graphical representation of the positions and orientations of the integrated site responses of the fish at each site relative to responses at the other sites. In addition, this procedure computes linear combinations

of all the variables under consideration and can detect statistical differences among means for the sites even if individual variables do not indicate such differences. A variable selection procedure (SAS 1985) was used to identify which variables contributed most to the discrimination among the integrated site responses. This variable selection procedure considered all possible combinations of the individual variables and, for any specified subset size, selected those with the best discriminating power.

In evaluating the health status of fish at each sample site, comparisons of the individual bioindicator response groups and the integrated effects were made between each of the sample sites in Poplar Creek and the Clinch River with two reference areas, Norris reservoir (CRM 125) and lower Watts Bar (TRM 530). Two reference sites are required in this study because Norris is a headwater system characterized by extremely low contaminant loading and low biological productivity. Lower WBR, however, also has relatively low contaminant loading but has much higher levels of biological productivity. Since some of the bioindicators responses measured in these fish can be modified or influenced by the level of biological productivity in the system (as reflected in feeding, nutrition, etc.), it is necessary to also compare the bioindicator responses of fish from sites in the Clinch River and Poplar Creek to an internal reference (TRM 530) that has somewhat similar trophic dynamics and productivity.

3.5.4.2 Functional response groups

For the purpose of analysis and evaluation, individual bioindicator responses were grouped into five functional categories representing indicators of (1) detoxification enzymes, (2) organ dysfunction, (3) histopathology, (4) overall fish health (condition indices), and (5) nutrition and feeding status. In addition the HAI was applied to individual fish to provide an overall health profile of the population at each site. These functional groups reflect gradients of both ecological relevance and time-course of responses to stressors such as contaminants (Adams 1990). Those variables in categories (1) and (2) are primarily short-term response indicators and have relatively low ecological relevance, while those variables in groups (3) through (5) are longer-term response indicators and are characterized by lower toxicological but higher ecological relevance.

For each sample site, the means and standard error for each bioindicator variable are presented in Tables C30 and C31 for female and male bluegill and Tables C32 and C33 for female and male largemouth bass. In this section on bioindicator analysis, only data for males of each species are discussed because information on females will be presented in Sect. 3.5.5 (Reproductive Analysis). Also, sample sizes for males are generally higher at each site and, therefore, more amenable to statistical analysis.

<u>Detoxification Enzymes</u>

The activity or level of liver detoxification enzymes is used to indicate exposure to and possible effects of various xenobiotics, such as hydrocarbons, PAHs, PCBs, and pesticides (Payne and Penrose 1975). Many of these compounds commonly occur in industrial and municipal effluents and are accumulated within living tissues (Ahokas et al. 1976; Neff 1978; Brown et al. 1986). As has been demonstrated in studies of other aquatic systems, EROD enzyme activity has been one of the best indicators of fish contaminant exposure in field populations (Adams et al. 1992a; 1992b).

Increased activity of EROD at the two lower Poplar Creek sites and in the Clinch River immediately downstream of the mouth of Poplar Creek (CRM 10), indicated that largemouth bass sampled from these sites had been exposed to elevated levels of contaminants relative to bass from the two reference sites (Fig. 3.57). Even though elevated activity was indicated at PCM 5.3, only one bass was collected at this site due to their low abundance in the area of the creek. Bluegill, however, did not show the same pattern

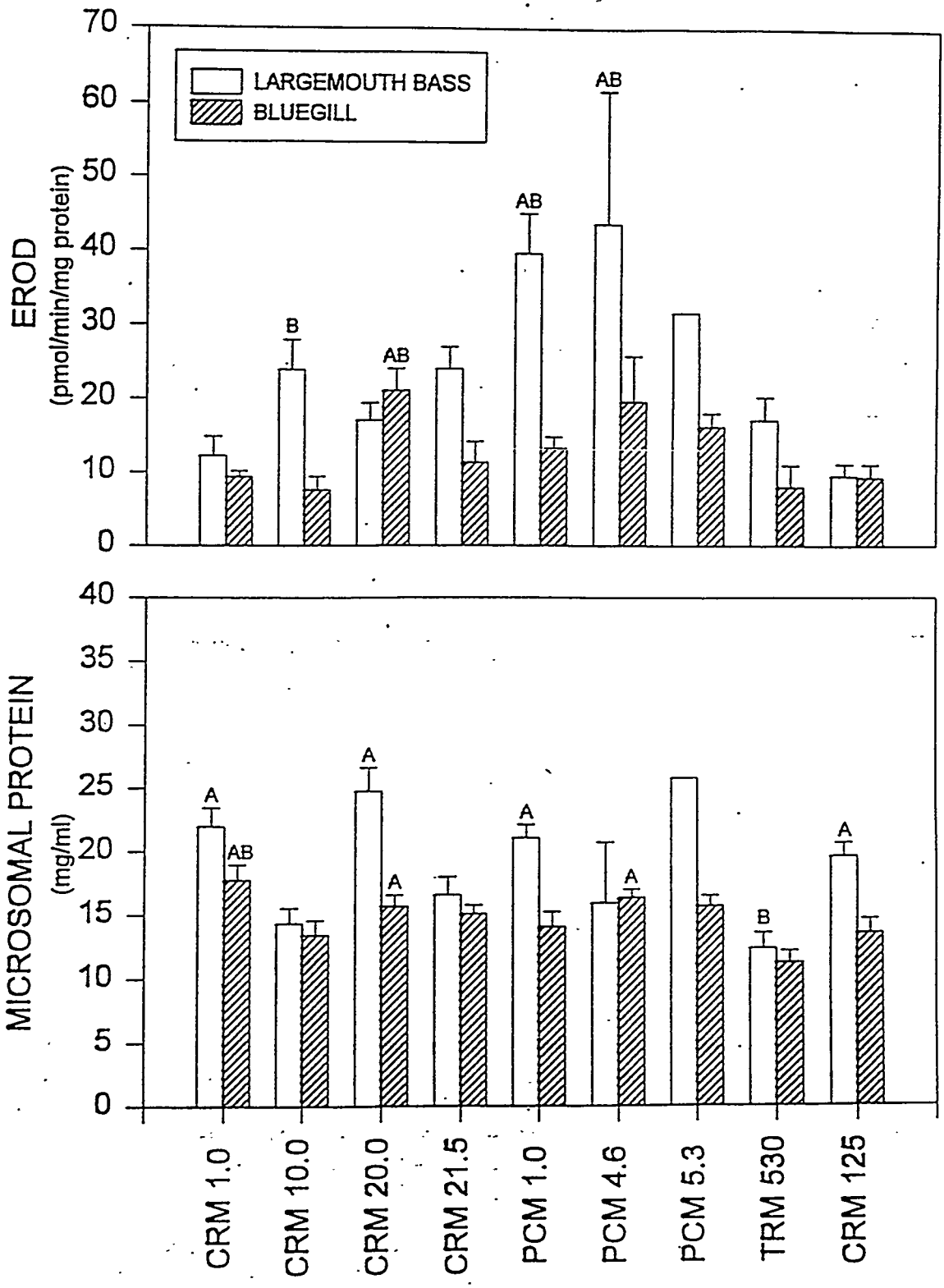


Fig. 3.57. Means + SE for detoxification enzyme indicators (EROD and microsomal protein) for male largemouth bass (clear bars) and bluegill sunfish (hatched bars) at each sample site 1993-1994. A = significantly different from TRM 530, B = significantly different from CRM 125.

of enzyme induction as did largemouth bass. Only bluegill at CRM 20 near the mouth of WOC demonstrated a significant increase in enzyme activity.

Microsomal protein, which is not only used as a standard for quantifying EROD activity but also as an indicator of microsomal proliferation in the cell, was higher at two Clinch River sites and two Poplar Creek sites compared to the internal reference (TRM 530). Microsomal protein in bluegill, however, displayed a similar trend to EROD activity in that only one site (CRM 10) was significantly higher than the reference.

There are two possible explanations for the higher EROD activity and microsomal protein values in largemouth bass compared to bluegill at some of the sample sites. Bass are longer lived species and, therefore, may have been exposed to contaminants for a longer period of time than bluegill. The most feasible explanation for these species differences, however, may be related to the nature of their respective diets. Shad are the main component in the diet of largemouth bass and these prey have higher body burdens of some contaminants such as PCBs than the benthic macroinvertebrates that are typically ingested by bluegill. In fact, levels of PCBs in shad are higher than the PCB levels measured in mayflies (Sect. 3.5.2).

PCBs have been shown to induce the mixed function oxidase (MFO) system in fish (Spies et al. 1982; Ankley et al. 1986; Melancon and Lech 1983). Even at relatively low levels, which approximate the body burdens of PCBs measured in some fish collected from the Clinch River and Poplar Creek, PCBs have been shown to induce MFO activity (Nasci et al. 1991). Studies by Greeley et al. 1994 demonstrated significant EROD induction in largemouth bass exposed to PCBs in Hartwell Reservoir (Georgia/South Carolina).

Histopathology

The histopathological condition of largemouth bass and bluegill were assessed both quantitatively, to determine the percentage of the total liver damage caused by various pathologies, and qualitatively, to assess the frequency occurrence of the various lesions present in the liver.

Quantitative evaluation. Indicators of histopathological condition demonstrated few changes in largemouth bass compared to bass collected from reference areas, but a variety of pathologies were evident in bluegill (Fig. 3.58). Macrophage aggregates, which are indicators of diseased or infected areas in tissue, were significantly higher than reference values for largemouth bass sampled from CRM 1. Even though increases in this pathology were indicated for bluegill in the upper two sites of Poplar Creek, values were not statistically different due to the high variability among sample means. Necrotic liver parenchyma was also somewhat elevated in bluegill from Poplar Creek and CRM 10. Also, the abundance of liver parasites was higher at two Clinch River and two Poplar Creek sites compared to the references. This increased frequency of pathologies in the liver tissue of bluegill collected from some Poplar Creek and Clinch River sites indicates that these sunfish have less viable liver to (1) produce MFO enzymes for detoxifying contaminants, (2) store energy reserves as glycogen and lipid, and (3) manufacture vitellogenin for oocyte and egg development.

Qualitative evaluation. The major lesions observed in the liver and spleen tissue of largemouth bass and bluegill were recorded by their severity. Six major types of pathologies were observed in the liver of bass and bluegill, while two and four types of lesions were found in the spleen of bluegill and bass, respectively (Tables C34 and C35). The average rank of all lesions served as an indicator of the severity of histopathological damage to the major organs of fish at each of the sample sites.

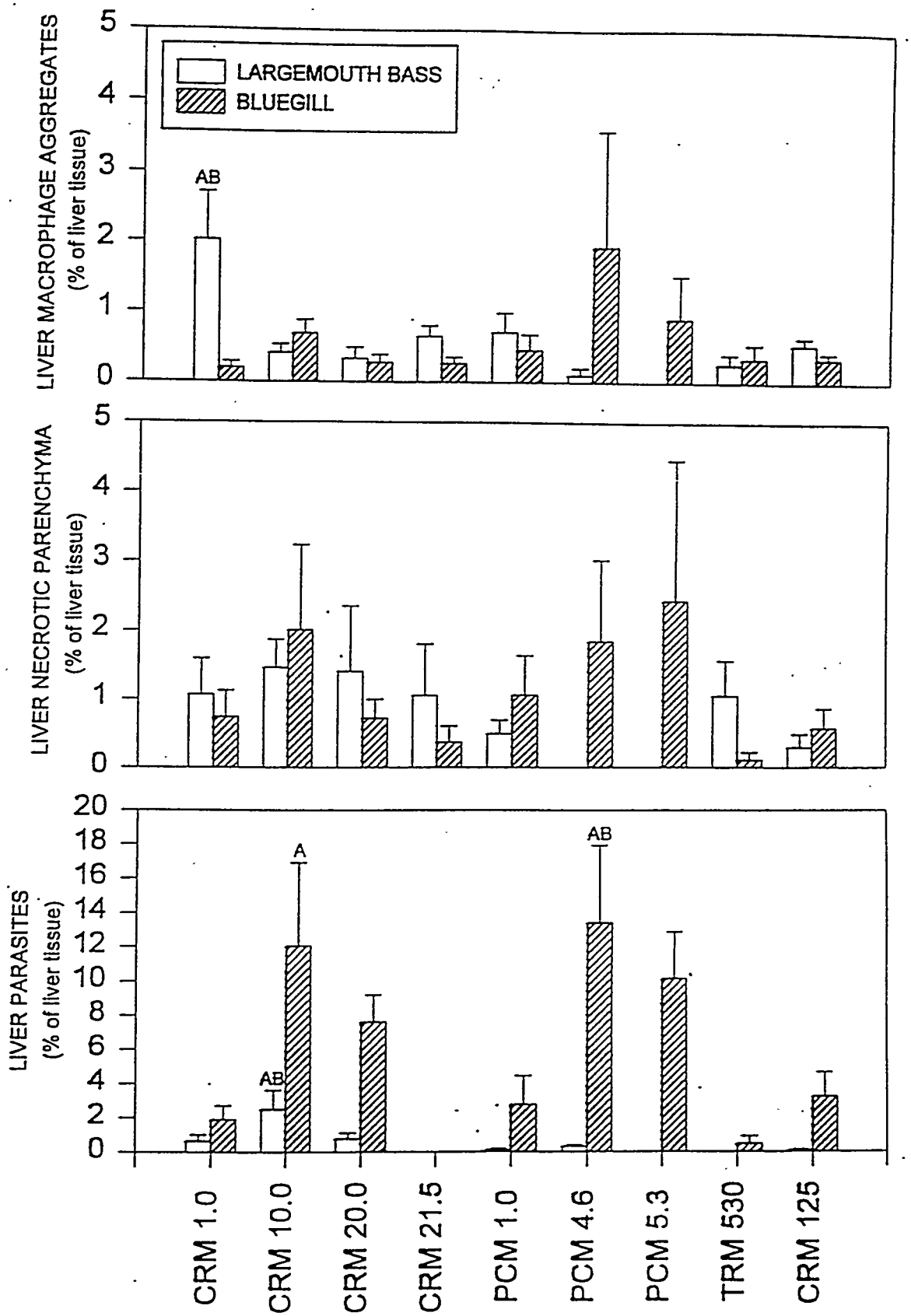


Fig. 3.58. Means + SE for histopathological indicators for male largemouth bass (clear bars) and bluegill sunfish (hatched bars) at each sample site 1993–1994. A = significantly different from TRM 530, B = significantly different from CRM 125.

The upper two sites in Poplar Creek (PCM 5.3 and 4.6), corresponding to the mouth of EFPC and Mitchell Branch, had the lowest average pathology rank and, therefore, represented the bluegill in the poorest histopathological condition (Table C34). Sites in the Clinch River—CRM 10.0, CRM 21.5, and CRM 1.0—ranked 3, 4, and 5, respectively, in their severity of liver and spleen lesions. Fish from lower Watts Bar (TRM 530) had the fewest lesions and were considered to be in the best histopathological condition. Since bluegill have restricted home ranges and movement patterns (Gatz and Adams 1994), the condition of these fish basically reflect the environmental and water quality conditions at these sites. It was somewhat surprising, however, that bluegill from CRM 20 (near the mouth of WOC) were in better condition than those bluegill 1.5 miles upstream of the WOC mouth.

Even though largemouth bass bass from PCM 4.6 demonstrated the poorest histopathological condition, the other two sample sites in Poplar Creek did not show such anomalies (Table C34). One potential explanation for the higher variability in histopathological condition of largemouth bass in Poplar Creek compared to bluegill is that largemouth bass are more transient and those individuals sampled from various sites in Poplar Creek may have migrated in from other areas of the Watts Bar system such as from the Clinch River. In contrast to bluegill, bass collected from near the mouth of WOC (CRM 20) had the second highest incidence of liver and spleen lesions. Further downstream at CRM 10, largemeouth bass from the Brashear Island area had the third poorest pathological condition, followed by those individuals collected from the lower Clinch River (CRM 1.0). In the Clinch River, therefore, there appears to be a downstream gradient in the pathological condition of largemouth bass which extends from CRM 20 downstream to CRM 1.0.

In several studies, PCBs have been implicated in the liver pathologies of fish. Exposure to PCB was found to increase the occurrence of hepatocellular necrosis and liver lesions in flatfish (Rhodes et al. 1985), and necrotic changes in hepatocytes were reported after fish were exposed to the PCB Aroclor 1254 (Hacking et al. 1978). In a river contaminated by PCBs, Peters et al. (1987) reported an increase in abundance of macrophage aggregates in fish liver tissue. In the Clinch River/Poplar Creek study, liver necrosis and macrophage aggregates were found at higher frequencies in liver tissue in those largemouth bass collected from the Clinch River and Poplar Creek sites than in fish from both references. Hinton and Lauren (1990) state that hepatocellular necrosis is a good biomarker of anthropogenic toxicant exposure, and is useful for identifying point sources of toxicant emissions. In the case of fish collected from the Clinch River and Poplar Creek, PCBs are the main contaminants of concern; therefore, it is reasonable to assume that the hepatic necrosis observed in these fish may have been caused by this contaminant.

Organ Dysfunction

Elevated creatinine levels are typically used as an indicator of kidney damage or malfunction (Tietz 1986). For largemouth bass, creatinine values at all Clinch River and Poplar Creek sites were elevated above the reference values, but only those fish from PCM 1.0 had significantly higher concentrations (Fig. 3.59). Creatinine levels in bluegill were generally similar to reference values with only those sunfish from PCM 1.0 being higher. Therefore, some possible kidney damage in largemouth bass and bluegill is implicated, particularly at the lower Poplar Creek site.

The transferase enzyme ALT (alanine aminotransferase) is generally used as an indicator of liver damage, and elevated levels in humans is a sign of liver cirrhosis, hepatitis, or disease which affects liver cell integrity. Levels of this enzyme in largemouth bass did not suggest liver damage, but in bluegill liver damage is implicated in individuals sampled from PCM 1.0. Histopathological examination of bluegill did in fact reveal a relatively high occurrence of liver pathologies for fish collected from Poplar Creek.

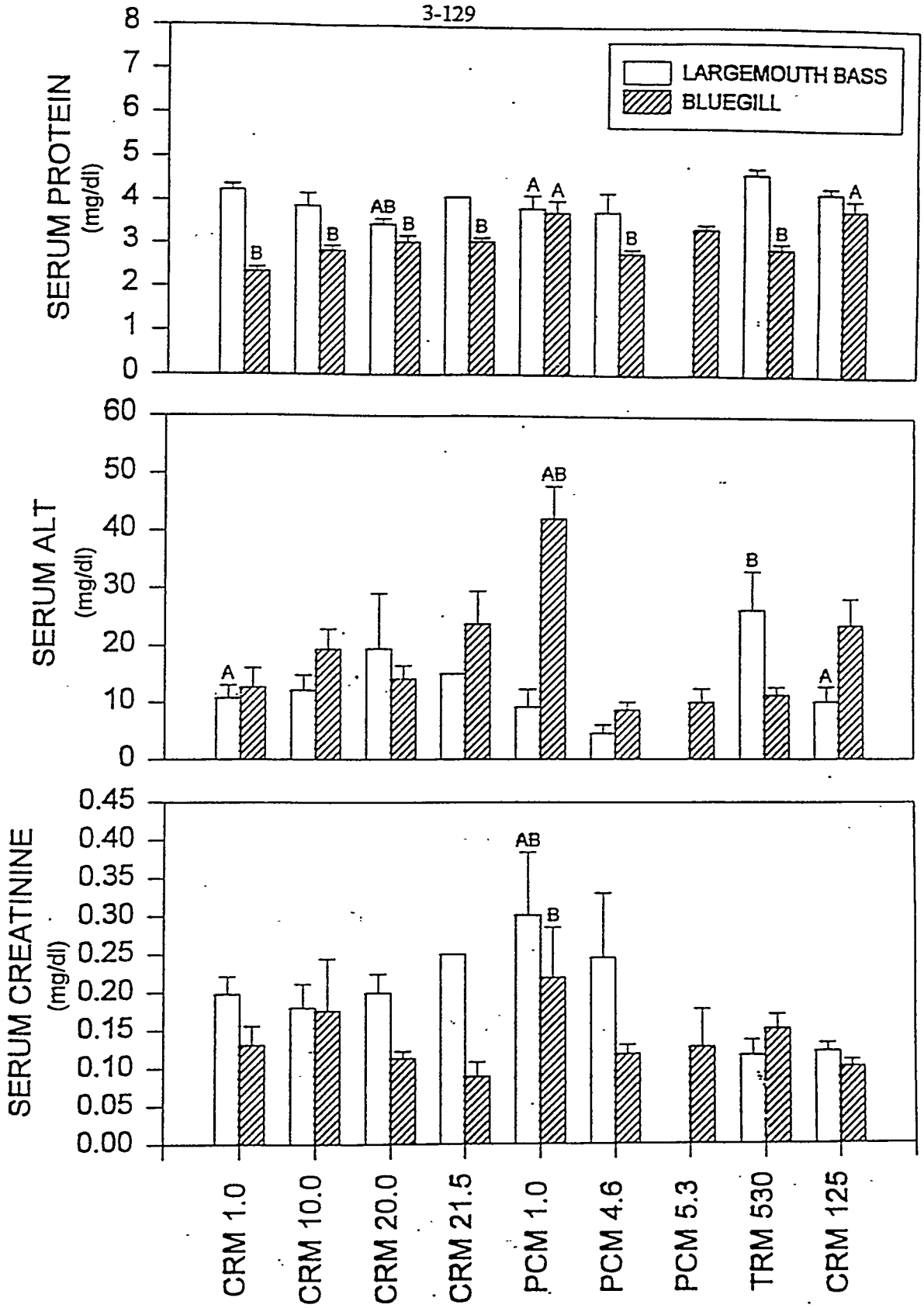


Fig. 3.59. Means + SE for organ dysfunction indicators (serum creatinine, ALT, protein) for male largemouth bass (clear bars) and bluegill sunfish (hatched bars) at each sample site 1993-1994. A = significantly different from TRM 530, B = significantly different from CRM 125.

Particularly evident among these pathologies is the incidence of focal necroses, which are direct indicators of liver damage.

Total serum protein is used as a general indicator of protein metabolism in organisms. Largemouth bass from CRM 20 and PCM 1 had significantly lower protein concentrations than did the reference fish. Bluegill collected from the Clinch River sites and PCM 4.6 all had lower values compared to the reference. Abnormally low values of blood protein observed in these fish can reflect anomalies in protein metabolism or nutritional stress (Lockhart and Metner 1984).

Condition Indices

Various condition indices were measured as indicators of the general health of fish. The condition factor, K, is a generalized indicator of the overall health or "plumpness" of a fish and can reflect the integrated effect of both metabolic stress due to contaminants and nutritional status. For largemouth bass, the condition factor was significantly higher at CRM 1 and PCM 1 than in the Norris reference bass, while the condition factor of CRM 20 fish was lower (Fig. 3.60). Because Norris is basically an oligotrophic system, the more appropriate reference site for comparison on a bioenergetic basis is the lower WBR site (TRM 530). For this comparison, only largemouth bass from CRM 20 were lower than the reference. Bluegill from all sites, however, had similar condition factors among sites.

The visceral-somatic index (VSI) reflects energy stored as lipids in the mesenteries of the viscera. The VSI generally reflects the level of total body lipids, which is used to indicate the overall fat storage and bioenergetic condition of fish. Largemouth bass sampled from all Poplar Creek and Clinch River sites except CRM 21.5 and PCM 4.6 had significantly higher VSI values than did the Norris reference, while values were all similar to the lower Watts Bar reference (Fig. 3.60). In contrast, the visceral-somatic indices for bluegill from CRM 20 and 21.5 and lower Poplar Creek were significantly lower than TRM 530, with only CRM 1 being higher than the Norris reference. Because of the lower lipid levels in bluegill from the upper Clinch River sites and the lower Poplar Creek area, some level of bioenergetic dysfunction in fish from these sites is indicated.

The liver-somatic index (LSI) is an indicator of metabolic energy demands (Adams and McLean 1985) and is sensitive to toxicant stress with both liver enlargement due to hyperplasia and hypertrophy being reported in fish exposed to toxic compounds (Fletcher et al. 1982, Addison 1988, Heath 1987). Largemouth bass sampled from all Clinch River sites except CRM 10 and all Poplar Creek sites had significantly lower LSI values than the Watts Bar reference bass (Fig. 3.60). Only at CRM 10 was the LSI significantly higher than the Norris reference. Because the LSI in largemouth bass is generally lower than that from Norris fish, the LSI in this case does not reflect changes in liver size due to toxicant exposure but probably is a response to nutritional and bioenergetic factors. For bluegill, the LSI was similar among all sites.

Nutritional and Feeding Status

In evaluating the effects of contaminant stress on fish, the nutritional status of the organism is important in interpreting the nature of these effects. For example, poor nutrition can weaken fish and render them more susceptible to other stresses (Shulman 1974, Adams et al. 1985). As an indicator of short-term feeding intensity, the percentage of food in the intestine was evaluated among sites for largemouth bass and bluegill (Fig. 3.61). Feeding by largemouth bass was generally low at all sites, while feeding intensity at CRM 1.0 and 21.5 and the lower two Poplar Creek sites indicated significantly lower

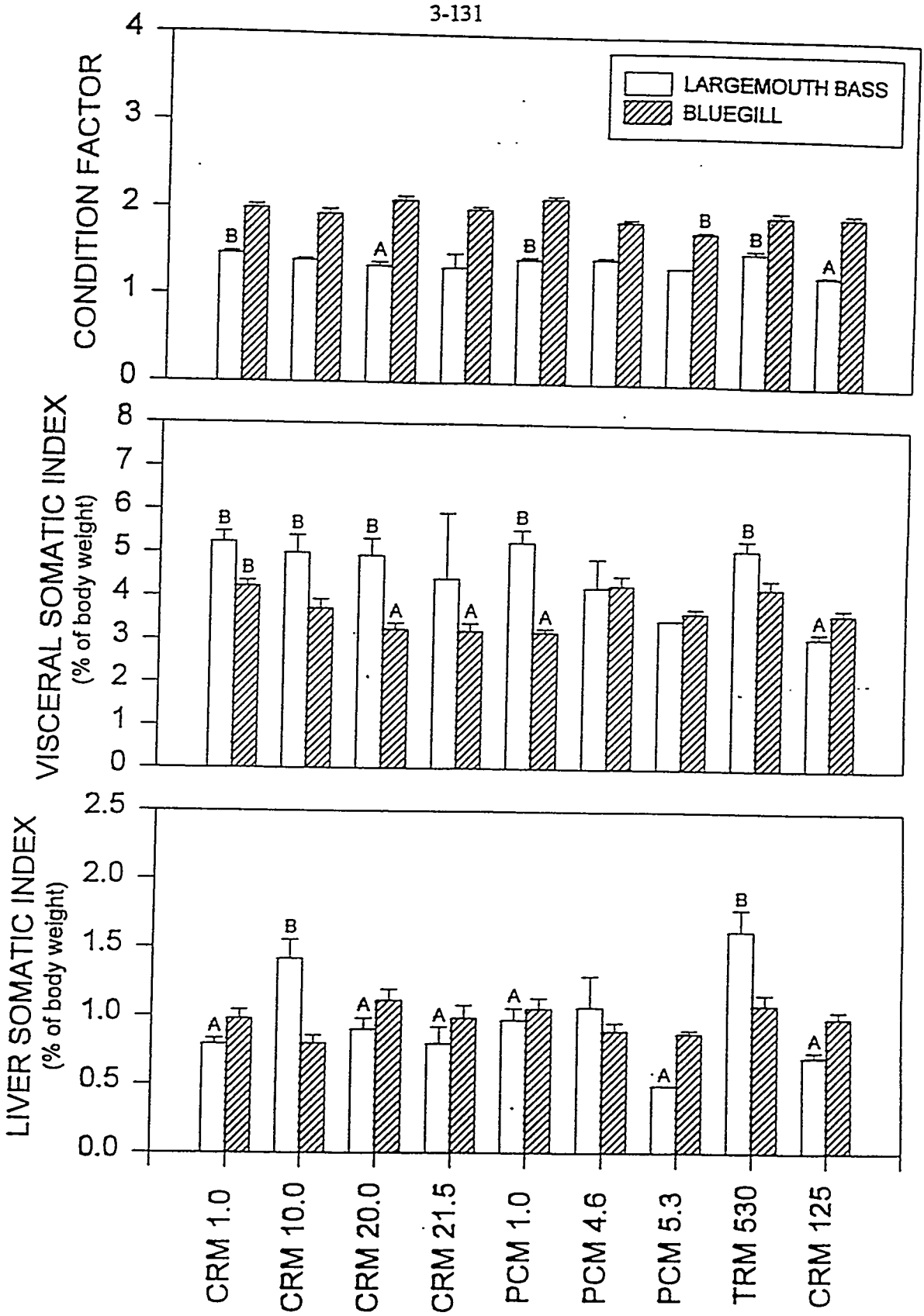


Fig. 3.60. Means + SE for three condition indices for male largemouth bass (clear bars) and bluegill sunfish (hatched bars) at each sample site 1993-1994. A = significantly different from TRM 530, B = significantly different from CRM 125.

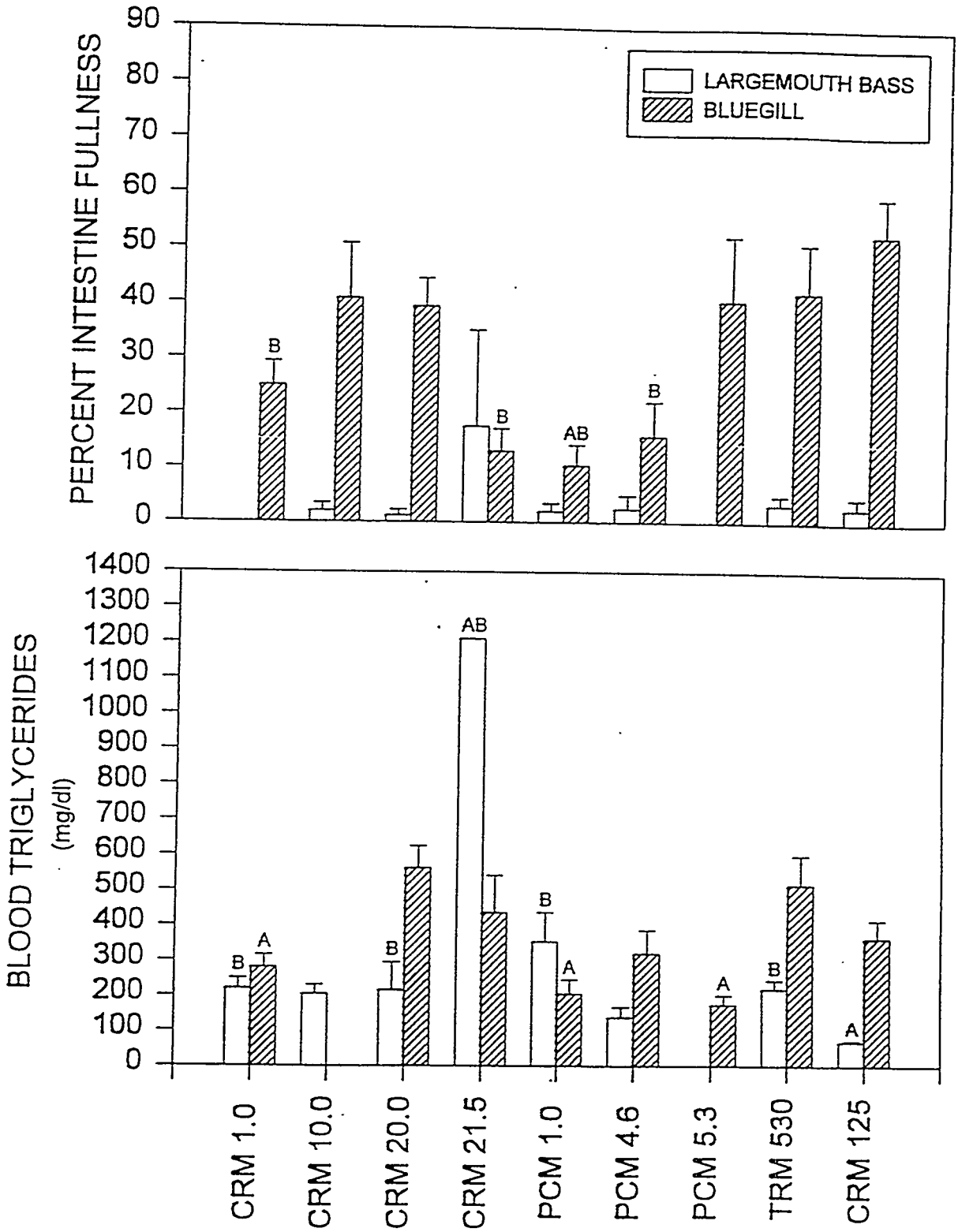


Fig. 3.61. Means + SE for feeding and nutritional indicators for male largemouth bass (clear bars) and bluegill sunfish (hatched bars) at each sample site 1993–1994. A = significantly different from TRM 530, B = significantly different from CRM 125.

feeding compared to the references. Serum triglycerides, which reflect a more long-term feeding status, were extremely low in the Norris reference bass and intermediate in Norris bluegill. Only bass collected from CRM 10 and the upper two Poplar Creek sites were not different from the Norris reference, while only bass from CRM 21.5 had higher triglyceride levels than the Watts Bar reference. Triglyceride levels in bluegill, however, were significantly lower than the Watts Bar reference at CRM 1.0 and PCM 1.0.

3.5.4.3 Health assessment index

The HAI, which provides an overall health profile of a fish population, indicated that even though bluegill sampled from the Clinch River and Poplar Creek had higher HAI scores than fish from other sites (and therefore poorer health), these values were not statistically different from the Norris reference site (CRM 125) (Fig. 3.62). Only bluegill collected from PCM 4.6 (downstream of Mitchell Branch) were in significantly poorer health than the reference fish. Anomalies in three of the index variables (kidney, parasites, and levels of serum protein) were primarily responsible for the elevated HAI values at this site. Bluegill collected from PCK 4.6 had a high incidence of swollen kidneys, which is a general indicator of organ pathology (Goede and Barton 1990). Abnormally low values of blood protein observed in these fish can reflect anomalies in protein metabolism or nutritional stress (Lockhart and Metner 1984).

The HAI demonstrated a more dynamic response in largemouth bass than it did in bluegill. Bass from two sites in Poplar Creek (PCM 01 and 5.3) and downstream of the mouth of WOC (CRM 20) had significantly higher HAI scores than did the other sites. Anomalies in the gills, spleen, liver, and blood protein were the primary variables responsible for the elevated HAI at these sites. Reduced condition factors, which reflect overall condition and the "well-being" of fish, also contributed to the poorer health of fish at PCM 5.3 and CRM 20. Because the spleen serves a hemopoietic function, abnormalities in this organ could indicate bacterial infection or disease. Gill damage in fish collected from PCM 5.3 and 1.0 could indicate potential impairment of gas exchange, osmoregulation, and excretory function in these fish. For bass collected from CRM 20, some liver damage was implicated. Liver damage in fish can result in reduced production of detoxification enzymes, impairment of glycogen and lipid dynamics within this organ, and decreased ability to produce vitellogenin necessary for proper egg development.

3.5.4.4 Integrated site analysis

The integrated response of fish to the environmental conditions at each study site was evaluated by incorporating bioindicators representing all five functional response groups and the HAI into the multivariate analysis. This holistic approach for evaluating the effects of water quality and other environmental factors on the health of fish has the primary advantage of providing an integrated assessment of fish health based on multiple rather than individual bioindicators. As a measure of the quantitative differences between site means, the Mahalanobis statistic was used to measure the linear distance between these means. Because of relatively low sample sizes, some sites could not be included into the discriminant analysis procedure. For the largemouth bass analysis, the two upper Poplar Creek sites and CRM 21.5 had to be excluded because bass were either not present or in low abundance at these sites. For bluegill, only PCM 5.3 and CRM 21.5 had to be excluded from the integrated site analysis because of sample size limitations.

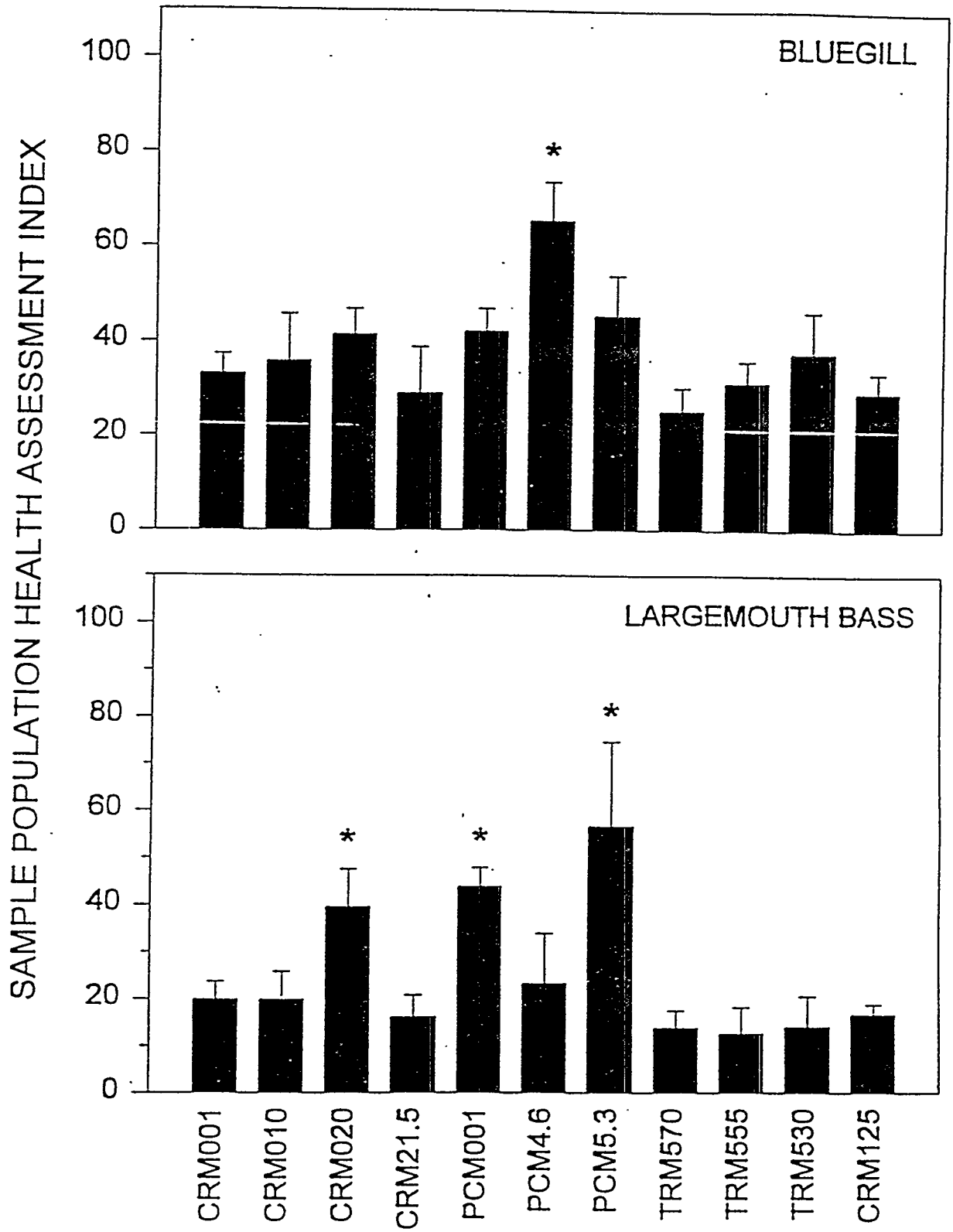


Fig. 3.62. Means + SE for the health assessment index (HAI) for male largemouth bass (clear bars) and bluegill sunfish (hatched bars) at each sample site 1993–1994. * = significantly different from CRM 125.

Results of the discriminant analysis revealed several patterns relative to the health of largemouth bass populations at the two reference sites compared to fish sampled from the Clinch River and lower Poplar Creek (Fig. 3.63). Norris bass were least similar to those fish sampled from lower Poplar Creek (PCM 1) and most similar to the lower Watts Bar reference site. Even though there are major differences in the trophic dynamics of biological productivity of these two reference sites, fish from these areas were more similar to each other than they were to the Clinch River and Poplar Creek fish. Bass sampled from PCM 1.0 were most similar to fish from CRM 10 and 20. The functional group analysis also demonstrated that bass from PCM 1.0 were in the poorest health as indicated by the detoxification enzyme, histopathological, and bioenergetic responses.

The individual response variables that best discriminated among the health status of fish from all sample sites were identified by a multivariate selection procedure. These variables were used to generate the final integrated site responses shown in Figs. 3.63 through 3.65. For largemouth bass, four variables were significant in discriminating among sites. These were, in order of importance, the VSI, EROD, microsomal protein, and the condition factor. Two of these variables, EROD and microsomal protein, are indicators of contaminant exposure, while the VSI and condition factor reflect the bioenergetic and overall condition of these fish (see Sect. 3.5.4.2). The primary factors, therefore, that are important for characterizing the health status of largemouth bass in the Clinch River and Poplar Creek are those that demonstrate that these fish have not only been exposed to contaminants, but bioenergetic function of these fish may have been impaired by this exposure.

The integrated site response of bluegill sampled from the Clinch River and Poplar Creek also demonstrated distinct patterns (Figs. 3.64 and 3.65). The two Poplar Creek sites segregate together as do the reference areas. The two reference sites were more similar to each other than they were to any of the Clinch River or Poplar Creek sites. Interestingly, the two Poplar Creek sites were more similar to CRM 20 than the other two Clinch River areas, even though CRM 10 is immediately downstream of the mouth of Poplar Creek.

In Fig. 3.65 the three Clinch River sites segregate as a group as do the two references. The upper Clinch River site (CRM 20) is the least similar to the two references, while CRM 10 is more like TRM 530 than the Norris reference. All three Clinch River sites are equally similar to each other implying that largemouth bass at these sites are equally affected by environmental conditions including contaminant exposure and the biological effect responses resulting from this exposure.

The variables most responsible for discriminating among sites for bluegill were EROD, the VSI, and microsomal protein. These are three of the same four variables that were also involved in site discrimination for largemouth bass. As was the case for largemouth bass, bluegill are exposed to contaminants in the CR/PC system, and one potential implication of this exposure is impairment of bioenergetic function in these fish.

3.5.4.5 Summary and conclusions—bioindicators task

The bioindicator data indicate an apparent gradient in biological effects extending from upper Poplar Creek down the Clinch River to lower WBR. Some of the major health effects responses observed in fish, such as detoxification enzyme induction and poor histopathological condition, are consistent with PCB exposure. Based on the evidence presented in this study, therefore, it appears reasonable to conclude that PCBs may be adversely affecting the health of fish in some areas of the CR/PC system.

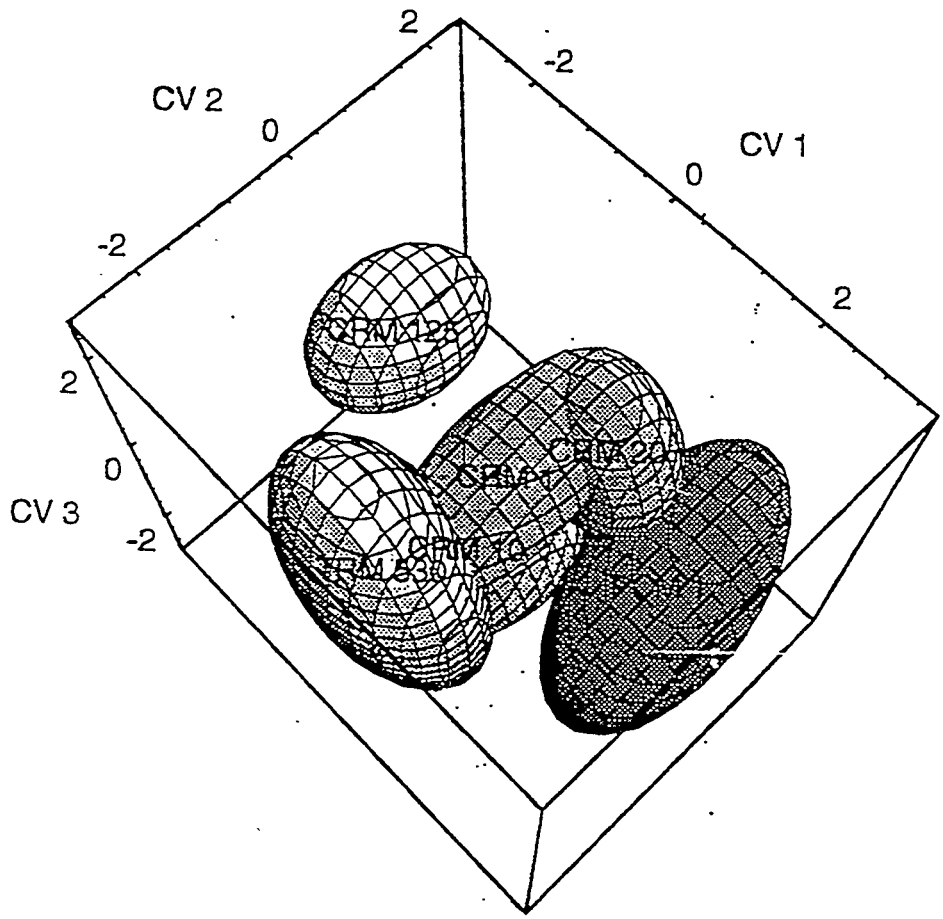


Fig. 3.63. Segregation of integrated health responses for male largemouth bass collected from two reference sites (CRM 125 and TRM 530), three Clinch River sites (CRM 1, 10, 20) and the lower Poplar Creek site (PCM 1.0). Ellipsoids represent the mean integrated responses of bass at a site for 1993–1994.

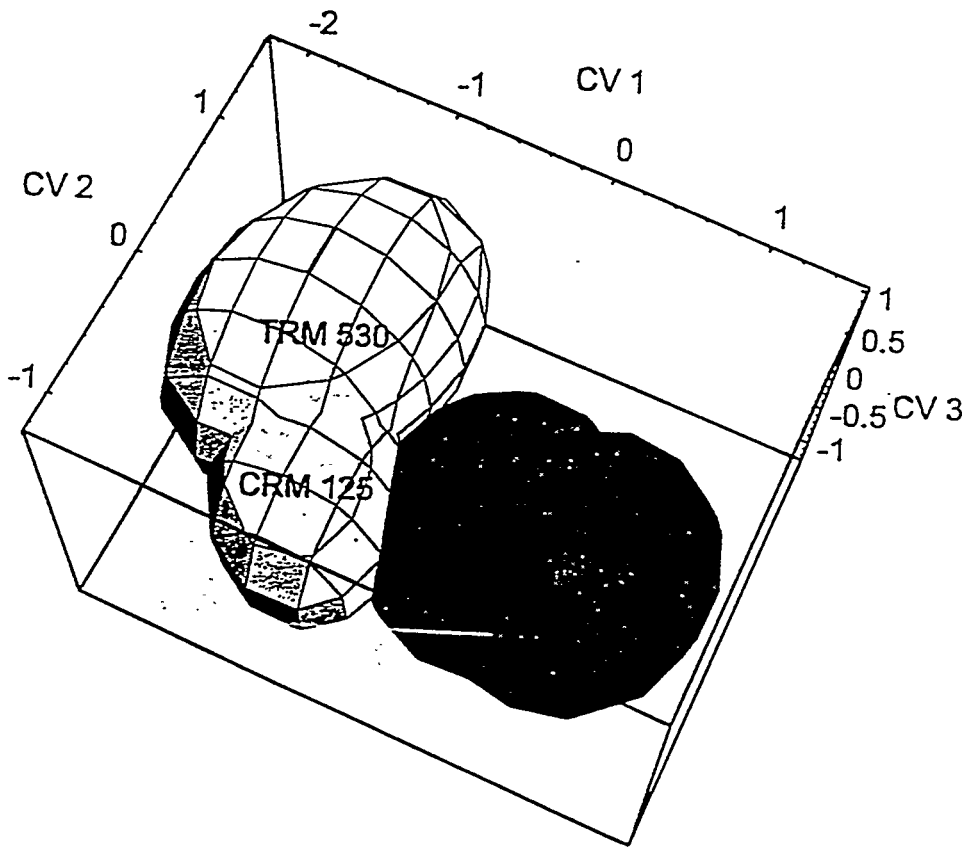


Fig. 3.64. Segregation of integrated health responses for male bluegill sunfish sampled from two reference sites (CRM 125 and TRM 530) and two Poplar Creek sites (PCM 4.6 and 1.0). Ellipsoids represent the mean integrated responses of bass at a site for 1993–1994.

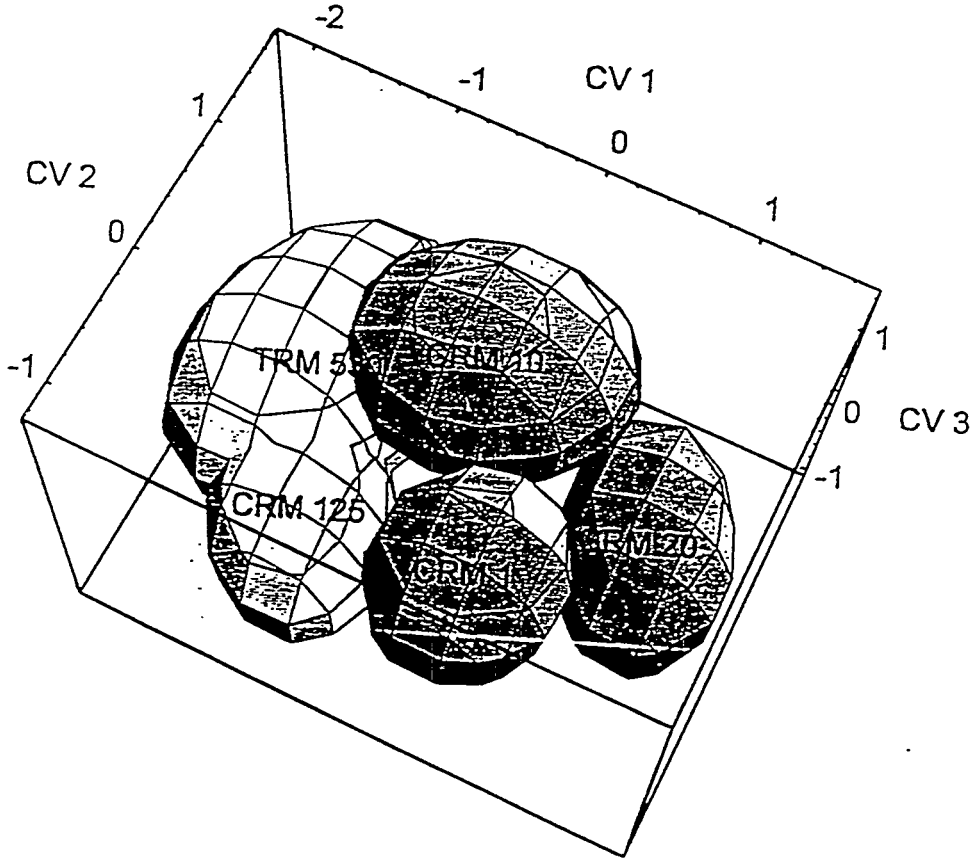


Fig. 3.65. Segregation of integrated health responses for male bluegill sunfish sampled from two reference sites (CRM 125 and TRM 530) and three Clinch River sites (CRM 20, 10, 1). Ellipsoids represent the mean integrated responses of bass at a site for 1993–1994.

3.5.5 Reproductive Effects Assessment

The establishment and maintenance of fish populations is intimately associated with the ability of individuals within a population to reproduce. Reproduction is thus generally considered to be the most critical life function affected by environmental contamination. From a regulatory perspective, the issue of potential contaminant-related effects on fish reproduction has a particular significance because the growth and propagation of fish and other aquatic life is one of the classified uses of the CR/WBR as determined by the state of Tennessee.

Common environmental contaminants, many of which are found in the CR/WBR, are known to have a variety of effects on the reproductive processes of fish, including decreases in the gonadal-somatic index (GSI) upon exposure of fish to PCBs (Monosson et al. 1994) and mercury compounds (Dey 1989, Kirubagaran and Joy 1992). Levels of testosterone and estradiol have been shown to decrease in fish blood following laboratory or environmental exposure to a number of potential environmental pollutants, including PCBs (Sivarajah et al. 1978, Thomas 1990), aromatic hydrocarbons (Johnson et al. 1988), paper and pulp mill effluents (McMaster et al. 1991, Munkittrick et al. 1992), lead (Thomas 1990), cyanide (Ruby et al. 1993), organochlorine or organophosphorus pesticides (Singh and Singh 1987), and crude petroleum (Truscott et al. 1983). Oocyte atresia has been associated with exposure to a number of chemical toxicants, including PAHs (Krarup 1969, Mattison et al. 1983, Takizawa et al. 1984), metals such as cadmium (Mattison et al. 1983), and mixed environmental contaminants (including PCBs and PAHs) (Johnson et al. 1994). Relatively high incidences of oocyte atresia have been previously observed in breeding redbreast sunfish from both upper EFPC (Hinzman 1993) and the Pigeon River, a stream heavily impacted by effluents from a paper and pulp mill (Adams et al. 1992). Abnormally high numbers of atretic oocytes have also been observed in fathead minnows undergoing acid-induced stress (McCormick et al. 1987).

The goal of this task was to evaluate the reproductive health of fish in the CR/WBR downstream of the ORR. This goal was addressed through a comparison of selected reproductive criteria in key fish species collected from the CR/WBR and reference sites. Largemouth bass and bluegill sunfish, both important sport fishes in the CR/WBR system, were the target organisms examined in the field portion of this task.

3.5.5.1 Methods and approach

Largemouth bass and bluegill sunfish were collected from seven sites in Poplar Creek, Watts Bar Lake and Norris Lake at the beginning of the 1993 reproductive season to assess the comparative reproductive status of fish populations at these sites. General measures of reproductive condition examined in both male and female fish included the GSI, a measure of gonad size relative to body size, and plasma concentrations of important reproductive hormones such as estradiol and testosterone. Hormones were measured by standard radioimmunoassay procedures (ER/CR-SOP2170) as adapted from Greeley et al. (1988). At least one testis from each male fish was also examined histologically for evidence of histopathological abnormalities, as well as to assess the developmental status of spermatogenic tissues within the organ. For female fish, reproductive status was quantitatively evaluated by sizing, staging and enumerating all oocytes above a certain threshold size contained within a weighed piece of ovary (ER/CR-SOP2160, as adapted from Greeley et al. 1987, Lin et al. 1989). Measures of reproductive condition derived from this exercise include one or more estimates of fecundity, total counts of vitellogenic ("yolk-laden") oocytes within an ovary, and the prevalence of parasitic lesions and oocyte atresia (oocyte death and/or reabsorption).

Data was log-transformed before statistical analysis. Homogeneity of variance was verified by a Levene's Test (Sokal and Rohlf 1981), an F-distribution test that compares the ratios of the variances from two independent sample populations. If variances proved to be homogeneous, a one-way ANOVA was used to test for site effects for the various reproductive parameters. If the ANOVA rejected a multisample null hypothesis of equal means, then Dunnet's test (Zar 1984) was used to test for significant site differences from the reference in response parameters. For data with non-homogeneous variances, difference between means were examined by the Kruskal-Wallis Test. In all cases, the significance level for rejecting the hypothesis of equal means between sites was set at $\alpha = 0.05$.

3.5.5.2 Results and discussion

Male Largemouth Bass

For male largemouth bass, the study sites with the highest mean GSIs proved to be the two reference sites in the upper reaches of Norris Lake (Table C36: CRM 125 and PRM 30). In contrast, the lowest GSIs were observed at PCM 1 and CRM 20, the two study sites adjacent to the ORR. Since the mean developmental stage of the testes were similar between sites, the smaller relative size of the gonads at PCM 1 and CRM 20 apparently represented a true decrease in male reproductive effort at these sites as compared with reference populations.

Plasma concentrations of the androgenic steroid hormone, testosterone, were also particularly low in male largemouth bass from PCM 1 and CRM 20, averaging approximately half the levels measured in fish from the reference sites (Table C36). The estrogenic steroid hormone, 17β-estradiol, which functions in female fish to regulate the production of yolk proteins, is generally not detectable in male fish. However, production of this typically female reproductive hormone may be stimulated in males upon exposure to compounds that act as either endocrine mimics or blockers. As expected, the mean concentrations of estradiol in plasma samples from the male bass collected for this study were very low at all study sites (sensitivity limit of the assay was 100 pg/mL; nondetects were assigned a value of one-half the sensitivity limit for the purposes of calculating the means). However, the frequencies with which detectable levels of estradiol occurred in male bass did differ markedly between sites. Estradiol was low but measurable in 88% of the males collected from CRM 20, 69% from CRM 0.5, and 41% from CRM 557. Corresponding incidences of detectable levels of estradiol in male bass at other sites were 36% for PRM 30, 11% for CRM 125, and 0% for TRM 570 and PCM 1. Therefore, sites with the highest frequencies of estradiol "detects" in male largemouth bass were the three sites in the Clinch River and Watts Bar Lake that lie downstream of the ORR.

Female Largemouth Bass

The mean GSIs of the female largemouth bass populations examined in this study tended to separate into two groupings (Table C37). One grouping was composed of sites with relatively low GSIs, and included PCM 1, CRM 20, and the two reference sites, CRM 125 and PCM 30. A second grouping was composed of sites with relatively higher mean GSIs, and included TRM 557, TRM 570, and CRM 0.5.

Estimates of fecundity were derived for female largemouth bass in the present investigation by two very different methods (Table C37). The sum of all obviously maturing oocytes, mature eggs, and/or shed follicles (the remnants of eggs left in the ovary following a spawn) in the ovaries of females collected either just prior to or immediately after the first spawn of the breeding season yielded one estimate of fecundity. The advantage of this method is that it probably best represents the actual numbers of eggs spawned by a female fish during any single spawning episode. The primary shortcoming of this method of estimation is that determining which oocytes are "obviously" maturing is inherently subjective.

Despite this limitation, the mean batch fecundities derived from this method of estimation proved to be very similar across all the study sites.

Fecundity was also estimated by a more widely accepted method of enumerating all oocytes greater than 0.75 mm in diameter in female bass collected at the beginning of the breeding season (Table C37). However, there are some potentially significant drawbacks to this method. The choice of oocyte sizes that are included in the estimate are based upon somewhat arbitrary assumptions. Furthermore, this method almost certainly underestimates the actual number of eggs to be spawned during the entire breeding season, for smaller oocytes appear to undergo rapid growth into this size range during the entire duration of the short breeding season (personal observations). Regardless of these shortcomings, however, estimates of fecundity derived by this method are probably the most suitable for comparing different bass populations, because the estimates (although admittedly flawed) are less subjective than those derived by alternative procedures. Using this method of estimation, the mean fecundities of female largemouth bass populations at PCM 1 and CRM 20 were determined to be approximately 20% lower than at any of the other study sites, although there were no statistically significant differences in this parameter between sites.

Oocyte death (atresia) prior to the completion of development is a natural occurrence (Saidapur 1978), but also is associated with exposure of an organism to chemical toxicants (Krarup 1969, Mattison et al. 1983, Takizawa et al. 1984, Johnson et al. 1994). In the present investigation, highest incidences of oocyte atresia were observed in female bass collected from PCM 1.0 and CRM 20 (Table C37), although only for the latter site did the prevalence prove to be statistically greater than in a reference population.

17β-Estradiol has the critical reproductive function in female fish of regulating the production of yolk proteins by the liver for incorporation into vitellogenic oocytes. Plasma concentrations of estradiol were lowest in female bass from CRM 20 and CRM 0.5 (approximately half the values at the reference sites), but again there were no clear statistically significant differences between sites (Table C37).The primary role of testosterone in female fish is less clear, although it serves as a precursor in the production of 17β-estradiol and may also function in regulating spawning behavior (Greeley et al. 1988b). Plasma testosterone concentrations were significantly lower in female bass from CRM 0.5 (compared with both reference sites), CRM 20 (compared with PRM 30), and TRM 557 (compared with PRM 30).

Male Bluegill Sunfish

The GSIs of male bluegill sunfish collected at the beginning of the 1993 breeding season did not differ significantly between sites (Table C38) . However, lowest GSIs were observed at the two Clinch River sites downstream of the ORR (CRM 20 and CRM 0.5), intermediate GSIs at the two Norris Lake reference sites (CRM 125 and PRM 30), and the highest GSIs at PCM 1 and the two Tennessee River sites (TRM 557 and TRM 570). The apparent trend for lower GSIs at CRM 20 and CRM 0.5 is probably due simply to these populations lagging slightly behind populations at the other sites in the progress of testicular development, as suggested by the lower mean testes stages at these sites. No obvious abnormalities in the spermatogenic composition of testicular tissue were observed at any site.

Testosterone concentrations were significantly higher in male bluegill sunfish at PCM 1 and TRM 557 than at one reference site, CRM 125 (Table C38). Otherwise, there was little significant variation between sites in the mean plasma concentrations of either testosterone or estradiol. Measurable estradiol was found in blood samples from male bluegill sunfish collected from TRM 557 (45% incidence), CRM 20 (15%), PCM 1 (18%), and CRM 125 (10%). Estradiol was not detected in male bluegill sunfish at any of the remaining study sites.

Female Bluegill Sunfish

As with male sunfish, the mean GSIs of female bluegill sunfish tended to be higher at PCM 1.0 than at any of the other study sites (Table C39). Similarly, mean fecundity (estimated in the bluegill from the size of an obvious clutch of simultaneously maturing oocytes) was also highest at PCM 1.0, although there were no statistically valid differences in fecundity between any of the study sites.

Oocyte atresia was relatively prevalent at all study sites other than the two Norris Lake reference sites (Table C39: CRM 125 and PRM 30). Highest incidences of atresia were observed in the ovaries of female sunfish from the three study sites nearest the ORR (PCM 1, CRM 20, and CRM 0.5).

Ovarian parasites were more prevalent in bluegill sunfish than in bass (Table C39). Although the highest incidences of parasites were again observed in samples from PCM 1.0, ovarian parasites were also observed in fish from the two reference sites as well as TRM 557.

The lowest mean concentrations of plasma estradiol occurred in female sunfish from PCM 1.0 and CRM 0.5 (Table C39). Plasma concentrations of testosterone were lowest in female sunfish from TRM 557 and PCM 1.0 and significantly greater than reference values at TRM 570.

3.5.6 Summary and Conclusions

An apparent pattern in the relative reproductive condition of largemouth bass populations at the various study areas is evident upon simultaneous examination of site-differences in both male and female reproductive indicators. In both sexes, mean GSIs and plasma levels of testosterone are depressed at PCM 1 and CRM 20 as compared with the corresponding values at either of the two upstream reference sites. Prevalences in male bass of measurable amounts of the typically female sex steroid, 17β-estradiol, are highest at CRM 20. In female bass, fecundity tends to be suppressed at PCM 1 and CRM 20, and plasma concentrations of both estradiol and testosterone are lower than in reference populations, especially at CRM 20. Highest incidences of oocyte atresia also occur at these two sites, again most markedly at CRM 20. The sum of these disparate observations strongly suggest that largemouth bass reproduction is adversely impacted at the two study sites adjacent to the ORR.

A similar trend is not readily apparent in the case of the bluegill sunfish populations examined in this study. In fact, for both males and female sunfish, highest mean GSIs were actually observed at a study site close to the ORR (PCM 1). However, as with the largemouth bass, the highest mean incidences of oocyte atresia in female sunfish were observed at PCM 1, although atretic oocytes were also relatively common at all non-reference study sites.

3.6 SUMMARY OF SITE CHARACTERIZATION

Historical studies indicated that contamination in the CR/PC OU consisted primarily of radionuclides (mostly ^{137}Cs) in sediment downstream of WOC, with greatest inventories being found in areas of sediment accumulation downstream of Poplar Creek. Levels of ^{137}Cs and ^{60}Co have been shown to be much lower in near-shore areas than in areas where water depth and sediment accumulation are greater. Mercury contamination of sediment and biota in Poplar Creek downstream of EFPC was well documented. Arsenic contamination of sediment in Poplar Creek and McCoy Branch was also known, the result of historical fly ash disposal from the K-25 and Y-12 steam plants, respectively. PCB and pesticide contamination was well documented in several fish species in the CR/PC system, WBR, and other East Tennessee waters.

Water. In the current study, mean concentrations of all analytes in surface water were below AWQC at all sites. Maximum concentrations of some analytes exceeded these criteria, but determining the duration of such events was beyond the scope of this study. In general, concentrations of most analytes were highest in summer, the period of least flow and dilution. Organic compounds were rarely detected and consisted entirely of phthalates and PAHs, classes of compounds that are relatively ubiquitous environmental contaminants.

Few metals were detected at levels that exceeded upstream reference values, but the use of sensitive analytical techniques allowed documentation of mean total mercury and total methyl mercury values that were elevated in Poplar Creek downstream of EFPC. Interestingly, the greatest concentrations were found at PCM 1.0 rather than immediately below EFPC; resuspension of sediment in Poplar Creek is the possible cause. Mean concentrations of nitrite/nitrate were significantly higher in Poplar Creek immediately below Mitchell Branch. The same is true of mean gross alpha and gross beta levels in winter.

Although the study design in McCoy Branch did not allow for statistical inference, arsenic concentrations there were the highest detected at any site in the study. Ford et al. (1995) had previously documented elevated levels of arsenic in surface water at McCoy Branch and the migration of dissolved arsenic from sediment during conditions of anoxia at the bottom of the water column.

The toxicity of surface water was evaluated for a number of sites in the CR/PC system. Several aquatic organisms were used in the assessment. The majority of tests revealed no consistent toxic response. However, tests using Japanese medaka to assess embryo-larval survival and the developmental abnormalities revealed consistent toxic responses at PCM 1.0 and 4.3; the effect was also observed in similar tests using redbreast sunfish.

Sediment. The characterization of contaminants in sediment documented increased levels of one or more analytes above reference values at several locations in the CR/PC OU. As expected, concentrations of ^{60}Co in Melton Hill Reservoir were elevated as a result of historical releases from a known source on Braden Branch, unrelated to DOE operations. Several metals (arsenic, selenium, vanadium) associated with coal ash were found at elevated levels in McCoy Branch.

The concentration of ^{137}Cs was elevated throughout the Clinch River downstream of WOC. As expected, highest concentrations were found immediately below WOC and highest inventories were found downstream of Poplar Creek. Previous studies have demonstrated that peak ^{137}Cs concentrations occur at depth in the sediment profile; therefore, contaminant profiles in deep sediment were not measured in this study. Selenium and manganese concentrations were elevated immediately below Grassy Creek. Near-shore concentrations of ^{137}Cs and ^{60}Co were low throughout the River. As expected, highest concentrations were found near the mouth of WOC and declined downstream. Mercury levels are elevated below the mouth of Poplar Creek; previous studies have demonstrated that peak concentrations of mercury also occur at depth in the sediment profile. Organic compounds, including PCBs, were detected infrequently in sediment; the most common analytes detected were again phthalates and PAHs.

Levels of mercury, chromium, copper, and cadmium were elevated throughout Poplar Creek below the mouth of EFPC. Levels of several metals, uranium, and ^{99}Tc were increased. Near the fly ash disposal area in lower Poplar Creek (subreach 3.04), mean concentrations of arsenic, boron, and vanadium were elevated.

Peak concentrations of mercury and methyl mercury in surface sediment were found between PCM 1.0 and the mouth of Poplar Creek, coinciding with peak surface water values. The presence of

elevated concentrations in surface sediment may indicate the recent deposition of mercury contaminated sediment from upstream.

The toxicity of surface sediment to several endpoint species revealed little evidence of toxic effects at any site. The sites at which effects were observed most often were PCM 4.3, CRM 9.0, and CRM 19.0.

Modelling of sediment and contaminant (^{137}Cs) transport and fate in the Clinch River evaluated future (30-yr) contaminant inventories in the river under several flow conditions. Results indicated that only under conditions of a local storm in the WOC watershed would the ^{137}Cs inventory increase in the Clinch River. This increase would be temporary, as sediment deposited by the flood event would quickly be scoured and transported downstream to Watts Bar Reservoir. A regional storm would actually decrease the ^{137}Cs inventory immediately as a result of scouring of existing sediment in the Clinch. Previous modelling had indicated that even with the addition of ^{137}Cs from the Clinch, over the 30 year model period inventories decrease as a result of radioactive decay (DOE 1995).

Biota. Three species of sportfish (largemouth bass, catfish, and bluegill) in the CR/PC system were analyzed for selected metals, PCBs, and pesticides. Radionuclide analyses were not conducted, as previous studies had indicated only low levels of radionuclides in fish flesh. Mercury was found to be elevated above reference values in all three species of fish from Poplar Creek, with concentrations in largemouth bass being highest. However, mean levels in all species were below the FDA action level. As expected, PCBs and chlordane were detected in each species at most sites during the study. Mean concentrations of both contaminants varied widely both spatially and temporally, with multiple sources of each contaminant to the CR/PC being likely.

A suite of biological parameters in largemouth bass and bluegill were measured to assess patterns in the health response of fish to contaminant exposure. In general, fish from Poplar Creek and the in Clinch River immediately downstream of WOC showed signs of toxic effects as measured by one or more of the biological indicators. For example, EROD activity in largemouth bass, histopathology in bluegill, and indicators of organ dysfunction in both bass and bluegill were highest in Poplar Creek. An assessment of overall health using a mulivariate analysis procedure rated bluegill from PCM 4.3 and bass from PCM 1.0, 5.3, and CRM 20 as being in the poorest condition. An analysis of the reproductive health of largemouth bass and bluegill indicated that bass from PCM 1.0 and CRM 20 were in poorer condition than fish from other sites. Bluegill, however, from these sites were generally in good reproductive health.

Analyses of mayflies collected from several sites in the CR/PC system demonstrated the presence of PCBs and several metals, including mercury, in most samples. Shad were found to contain PCBs, although at levels generally less than in sportfish collected at the same sites. Mercury concentrations were found to be significantly elevated in bottom dwelling fish from Poplar Creek. Great blue heron eggs and chicks collected from a rookery on Poplar Creek near the K-25 site had elevated levels of mercury and PCBs relative to those from reference colonies. In a seven month feeding study, mink fed a diet of fish from Poplar Creek adjacent to the ORR developed increased body burdens of mercury and PCBs compared to mink feeding on fish collected from reference sites. These mink also had significantly smaller average litter sizes, evidence of decreased reproductive success. Taken together these results demonstrate that organisms at lower trophic levels (mayflies, shad, forage fish) can serve as a pathway for contaminant transfer to insectivores (e.g., bluegill) and piscivores (e.g., bass, heron, mink).

In summary, increased levels of mercury are known to occur in surface water, sediment, and at several trophic levels of biota in Poplar Creek below EFPC. Toxicity of these waters to Japanese medaka and redbreast sunfish has been demonstrated, and measures of several indices of biological and reproductive health in fish demonstrated that fish from Poplar Creek. It is unclear whether the mercury found in these media is primarily entering from EFPC (and is the focus of upstream remedial action) or whether it is being physically or chemically mobilized from sediment in Poplar Creek. In addition, elevated levels of radionuclides in sediment are found in the Clinch River immediately downstream of WOC, and several of the biological indicators in fish at this location were consistent with contaminant exposure and effects. However, none of the aqueous or sediment toxicity tests clearly demonstrated toxicity in the Clinch River near the mouth of WOC.

4. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d) of CERCLA specifies that remedial actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate to the hazardous substances or particular circumstances at a site. Inherent in the interpretation of applicable or relevant and appropriate requirements (ARARs) is the assumption that protection of human health and the environment is ensured.

Appendix D of this report provides a preliminary list of available federal and state chemical-, location-, and action-specific ARARs for the remediation of the CR/PC OU. "Chemical-specific requirements set health- or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants" (53 *FR* 51437). These requirements generally set protective cleanup levels for the chemicals of concern in the designated media or indicate a safe level of discharge that may be incorporated when a specific remedial activity is being considered. The only medium under consideration in the FS is contaminated sediment. However, ARARs for cleanup of contaminated surface water are presented in Appendix D for comparison with surface water sampling results to confirm this decision. There are no ARARs for cleanup of contaminated sediments, although TBC guidance is available for soil/sediment contaminated with polychlorinated biphenyls.

Location-specific requirements "set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations" (53 *FR* 51437). The area along the Clinch River, Poplar Creek, and McCoy Branch contains several sensitive resources that are protected either by federal or state regulations, including wetlands, floodplains, cemeteries, and state-designated natural areas. Preconstruction activities performed for alternative 3, such as building of access roads or removal of bank vegetation, as well as actual containment activities may trigger certain location-specific ARARs. The location-specific ARARs summarized in Appendix D will not apply to either the no action or the institutional controls alternatives since no such activities will be performed.

The TVA, U.S. Army Corps of Engineers (COE) and the TDEC regulate activities under §26(a) of the TVA Act, the COE Nationwide Permit Program, and the TDEC Aquatic Resource Alteration Permit Program, respectively. Although permits are not required for CERCLA on-site actions, activities that would normally require permits under these programs must meet the substantive requirements of the appropriate regulations. Appendix D summarizes these requirements.

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to the management of hazardous waste (53 *FR* 51437). Selection of a particular remedial action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. Action-specific ARARs are presented in Appendix D and summarized in Sect. 9.1.2.

5. HUMAN HEALTH RISK ASSESSMENT

This baseline human health risk assessment quantifies the carcinogenic risk and noncarcinogenic hazard associated with human exposure to contaminants detected in fish, water fowl, sediment, and surface water collected in the Clinch River and Poplar Creek. Specifically, this baseline risk assessment evaluates the potential for exposure to an individual who might regularly use the resources of either the Clinch River or Poplar Creek under the conditions that would exist if the current institutional controls (i.e., fishing advisories and dredging controls) were removed and no remediation occurs. The results of the baseline human health risk assessment are used in Sect. 5.6 to develop remediation goals and in Chap. 8 to develop remedial alternatives for the Clinch River and Poplar Creek.

The Environmental Protection Agency, Region IV, Tennessee Department of Environment and Conservation, and Department of Energy-Oak Ridge agreed in the data quality objectives working group meetings held prior to the development of the *Phase 2 Sampling and Analysis Plan, Quality Assurance Project Plan, and Health and Safety Plan for the Clinch River Remedial Investigation: An Addendum to the Clinch River RCRA Facility Investigation Plan* (Cook et al. 1993) that this will be a focused risk assessment. The focus is on contaminants of potential concern (COPCs) that were identified in previous human health risk assessment reports (Table 5.1).

Prior to the Phase 2 data collection that occurred in both the Clinch River and Poplar Creek, several efforts were undertaken to evaluate the potential risk/hazard posed by exposure to contaminants in the Clinch River. A screening assessment conducted by Hoffman et al. (1991) identified PCBs in fish and external exposure to radiation from ^{137}Cs in dredged sediments as the priority contaminants and exposure pathways that are of potential concern in the Clinch River downstream of the ORR. Hoffman et al. (1991) also identified several inorganics that posed a risk/hazard via the evaluated dredging pathways. Cook et al. (1992) confirmed these contaminants and exposure pathways of potential concern based on CRRI Phase 1 data and also identified chlordane in fish as a COPC. Most recently, the baseline human health risk assessment for the lower WBR OU (DOE 1995) identified PCBs, pesticides, and chlordane in fish and external exposure to ^{137}Cs and ^{60}Co. Therefore, the Phase 2 sampling and analysis of the Clinch River and Poplar Creek was intended to further evaluate the potential risk/hazard for those contaminants known to be present in the Clinch River and Poplar Creek systems.

5.1 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

5.1.1 Data Compilation Considerations

As indicated in Sect. 3.2 of this document, multiple studies were conducted on the Clinch River and Poplar Creek environmental media prior to the Clinch River investigation. Although the sampling and analytical protocols used during the studies were appropriate for their intended purpose, these protocols, in some cases, may not have been appropriate for use in a baseline risk assessment. As a result, prior to the compilation of the risk assessment database, existing data were compared to specified criteria (as discussed in the following text) to determine their useability for risk assessment purposes.

Table 5.1. Contaminants of potential concern in the Clinch River as identified in previous screening-level risk assessments

Analyte	Contaminants of Concern Identified by Hoffman et al. (1991)[a] and Associated Exposure Pathway	Contaminants of Potential Concern Identified by Cook et al. (1992)[b] and Associated Exposure Pathway	Contaminants of Concern Identified In DOE/OR/01-1282&D4 (1995) and Associated Exposure Pathway
Arsenic	Dredging – Agricultural Exposure	Fish Consumption Dredging – Direct Exposure Dredging – Agricultural Exposure	Fish Consumption[d]
Beryllium	Dredging – Agricultural Exposure	Fish Consumption Dredging – Direct Exposure Dredging – Agricultural Exposure	Shoreline use - sediment ingestion[e] Fish Consumption[e] Dredging – Sediment Ingestion[e] Dredging – Meat and Vegetable Ingestion[e]
Cadmium		Dredging – Agricultural Exposure	Dredging – Milk and Vegetable Ingestion[d]
Chromium	Dredging – Agricultural Exposure	Dredging – Direct Exposure	Shoreline use – Sediment Inhalation[e] Dredging – Sediment Inhalation[e] Dredging – Milk and Meat Ingestion[d]
Copper		Fish Consumption Dredging – Agricultural Exposure	
Manganese			Drinking Water Ingestion[d]
Mercury	Dredging – Agricultural Exposure	Fish Consumption Dredging – Agricultural Exposure	Fish Consumption[d] Dredging – Milk, Meat, and Vegetable Ingestion[d]
Nickel		Dredging – Agricultural Exposure	
Selenium	Irrigation Dredging – Agricultural Exposure		
Silver		Dredging – Direct Exposure Dredging – Agricultural Exposure	
Zinc	Dredging – Agricultural Exposure	Dredging – Agricultural Exposure	Dredging – Milk and Meat Ingestion[e]

Table 5.1. Contaminants of potential concern in the Clinch River as identified in previous screening-level risk assessments (continued)

Analyte	Contaminants of Concern Identified by Hoffman et al. (1991)[a] and Associated Exposure Pathway	Contaminants of Potential Concern Identified by Cook et al. (1992)[b] and Associated Exposure Pathway	Contaminants of Concern Identified In DOE/OR/01-1282&D4 (1995) and Associated Exposure Pathway
Aroclor-1254[c]	Fish Consumption	Fish Consumption	Fish Consumption[d]
Aroclor–1260[c]	Fish Consumption	Fish Consumption	Fish Consumption[d]
Aldrin		Fish Consumption	Fish Consumption[d]
Chlordane		Fish Consumption	Fish Consumption[d]
4,4'DDE			Fish Consumption[e]
4,4' DDT			Fish Consumption[e]
Dieldrin			Fish Consumption[e]
Lindane			Fish Consumption[e]
^{137}Cesium	Dredging – Direct Exposure Dredging – Agricultural Exposure	Near-shore Direct Exposure Dredging – Direct Exposure	Drinking Water Ingestion[e] Shoreline Use – External Exposure[e] Fish Consumption[e] Irrigation – External Exposure[e] Irrigation – Milk and Meat Ingestion[e] Dredging – External Exposure[e] Dredging – Milk, Meat, and Vegetable Ingestion[e]
^{60}Cobalt	Dredging – Direct Exposure	Dredging – Direct Exposure	Dredging – External Exposure[e] Irrigation – External Exposure[e]
^{90}Strontium		Dredging – Agricultural Exposure	
Uranium, total			Drinking Water Ingestion[e]

Table 5.1. Contaminants of potential concern in the Clinch River as identified in previous screening-level risk assessments (continued)

[a]Hoffman et al. (1991) used an excess cancer risk of 10^{-5} and hazard quotient of 1.0 in a nonconservative and conservative screening to indicate "definitely or potentially high priority" and "potentially high priority" contaminants, respectively.

[b]Cook et al. (1992) used an excess cancer risk of $10^{-6} - 10^{-4}$ and hazard quotients of 0.1 – 1.0 in a conservative and nonconservative screening, respectively, as an indicator of COPCs in the Phase 1 CRRI.

[c]Identified via nonconservative screening in each study.

[d]Calculated risk/hazard for these pathways were either $>10^{-4}$ for carcinogens or >1.0 for noncarcinogens (DOE 1995).

[e]Calculated carcinogenic risk for these pathways was between 10^{-5} and 10^{-6} (DOE 1995).

Data sets available for use in this risk assessment consisted of data collected as part of the CRRI Phases 1 and 2 and all available historical data. The quality of the CRRI Phase 1 data is well documented (Holladay et al. 1993) as is that of the CRRI Phase 2 data (see Appendix G); however, quality control (QC) records are not available for some historical data. Therefore, two quality assurance (QA) criteria for using historical data quantitatively in this risk assessment were implemented. First, the quality of the data must have been assessed by the researchers/investigators performing the sampling and analysis. The individuals who planned the historical studies must have, in some form, established criteria against which they then compared the quality of the data. Second, these quality-assured data must have been subsequently published in literature that was available to the public. Because the Oak Ridge National Laboratory (ORNL) and the other DOE facilities have established criteria for the publication of reports that include a specified amount of peer review prior to the release of information to the public, this second criterion was implemented to ensure that only data that had undergone extensive peer review were used.

A brief summary of the QA procedures employed in each study from which data were used in the risk assessment is presented in Table 5.2. The following subsections describe in detail the data sources that were used, the number and types of samples collected, and the aggregation of data sources, if applicable.

5.1.2 Data Compilation

The data sets used in the baseline human health risk assessment and their sources are shown in Tables 5.3 – 5.6. Typically, data collected during a remedial investigation comprises the majority, if not all, of the data used in the baseline risk assessment, and all available data are compiled into media-specific databases. Because multiple data sources and collection methods were used, a determination was made as to the appropriateness of combining all data for a particular media into one database. As a result of this evaluation, a single media-specific database was created for use in the baseline risk assessment.

For each of the datasets evaluated in this baseline risk assessment, tables of summary statistics have been prepared and are presented in Tables E.1– E.7. The tables include a reach identifier; the type of chemical (inorganic, organic, or radionuclide); the frequency of detection; the minimum, maximum, and mean concentrations; the representative concentration; units of measure; and a use flag. The frequency of detection column as well as the use flags will be defined in Sect. 5.1.3. The following list provides a brief description of each of the table headings that refer to concentrations:

- Minimum concentration is defined as either the minimum detected value or the minimum detection limit contained within the dataset for a given analyte whichever is smaller.

- Maximum concentration is defined as either (1) the maximum detected value, (2) the maximum detection limit for those analytes within the dataset that were all nondetects (i.e., the frequency of detection was zero), or (3) the maximum detection limits from previous studies, in the case where Phase 2 sample detection limits were less than the historical detection limits.

- Mean concentration (listed as PLE mean) is defined as the mean of the sample dataset calculated using the product limit estimation technique described in Sect. 5.2.3.1 and is calculated as an average of all the sample values including detection limits as proxy concentrations for those samples that were nondetects when the frequency of detection is

Table 5.2. Quality assurance review of data sources used quantitatively in the baseline risk assessment

Data Sources	Published Reference	Description of Quality Assurance Protocols
Oak Ridge Reservation Environmental Monitoring Program	*Oak Ridge Reservation Environmental Monitoring Report for 1992*, EH/ESH-31/V1. Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1993. (Energy Systems 1993)	• Conducted extensive internal QC programs, participated in several external QC programs (including EPA's Contract Laboratory Program), and statistically monitored performance on a routine basis. • Certified by State of Tennessee to conduct drinking water analyses • Used standard reference materials for instrument calibration, to standardize methods, and as spike additions for recovery tests. • Used single, blind, and control samples to evaluate laboratory performance
Clinch River Remedial Investigation Phase 1 (Cook 1992) and Phase 2	Phase 1: *Quality Assurance/Quality Control Summary Report for Phase 1 of the Clinch River Remedial Investigation*, ORNL/ER-152, Holladay, S. K., et al., Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1993. (Holladay 1993) Phase 2: Appendix G of this document	• Used field duplicates to assess the overall data precision • Used laboratory control samples, matrix spikes, surrogate spikes, and performance evaluation samples to assess data accuracy • Used standard analytical methods, proper preservation techniques, proper containers; adhered to samples holding times; and used field and laboratory blanks and equipment rinseate samples to ensure that the representativeness of the data was not compromised. • Data were validated by an external laboratory

greater than zero. Please note, in the case where the frequency of detection is equal to zero, it is not possible to calculate a sample mean.

- Representative concentration is defined as either the upper 95% confidence bound on the mean or the maximum concentration in the case where either the maximum concentration is less than the upper 95% confidence bound or the frequency of detection is 1 or less. A more in depth discussion of the derivation and use of the representative concentration is included in Sect. 5.2.3.

5.1.2.1 Water data

As indicated in Table 5.3, data from the CRRI Phase 1 and Phase 2 sampling activities were used in this risk assessment. In addition, monitoring data from the Clinch River and Poplar Creek, which were collected by the Oak Ridge Reservation Environmental Monitoring Program (ORREMP), were used to assess human health risk. Because the sampling and analytical methods are comparable for both the CRRI and the ORREMP activities, the various surface water datasets were combined into one media-specific database. The following paragraphs briefly describe each sampling activity. Summary statistics for the water data are listed in Tables E.1 and E.2.

The CRRI Phase 1 (Cook et al. 1992) sampling occurred between December 1989 and February 1990. The analytical results were validated and a QA report was generated (Holladay et al. 1993). Analytes of concern for this sampling activity were inorganics, organics, and radionuclides. Sampling locations and analytical results for this activity are described in Sect. 3.

The CRRI Phase 2 (Cook et al. 1993) sampling occurred between November 1993 and September 1994. The original sampling and analysis plan was modified by an addendum at the request of the DOE (DOE 1994b). As a result, fewer surface water samples were collected, and the water-biased event study was added.

The CRRI Phase 2 surface water sampling activities consisted of several activities including: investigation of current contaminant sources (labelled W1.1), water-biased event study (labelled W1.1B), contaminant data for toxicity tests (labelled W1.1T), contaminant remobilization from sediments study (labelled W1.1R), and an in-stream distribution of contaminants from point sources study (labelled W1.4).

The ORREMP surface water data consisted of samples collected between March 1993 and September 1994. Eight surface water sampling locations were included in the dataset: CRM 40.9, CRM 36, CRM 49.7, CRM 52.2, CRM 19.9, CRM 14.3, CRM 9.9, and PCM 1.4. Samples were analyzed for inorganics, radionuclides (gross alpha, gross beta, ^{90}Sr, ^{3}H, ^{99}Tc, total U, ^{137}Cs, ^{60}Co), volatile and semivolatile compounds, and pesticides/PCBs (DOE 1992). Because volatile contaminants were analyzed for but not found to be chemicals of concern in previous studies and because they would dissipate rapidly from the system, the volatile contaminants were not included in the risk assessment. The ORREMP analyzes for specific alpha emitters only if the gross alpha counts exceeded 3 pCi/L (0.11 Bq/L). Therefore, isotopic analyses for uranium isotopes and other alpha emitters are available for a subset of the total number of samples.

Table 5.3. Sources of surface water data evaluated quantitatively in the baseline human health risk assessment.

Source	Analyses	Number of Samples per Reach				
		1	2	3	4	7
CRRI Phase I (Cook et al. 1992 and Holladay et al. 1993)	Inorganics	3	2	4	3	0
	Organics	3	2	4	3	0
	Radionuclides	3	2	4	2	0
CRRI Phase 2- Task W1.1 (Chap. 3)	Inorganics	2	1	41	1	0
	Organics	2	1	41	1	0
	Radionuclides	2	1	41	1	0
CRRI Phase 2 - Task W1.1T (Chap. 3)	Inorganics	0	7	12	2	4
	Organics	0	7	8	2	4
	Radionuclides	0	7	12	2	4
CRRI Phase 2 - Task W1.1B (Chap. 3)	Inorganics	12	15	3	15	12
	Organics	12	15	3	15	12
	Radionuclides	12	15	3	15	12
CRRI Phase 2 - Task W1.1R (Chap. 3)	Inorganics	6	0	0	12	6
	Organics	6	0	0	12	6
	Radionuclides	6	0	0	12	6
CRRI Phase 2 - Task W1.4 (Chap. 3)	Inorganics	0	0	26	0	0
	Organics	0	0	0	0	0
	Radionuclides	0	0	30	0	0
Oak Ridge Reservation Environmental Monitoring Program (DOE 1992)	Inorganics	28	18	9	9	0
	Organics	28	18	9	9	0
	Radionuclides	28	18	9	9	0

5.1.2.2 Sediment Data

The sediment data available for use in this risk assessment were collected as part of the CRRI Phases 1 and 2 sampling and the near-shore surface sediment characterization activities. The data sources and the number of samples per reach for each are listed in Table 5.4.

Table 5.4. Sources of sediment data evaluated quantitatively in the baseline human health risk assessment

Source	Analyses	Number of Samples per Reach				
		1	2	3	4	7
Deep-water data						
CRRI Phase I (Cook et al. 1992 and Holladay et al. 1993)	Inorganics	2	2	2	2	0
	Organics	2	2	2	2	0
	Radionuclides	2	2	2	3	0
CRRI Phase 2 - Task S1.B (Chap. 3)	Inorganics	0	8	25	33	2
	Organics	0	8	25	33	2
	Radionuclides	0	8	24	33	2
Near-shore data						
Near-Shore Sediment Characterization (Levine et al. 1994)	Inorganics	0	0	0	0	0
	Organics	0	0	0	0	0
	Radionuclides	21	159	0	150	0
CRRI Phase I (Cook et al. 1992 and Holladay et al. 1993)	Inorganics	2	2	2	2	0
	Organics	2	2	2	2	0
	Radionuclides	4	3	4	4	0
CRRI Phase 2 - Task S1.B (Chap. 3)	Inorganics	0	9	26	33	2
	Organics	0	9	25	33	2
	Radionuclides	0	9	24	33	2

During the Phase 1 sampling activities (December 1989–June 1990), both surface sediment grab and sediment core samples were collected from most sampling locations. These samples were analyzed for inorganics, organics, and radionuclides. The Phase 1 results are summarized in the *Phase 1 Data Summary Report for the Clinch River Remedial investigation: Health Risk And Ecological Risk Screening Assessment* (Cook et al. 1992). The report *Quality Assurance/Quality Control Summary Report for Phase 1 of the Clinch River Remedial Investigation* (Holladay, et al. 1993) provides a written summary of the data quality.

Subsequent to completion of the Phase 1 sampling, an extensive project was initiated in July 1990 to collect surface sediment grab samples from near-shore areas of both the Clinch River and the Watts Bar Reservoir. The purpose of this near-shore sampling was to determine the extent to which near-shore surface sediments are contaminated by releases from the ORR and provide data to the Watts Bar Reservoir Interagency Permitting Group (WBRIPG) for evaluation of human health risks from exposure to sediments during and following any proposed near-shore dredging operations. The near-shore sediment samples were analyzed by gamma spectrometry for ^{137}Cs and ^{60}Co. The results of the near-shore sediment characterization are contained in the *Data Summary for the Near-Shore Sediment Characterization task of the Clinch River Environmental Restoration Program* (Levine, et al. 1994) and are also described in Chap. 3 of this report.

The CRRI Phase 2 sediment data from the following sampling activities were included in the human health risk assessment: (1) sediment contaminant characterization (labelled S1.B) and (2) a continuation of the near-shore surface sediment grab sample collections in areas where a dredging permit had been requested and was undergoing review by the WBRIPG (labelled S2). Chapter 3 of this document presents the results of the sediment characterization activities. A QA evaluation of the sediment data is contained in Appendix G.

In compiling the sediment data for use in the baseline risk assessment for the Clinch River and Poplar Creek, the data were split into two subsets (near-shore and deep-water). For purposes of the exposure pathways to be evaluated in the risk assessment, the near-shore dataset, which comprises all samples collected at an elevation of 733 ft or greater will be used to assess the shoreline use exposure pathways. The remainder of the cores will be used to assess the deep-water environment via the dredging exposure pathways.

Based on the aforementioned criteria and the average water depth maintained above the Melton Hill Dam, no samples collected in either reach 1 or 7 can be defined as "near-shore." Therefore, no shoreline-use exposure pathways will be evaluated for Reaches 1 or 7. Summary statistics for the "near-shore" are listed in Table E.3 and for the "deep-water" datasets are listed in Tables E.4 and E.5.

The near-shore environment has historically been defined as the area at summer pool level that is covered by no more than 6 ft of water. However, at the time this report was prepared, water depth information was not available for all of the sediment samples. Therefore, the risk assessors decided to use all grab samples collected as a means of conservatively estimating the concentration in the near-shore sediments. The representative concentrations used to evaluate the near-shore exposure pathways are considered conservative based on the previous studies conducted and the fact that some of the grab samples were collected from locations that are known to be depositional zones in the deep-water environment. Summary statistics for the "near-shore" are listed in Tables E. 3 and E.4 and for the "deep-water" datasets are listed in Tables E.5 and E.6.

5.1.2.3 Fish Data

Sources of data on levels of contaminants in fish include the CRRI Phase 1 and 2 (Table 5.5). Locations for sampling are described in Chap. 3. The CRRI Phases 1 and 2 fish samples were analyzed by the Tennessee Valley Authority (TVA). All data were combined into one media-specific database. Data were available for the following species of fish: bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), striped bass (*Morone saxatilis*), hybrid bass (*Morone chrysops/Morone saxatilis*), channel catfish (*Ictalurus punctatus*), gizzard shad (*Dorosoma cepedianum*), threadfin shad (*Dorosoma pentense*), carp (*Cyprinus carpio*), and white crappie (*Pomoxis annularis*). For the purposes of this risk assessment, only common food fish (bluegill, bass, and catfish) were used in the analyses. White crappie, a common food fish, was not analyzed due to an insufficient number of samples (one sampling activity at one location).

Not all species of fish accumulate contaminants to the same extent and not all species of fish were analyzed for the same contaminants; therefore, species were evaluated separately. The analyses were designed not only to identify the chemicals of concern (COCs) but also to focus on the species with the highest concentrations. Bluegill were analyzed for inorganics and radionuclides; catfish and largemouth bass were analyzed for inorganics, organics, and radionuclides; and striped and hybrid bass were analyzed for organics.

Table 5.5 Sources of fish data evaluated quantitatively in the baseline human health risk assessment.

Source	Analyses	Number of Samples per Reach*				
		1	2	3	4	7
CRRI Phase I (Cook et al.1992 and Holladay et al. 1993)	Inorganics	13	29	35	27	0
	Organics	8	22	36	18	0
	Radionuclides	13	51	54	40	0
CRRI Phase 2- (Chap. 3)	Inorganics	0	66	68	105	0
	Organics	3	61	72	142	0
	Radionuclides	0	0	0	0	0

*Number of samples per reach indicates a total number of analyses per reach, independent of species type.

Fish were analyzed for Aroclor–1260 and Aroclor–1254 to determine the concentration of PCBs in fish tissue because these two chemical mixtures are the major contributors to the total PCB concentration. Emphasis was placed on analyzing catfish for PCBs because of their relatively high lipid content, which is directly related to their propensity for accumulating PCBs. Striped bass, a species introduced into Watts Bar Reservoir, were analyzed for PCBs and organic pesticides and herbicides because of their high lipid content, large size, and food use.

With the exception of striped and hybrid bass, which were lumped into one dataset due to limited sample size and like characteristics, separate risk calculations were made for each species. Summary statistics were then calculated for each species of fish (Table E.6). Although some individuals consume other parts of fish (fish patties containing bone, fish roe, etc.), this risk assessment evaluates a reasonable maximum exposure only (i.e., the ingestion of fish fillets).

5.1.2.4 Waterfowl data

The waterfowl data that were available for use in the Clinch River and Poplar Creek baseline risk assessment included data on Canada geese and wood ducks that were collected as part of the Oak Ridge Biological Monitoring and Abatement Program. Evaluation of the available data suggested that Canada geese are the waterfowl species that would be most representative of site conditions and are the most prolific and more heavily hunted on or near the ORR. Furthermore, the Canada geese that were sampled and analyzed were collected from actual waste disposal ponds and on-site (i.e., within plant boundaries) surface water bodies. Therefore, these geese potentially represent the maximally contaminated members within the goose population. Summary statistics are listed in Table E.7.

5.1.3 Data Evaluation

5.1.3.1 Blanks

The CRRI QA personnel evaluated the analytical data and compared measured concentrations in samples with detected concentrations of a particular contaminant in the associated method and field blanks. Using the protocol outlined in *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A)* (EPA 1989c), common laboratory contaminants were considered as positively detected values only if the measured concentration in the sample was ten times greater than the measured concentration in the blank. For all other analytes, the analyte was considered a positively detected value, only if the measured concentration in the sample was five times greater than the measured

concentration in the blank. Sample results were then flagged appropriately in the CRRI database. A summary of the blank comparison and the results for the CRRI Phase 2 samples are contained in Appendix G of this document. The CRRI Phase 1 data were validated previously, and the results of that validation are contained in the *Quality Assurance/Quality Control Summary Report for the Phase 1 of the Clinch River Remedial Investigation* (Holladay et al. 1993). No blank comparisons were performed for the historical data incorporated in the datasets because blank information was not available. Thus, no historical contaminants were eliminated based on this comparison.

5.1.3.2 Original samples versus duplicate samples

For those media and sampling locations where both original samples and duplicate or replicate analyses were conducted, the measured concentration in the original sample was averaged with the concentration in the duplicate or replicate to obtain a concentration value for that location.

5.1.3.3 Obtaining a measure for total chlordane

The reporting method used by the laboratory for chlordane provided concentrations for the various chlordane isomers, but did not give a measure for total chlordane. However, based on the analytical method and the known physicochemical action of the various isomers, a measure of total chlordane was obtained by summing the measured concentrations of the isomers. As a result, all concentrations of the chlordane isomers (alpha-chlordane, gamma-chlordane, alpha-chlordene, gamma chlordene, chlordene, chlordane, oxychlordane) were summed and a "chlordane, total" entry was added to the dataset.

5.1.3.4 Radionuclide considerations

The ORREMP surface water monitoring data contained entries for uranium-radioactive while the other available surface water data listed individual isotopic measurements for the various uranium isotopes (^{234}U, ^{235}U, ^{236}U, and ^{238}U). As a result, the ORREMP results for uranium-radioactive were conservatively included in the derivation of a representative concentration for ^{238}U.

In addition, the ORREMP surface water monitoring data contained entries for strontium-radioactive. Because the radioactive half-lives of the various strontium isotopes (^{89}Sr, ^{91}Sr, and ^{92}Sr) are so short-lived, the only strontium typically detected in a sample is ^{90}Sr. As a result, the ORREMP results for strontium-radioactive were included in the derivation of a representative concentration for ^{90}Sr.

To ensure that all available data are considered to be representative of current conditions, all radionuclide concentrations were decay-corrected to January 1, 1995.

5.1.3.5 Nondetected contaminants

For each media-specific dataset, a determination was made as to whether a contaminant was not detected in any sample. If a contaminant's frequency of detection was zero at all sampling locations within a given exposure unit, then that contaminant was eliminated from consideration in the risk assessment. All nondetected contaminants are flagged in each of the media-specific summary statistics tables (Tables E.1–E.7) with an "ND" in the Use Column.

5.1.3.6 Essential nutrients

Essential nutrients (including calcium, copper, iron, magnesium, phosphorus, potassium, and sodium (Dunne 1990) are considered to have little or no adverse effects on human health. Furthermore,

these nutrients are not expected to have been released in the Clinch River or Poplar Creek. These analytes have been included in the summary statistics for the purpose of reporting all the available information but are not considered to be COPCs.

5.1.3.7 Frequency of detection

As is noted in the *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual* (EPA 1989c) "chemicals that are infrequently detected may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal practices." For the purposes of this baseline risk assessment, the frequency of detection of all analytes was evaluated prior to the calculation of risk/hazard. Those chemicals that had a frequency of detection of less than 5% (i.e., one detect in 20 samples) were eliminated from further consideration in the risk assessment due to the uncertainty associated with the accuracy/precision of the available analytical measurements. Chemicals that exhibited a frequency of detection of less than 5% are flagged in the summary statistics tables (Tables E.1– E.7) with a flag of "FD."

5.1.3.8 Summary statistics

The result of the data manipulations described in the preceding sections is a final dataset for each medium that will be evaluated in the baseline human health risk assessment. Summary statistics are provided for all contaminants in Tables E.1–E.7. These tables provide a listing of contaminants by exposure unit (reach) along with their frequency of detection; minimum, maximum, mean, and representative concentration (see Sect. 5.2.3); and any associated use flag. The use flags (ND, +, and -) are provided as an indication of those contaminants that will be 1) evaluated quantitatively (i.e., use flag of +), 2) evaluated qualitatively (i.e., use flag of -), or 3) eliminated from consideration (i.e., use flag of ND or FD). All contaminants that remain after the elimination of the contaminants that were 100% nondetects or were detected in less than 5% of the samples are considered to be COPCs.

5.2 EXPOSURE ASSESSMENT

Exposure, in the context of human health risk, is defined as the contact of a person with a chemical or physical agent. For exposure to occur, a source of contamination or contaminated media must exist which serves as either (1) a point of exposure or (2) transports contaminants away from the source to a point where exposure could occur. In addition, a receptor must come into either direct contact (i.e., ingestion, inhalation, dermal contact, or external exposure) or indirect contact (ingestion of foodstuffs that have bioaccumulated contaminants within their systems) with the contaminant. This concept is referred to as an exposure pathway. The elements of an exposure pathway are source, environmental transport/transfer media, exposure point, exposure route, and receptor.

An exposure assessment is the determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, route of exposure, and receptor population for each pathway evaluated in a baseline risk assessment. During the exposure assessment process, the risk assessor:

- characterizes the exposure setting in an effort to identify the potentially exposed populations (receptors), their activity patterns, and any other characteristics that might increase or decrease their likelihood of exposure;

- identifies exposure pathways based on the characterization of the exposure setting [each exposure pathway identifies a unique mechanism by which a population may be exposed to the contaminants (swimming, gardening, private well use, etc.)];

- quantifies the exposure to a contaminant by estimating concentrations to which a receptor may be exposed; and

- calculates a chemical-specific intake or dose typically measured in milligrams per kilogram of body weight per day (mg/kg· day) and a radionuclide-specific dose typically measured in (risk per pCi of contaminant) for each exposure pathway.

Based on the activity patterns of a population, any given individual may be exposed to more than one exposure pathway. For example, an individual who dredged sediment from the Clinch River would be exposed not only via dermal contact with the sediment but also via inhalation of any resuspended particulates, inadvertent ingestion, or if the dredge soils were used as garden soil, via ingestion of homegrown produce. Therefore, the exposure assessment must also evaluate the activity patterns of the potential receptors and determine what combination, if any, of exposure pathways could affect an individual. This evaluation results in the generation of exposure scenarios. Exposure scenarios represent the combination (if applicable) of exposure pathways that an individual could be exposed to based on his/her activity patterns.

Once the appropriate exposure pathways and scenarios have been identified, the risk assessor must select the appropriate equations and associated parameter values to calculate the amount of contaminant that is in contact with the body (skin, lungs, gut) per unit body weight per unit time (intake or dose) for each exposure pathway. The output of this activity is used in conjunction with the output from the toxicity assessment (Sect. 5.3) to quantify risks/hazards to receptors during risk characterization (Sect. 5.4). The exposure assessment process as applied to the Clinch River is detailed in the following subsections of this report.

5.2.1 Characterization of Exposure Setting

A detailed description of the geography, demography, climate, topography, etc. of the area surrounding the Clinch River and Poplar Creek is contained in Chap. 2. With respect to the baseline human health risk assessment, the area under evaluation is the Clinch River from CRM 50.5 to CRM 1.0 and Poplar Creek from PCM 5.5 to 0.0 (See Chap. 3 for a detailed map). Because this area is quite large, a decision was made prior to the initiation of Phase 2 sampling to divide the OU into smaller sections or reaches. The boundaries of each reach were delineated based on the location of a specific physical/topographic feature (i.e., dams, streams or river confluences, etc.). Each of the reaches is described in detail in Chap. 3. Furthermore, each reach was then divided into subreaches based on information about zones of sediment deposition.

Prior to the preparation of this baseline risk assessment, the risk assessors had to determine whether surface water, sediment, and fish data would be evaluated on a reach or subreach basis. The sampling locations for waterfowl negate the need for such an evaluation (Sect. 5.1.2.4). The evaluation process involved examination of the existing data to determine (1) if concentrations varied significantly enough between subreaches to indicate that "hot spots" of contamination were present and (2) if the quantity of existing data for each of the subreaches was both adequate and appropriate for drawing conclusions regarding risk/hazard. The results of this evaluation were (1) for fish and surface water data collected within the Clinch River, risks/hazards would be calculated and presented on a reach basis for reaches 1, 2, 4, and 7; (2) for deep-water sediment collected in the Clinch River, risks/hazards would be calculated

for reaches 1 and 7 and subreaches 2.04, 4.01, 4.02, 4.03, and 4.04; (3) for "near-shore" sediment collected in the Clinch River below the Melton Hill Dam risks/hazards would be calculated for subreaches 2.04, 4.01, 4.02, 4.03, and 4.04; and (4) for surface water and sediment (both near-shore and deep-water) collected in Poplar Creek risks/hazards would be evaluated for subreaches 3.01, 3.02, 3.03, and 3.04.

As discussed in Chaps. 2 and 3, land surrounding the Clinch River is used for residential, farming, industrial, and recreational purposes. The Clinch River and Poplar Creek both flow through agricultural and industrial areas, where contaminants from both point and nonpoint sources can enter the water. The fate of a contaminant depends not only on the flow rate of the water but also on the physical and chemical properties of the contaminant. Dissolved substances are usually flushed through the system in a matter of weeks, whereas particle-associated contaminants may accumulate in the sediment and remain indefinitely. This is evidenced by the fact that peak concentrations of contaminants known to have been released in the past are buried at depths that can be correlated with release histories. These buried contaminants are indicative of areas of sediment accumulation that have remained stable for 40 years.

The Clinch River and, to a lesser degree Poplar Creek, provide a variety of recreational opportunities, such as sport fishing, hunting, boating, swimming, water skiing, and camping. The greatest participation in these activities occurs in the summer, but because the area has a temperate climate, some activities are pursued year round. The area also draws a substantial number of out-of-town visitors. This risk assessment focuses on local inhabitants who regularly engage in activities where they can come in contact with or ingest fish, sediment, and/or surface water from the Clinch River or Poplar Creek.

Currently, a fish advisory exists which limits the consumption of fish from the Clinch River and Poplar Creek because of concern over PCB contamination. PCBs have been released from the ORR (Loar et al. 1992); however, PCBs also occur in many streams and lakes in eastern Tennessee.

5.2.2 Identification of Exposure Scenarios

For Superfund sites, EPA recommends the use of a reasonable maximum exposure (RME) scenario, where "reasonable maximum" is defined so that only those exposures that are likely to occur will be included in the exposure assessment (EPA 1989a). The RME is a conservative estimate of exposure reasonably expected to occur at a site, but it is expected to be within a realistic range of exposure. Estimating the RME involves the use of both EPA's standard default assumptions and best professional judgment. For quantification, each contaminant is evaluated according to its potential to cause adverse human health effects, both carcinogenic and noncarcinogenic.

As is indicated in the site conceptual model (Fig. 5.1), several exposure scenarios were selected for evaluation in this baseline risk assessment: ingestion of untreated surface water, fish consumption, ingestion of waterfowl, exposure to near-shore sediment via shoreline use, exposure to surface water via swimming, irrigation, and the use of deep-water dredged sediments for agricultural purposes. Most of the scenarios included in this risk assessment were previously evaluated in thescreening assessments of Hoffman et al. (1991) and Cook et al. (1992). Because both the Clinch River and Poplar Creek are readily accessible to the public and are not protected property of the DOE, all exposure pathways are considered residential. In addition, because not all individuals use the resources of the Clinch River or Poplar Creek in the same way, the risk assessment process includes a variety of exposure scenarios to account for the different ways an individual might be exposed to potentially harmful contaminants.

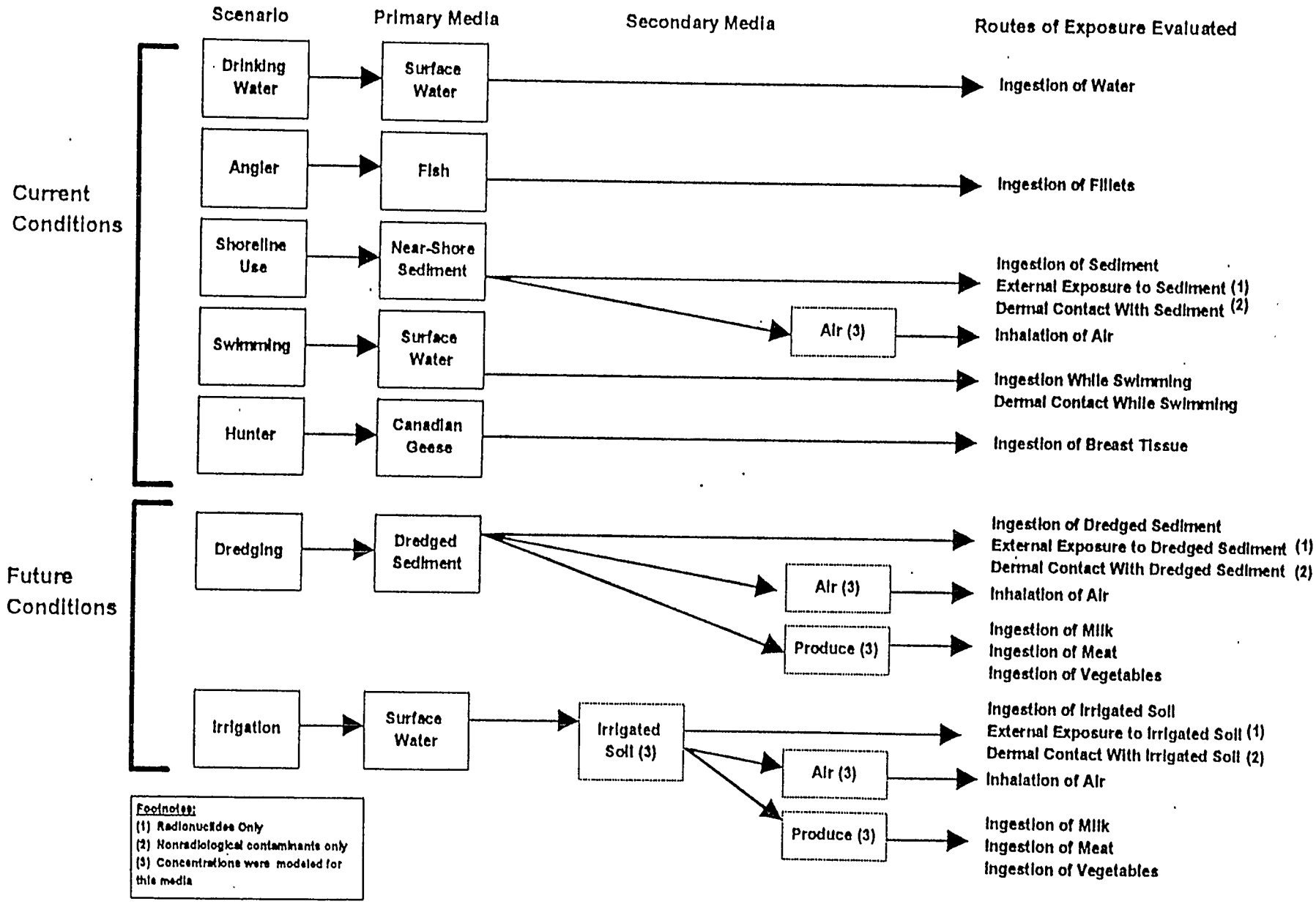


Fig. 5.1. Site model for human health risk assessment.

Exposure scenarios were designated as either current or future in the present risk assessment. Current exposure scenarios evaluate those exposure pathways that are considered to occur or have the potential to occur using measured contaminant concentrations for the media of interest. These scenarios include fish consumption, ingestion of waterfowl, exposure to near-shore sediments via shoreline use, exposure to surface water via swimming, and ingestion of untreated surface water.

Future exposure scenarios evaluate exposure pathways that are not currently occurring but have the potential to occur at a later date. This assessment, the deep-water dredging and irrigation scenarios are considered future exposure scenarios which use modelled estimates of contaminant concentrations for the media of interest. For example, contaminant concentrations for soil irrigated with surface water were not available; nevertheless, concentrations were predicted with mathematical models. Other models were used to predict the uptake of the contaminants in the soil by pasture forage and the subsequent transfer into the milk and meat from cattle that consume the forage. Consumption of milk and meat from cattle that have grazed on pastures irrigated with Clinch River or Poplar Creek surface water are examples of future exposure pathways in the risk assessment.

5.2.3 Quantification of Exposure

As stated previously, exposure, in the context of risk to human health, is defined as the contact of a person with a chemical or physical agent. To quantify exposure, one must determine a representative concentration for each analyte and then calculate chemical intakes for the various exposure pathways identified for the site.

5.2.3.1 Derivation of an exposure concentration

Prior to the derivation of the chemical-specific intake values for each pathway, an exposure concentration must be developed. The exposure concentration, the amount of each chemical in the media of interest, is the first variable to be defined in the exposure assessment process. EPA (1989c) recommends using the arithmetic average (mean) of the chemical concentration in a medium as the exposure concentration. Because of the variability inherent in sampling natural systems where the degree and extent of contamination is unknown, accurately estimating the true mean becomes difficult. Because it is not possible to know the true mean concentration of a contaminant, the 95% upper confidence limit (UCL) of the mean is used as a conservative estimate of the true mean. Measured contaminant concentrations were not available for all exposure media so mathematical models were used to estimate the concentrations. For media with limited sample data or extreme variability in the measured or modeled concentrations, the UCL can be greater than the highest measured or modeled concentration. In these cases, the maximum measured or modeled value is used as the exposure concentration instead of the UCL. It should be noted, however, that the true (but unknown) mean could be higher than the maximum value, especially if the most contaminated portion of the site has not been sampled. This issue will be revisited in the uncertainty analysis (Sect. 5.5).

Prior to the derivation of summary statistics, estimates and confidence bounds for mean concentrations were computed by three methods: (1) by substituting detection limits for nondetect results and computing the usual arithmetic mean and standard error; (2) by computing the mean and standard error using the lognormal model and the method of maximum likelihood; and (3) by computing a mean and standard error from the product limit estimate (PLE). The purpose of this evaluation was to determine the most appropriate statistical method to use to derive summary statistics for the Clinch River datasets since the datasets were comprised not only of CRRI Phase 1 and 2 data, but also existing historical data.

The PLE is a nonparametric distribution function estimate that statistically accounts for nondetects. It was originally defined for right-censored (failure-time) data (Kaplan and Meier, 1958), but applies to left-censored (nondetect) data, as well. The left-censored version is given in Schmoyer, Beauchamp, Brandt, and Hoffman (1995).When there are no nondetects, the PLE reduces to the usual empirical distribution function. If there are nondetects, however, and if the smallest observation (concentration or detection limit) is a nondetect, then, the PLE is not uniquely defined for concentration values below that smallest observation. In such cases the mean of the PLE is likewise undefined.

To accommodate these cases, various ad hoc definitions of the PLE have been proposed. Perhaps the most conservative is to take the PLE to be zero for concentrations smaller than the smallest detected value. This conservative definition is the one used, for example, in the SAS Lifetest procedure (for right-censored data). Simulation results of Schmoyer et al suggest that even this conservative PLE mean tends to be slightly anti-conservative for nonnormal data distributions. We therefore adopted the conservative definition for the PLE and PLE mean estimate. From the same simulation results, the authors further concluded that the PLE mean is preferable to either approaches (1) or (2), which tend to be too conservative (when there is no physical basis for the lognormal model).Therefore, we selected PLE means and standard errors (and confidence bounds) as the primary statistics for this RI. Means and standard errors computed by the other two methods were carried along as a check, but are not reported.

5.2.3.2 Derivation of the chronic daily intake

Once the exposure concentration is calculated, exposure to contaminants is evaluated quantitatively by deriving the chronic daily intake of a chemical or radionuclide. For this baseline human health risk assessment, intake is defined as the amount of a contaminant that an individual takes into his/her body per day via ingestion, inhalation, or dermal contact; dose is defined as the total absorbed energy from exposure to a particular radionuclide.

The general equation for calculating chemical-specific intakes for receptors and the exposure pathways to be evaluated in the risk assessment has been defined by EPA (1989c) as:

$$Intake = \frac{C \times IR \times EF \times ED}{BW \times AT} \qquad (5.1)$$

where

C = Concentration of a chemical in the environmental media of concern,
IR = Ingestion rate of the media per day or per hour, as appropriate,
EF = Exposure frequency,
ED = Exposure duration,
BW = Body weight,
AT = Averaging time.

Ingestion rates for the various environmental media as well as recommendations for exposure frequencies and durations for various exposure pathways have been provided by the EPA. EPA's standard default exposure factors (EPA 1989c and EPA 1991a) are used in calculating the pathway-specific intakes where appropriate. Knowledge of site-specific conditions and receptor activity is used when guidance is not available or when professional judgment deems necessary. The default values are typically either the average value, the 50th percentile value, or the 90th percentile value.

Equation 5.1 must be modified based on pathway-specific considerations. Depending on the pathway under evaluation, the exposure frequency might differ or an exposure time might be included in the equation to more reasonably estimate the intake of the chemicals of concern. The pathway-specific equations that were used in this baseline human health risk assessment are listed in Tables E.8–E.12, E.14–E.25, E.27–E.31 and E.34. These tables contain a detailed listing of the exposure parameters used in the pathway-specific equations and a source for each of the parameters.

One of the primary differences in this baseline human health risk assessment and the previous screening assessments is the use of different exposure parameters. A baseline human health risk assessment should reflect realistic exposure conditions, whereas screening assessments often include very conservative exposure parameters. However, the present baseline human health risk assessment uses EPA-recommended parameter values that in many instances may be more conservative than those used in the previous screening risk assessments. This risk assessment evaluates the health risks to both a child (0–6 years old) and to an adult for exposure to noncarcinogens. Exposure to carcinogens is assessed only for adults because the 30-year adult exposure period exceeds the 6-year child exposure period. It would be possible to evaluate the risk to an adult whose exposure began as a child; however, the end result would not be substantially different from the result reached by considering an adult. Each of the exposure scenarios and their associated pathways are described briefly in the following text.

5.2.3.3 Surface water ingestion scenario

The surface water ingestion scenario assumes that an adult weighing 70 kg and a child weighing 15 kg drinks untreated water from the reservoir at a rate of 2 L/day and 1 L/day, respectively. The duration of exposure for adults is 30 years whereas the duration of exposure for a child is 6 years. As far as is known, no one routinely drinks untreated reservoir water, but because the possibility exists, this exposure scenario is included in the risk assessment. The exposure equation for the ingestion of drinking water is listed in Table E.8.

5.2.3.4 Shoreline use scenario

The shoreline use pathways, as evaluated for subreaches 2.04–4.04, consider persons who spend time along the shoreline of the reservoir where they may come in contact with near-shore sediment through activities such as walking, searching for artifacts, wading, etc. Some activities such as walking and searching for artifacts are often more popular in the fall and winter when the water level in the reservoir is at its lowest. In many locations, the winter water level provides a broader beach and easier access. The contaminant exposure concentrations for the shoreline use pathways are listed in the representative concentration column in Table E.3.

Four exposure pathways are included in the shoreline use pathways: inadvertent ingestion of near-shore sediment, inhalation of the sediment in the form of dust, external exposure to gamma-emitting radionuclides in the sediment, and dermal contact with near-shore sediment (Fig. 5.1). The parameter values and equations used for the human health risk assessment are given in Appendix E for exposure to the following pathways: (1) inadvertent ingestion of near-shore sediment (Table E.9); (2) dermal contact with near-shore sediment (Table E.10); (3) inhalation of resuspended sediment (Table E.11); (4) external exposure to radiation from gamma-emitting radionuclides in near-shore sediments (Table E.12). Each pathway is discussed briefly in the following text.

Shoreline use: inadvertent ingestion of near-shore sediment. An individual who spends time along the shore of the Clinch River or Poplar Creek is assumed to inadvertently ingest a small quantity of sediment. Table E.9 lists the intake equations and exposure parameters used to assess the risk of

adverse health effects from the inadvertent ingestion of near-shore sediment. Parameter values used in the exposure equation have been derived from standard intake rates, exposure frequencies, exposure durations, and averaging times. These values are based on EPA standard default values for residential settings.

Shoreline use: dermal contact with near-shore sediment. An individual who spends time at a beach area is assumed to come into physical contact with the sediment and to absorb some fraction of the contaminant(s) in the sediment through the skin. Radionuclides were not evaluated for dermal exposure because it was assumed that the dose from external exposure to the radionuclides would provide a much greater health risk than the dose from dermal contact with those same radionuclides. In addition, it was assumed conservatively that an individual would only visit the beach area for a maximum of 6 months per year or half of the standard exposure frequency of 350 days per year. Pathway-specific intake parameters are listed in Table E.10.

Shoreline use: inhalation of resuspended particles from near-shore sediment. The evaluation of the exposure of an individual to contaminants in near-shore sediment that are resuspended in the air is dependent on the quantity of fugitive dust (resuspended sediments) generated by the wind. Although no air monitoring data were available for the Clinch River or Poplar Creek area, the quantity of fugitive dust generated by the wind was empirically derived by the method described in Eckerman and Young (1980). This method was also used in the previous screening risk assessments conducted by Hoffman et al. (1991) and Cook et al. (1992). The risk assessment equations and parameter values are given in Table E.11.

Shoreline use: external exposure to near-shore sediment. The external exposure pathway is concerned only with external exposure to gamma radiation from radionuclides while an individual spends time along the shoreline. Radionuclides are carcinogens, and as noted earlier, only adults are considered for exposure to carcinogens. Exposure equations and related parameter values are listed in Table E.12. These equations and parameter values were obtained from the National Council on Radiation Protection (NCRP 1984) and EPA (1989c).

5.2.3.5 Swimming scenario

An individual can be exposed to water in the Clinch River or Poplar Creek through recreational activities such as swimming, water skiing, and wading. The swimming pathways are included in the risk assessment because swimming offers the greatest potential for dermal exposure. The exposure frequency for the swimming pathways is limited to 45 days because swimming is a local summer activity and EPA (Region IV) has established 45 days as a reasonable maximum exposure frequency for the southeast (EPA 1991b). Water data were collected during the Phase 1 and Phase 2 sampling activities. In addition, surface water data collected as part of the ORREMP were used to supplement the surface water dataset. The exposure concentrations detected in the surface water samples are listed in the representative concentration column in Tables E.1 and E.2.

Swimming: inadvertent ingestion of surface water. Many swimmers will ingest some of the surrounding water while swimming. Standard EPA default intake equations and parameter values were used to calculate exposure estimates from this exposure pathway. The equations and parameter values are listed in Table E.14.

Swimming: dermal contact with surface water. Chemicals that are dissolved in the water can be absorbed through the skin while swimming. The rate of absorption is chemical specific and is represented by a permeability constant. (These constants are discussed in Sect. 5.3 and are presented in

Table E.13). As in the case of dermal contact with near-shore sediments, radionuclides were not included in the dermal absorption pathway because the risk of health effects from external exposure to radiation would be much greater than the chemical effects. The exposure equations and associated parameter values for dermal contact with surface water are listed in Table E.15.

5.2.3.6 Fish consumption scenario

Many individuals who live in the vicinity of the Clinch River and Poplar Creek are avid anglers. The fish consumption scenario represents an avid fisherman (or woman) who regularly catches fish in the Clinch River or Poplar Creek and uses the fish to feed the family. Because many fishermen are selective in the species of fish they eat and not all species of fish accumulate contaminants in their tissues to the same extent, several species of fish are included in this assessment; these species are bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), striped bass (*Morone saxatilis*), hybrid bass (*Morone chrysops/Morone saxatilis*), and channel catfish (*Ictalurus punctatus*). With the exception of striped and hybrid bass, which were lumped into one dataset due to limited sample size and like characteristics (see Sect. 5.1.2.3), separate risk calculations were made for each species.

The equations and parameter values used for calculating the baseline human health risk assessment for the fish consumption exposure pathway are given in Table E.16. The contaminant exposure concentrations for this scenario are listed in the representative concentration column in Table E.6.

Separate risks were calculated for the ingestion of different species of fish to provide risk factors for individuals who eat only one species of fish. The EPA-recommended ingestion rate of 54 g of fish per day was used to calculate the risk for each species; therefore, the risk for each species should not be added to obtain a risk to an individual who eats all species. Instead, the risk for the species that has the maximum value should be used as the upper-bound risk for the ingestion of fish.

5.2.3.7 Waterfowl consumption scenario

As described in Sect. 5.1.2.4, the waterfowl data available for use in the baseline human health risk assessment were limited to data collected as part of the CRRI Phase 1 and Phase 2 sampling activities. Of the available data, only the tissue data for Canada geese were used to evaluate risk to human health. Standard EPA default exposure parameters are not available for intake and exposure duration for the ingestion of waterfowl. Therefore, based on personal communication with the TWRA, posted bag limits for the various species of waterfowl, and the duration of the hunting season, best professional judgement was used to establish an ingestion rate and exposure duration for the consumption of Canada geese.

The ingestion rate that was established is based on the assumption that the average hunter would harvest two geese per year. Although the hunting season is typically 45 days and the bag limit is two geese per day, the TWRA provides estimates of the number of hunting permits issued and the estimated kills based on their tag and check-out system. For 1992–1993, the number of permits issued for the Watts Bar hunt unit was 639 and the estimated kill for those years was 173 (TWRA 1994). Therefore, the assumption that the average hunter would harvest two geese per year is considered by the assessors to be reasonable. The exposure frequency was considered to be 14 days per year or 2 weeks.

A Canada goose on average weighs approximately 12 pounds. Individuals typically eat only the breast tissue which is approximately 1/3 of the weight of the goose or 4 pounds. In addition, the typical hunter would share half his kill with his family or friends. Therefore, for use in this baseline risk assessment each hunter was assumed to consume approximately 4 pounds of goose per year (equals 12

pounds/goose × 2 geese/year × 1/3 × 0.5). The exposure equation and parameter values for the ingestion of Canada geese are listed in Table E.17.

5.2.3.8 Dredging scenario

Historical and recently collected data indicate that the highest concentrations of ^{137}Cs and mercury in the sediment of the Clinch River are buried under 40 to 80 cm (1 to 2 ft) of less contaminated sediment in depositional zones along the old river channel (Energy Systems 1992, Olsen et al. 1992). This situation occurs because releases of contaminants from the ORR have decreased significantly since the 1950s and 1960s (Chap. 3), and the more recently deposited sediments are much less contaminated. As long as the sediments with the highest levels of contamination remain buried, there is no realistic exposure pathway for humans and no risk to human health. Therefore, the most viable pathway for human exposure would result from dredging the deep-water sediment to maintain a navigational channel or for other reasons. If the dredged spoils are placed on the shore, they provide a potential pathway for human exposure. Because dredging is an action that could occur in the future, a dredging scenario was used to evaluate the health risks associated with using deep sediments for agricultural purposes.

Dredging activities in the Clinch River and Poplar Creek are regulated by the TVA and the U.S. Army's Corps of Engineers so that the uncontrolled disposal of dredged spoils is unlikely. The dredging scenario assumes that deep-water sediment is removed from the reservoir and deposited upon the agricultural land, where it is used to grow crops and raise livestock. The sediment is assumed to be spread deep enough so that plowing would not dilute the material by mixing it with the underlying soil. Therefore, this exposure scenario assumes worst-case conditions.

Occasionally, a lake-front property owner will request permission from the TVA to remove sediment from an area near his /her property to provide navigable water to a boat dock. In such instances, the dredged spoils may be placed on shore where humans could come in contact with them or where the spoils could be used for agricultural purposes. However, because the shoreline use pathways include direct exposure pathways for near-shore surface sediment and the quantity of sediment that would be dredged is typically only several cubic yards or less, dredged near-shore surface sediment is not considered in the dredging scenario.

The five exposure pathways evaluated under the dredging scenario are also evaluated for the irrigation scenario (Fig. 5.1). Direct exposure occurs via ingestion of dredged sediment, dermal contact with the sediment, inhalation of air containing dust derived from the sediment, and external exposure to gamma-emitting radionuclides. Indirect exposures occur via the ingestion of milk, meat, and vegetables produced on the dredged sediment.

Data for the dredging scenario came from cores taken during the CRRI Phase 1 (Cook et al. 1992) and Phase 2. Individual core concentrations were calculated from mass-weighted averages over the entire length of the core. Data from all cores were combined into one data set and summary statistics were calculated from this data set (Tables E.4 and E.5). Contaminant concentrations for milk and meat, and vegetables produced on dredged sediment were calculated in the same way as those produced on irrigated soil (Tables E.18–E.21).

Dredging scenario: inadvertent ingestion of dredged sediment. Table E.22 lists the exposure parameters for the inadvertent ingestion of dredged sediments. The parameter values used in the exposure equation are standard EPA default values for residential exposure.

Dredging scenario: dermal contact with dredged sediment. The sediment concentrations for dermal contact with the dredged sediments are the same as those for ingestion of dredged sediment (Tables E.4 and E.5). Radionuclides were not evaluated in this pathway because the dose from external exposure to the radionuclides was assumed to be much greater than the dose received from dermal absorption of the same radionuclides. Exposure equations and pathway-specific intake parameters are listed in Table E.23.

Dredging scenario: inhalation of resuspended particles from dredged sediment. No air monitoring data were available for the Clinch River or Poplar Creek area; therefore, transport equations were used for estimating air concentrations associated with the dredged sediments. Equations and parameter values used to estimate exposure to a receptor are given in Table E.24.

Dredging scenario: external exposure to dredged sediment. The equation and parameter values used to estimate the dose from external exposure to radionuclides are listed in Table E.25 . The pathway-specific exposure equations and parameter values listed in Table E.25 were taken from NCRP (1984) and EPA (1989c).

Dredging scenario: ingestion of vegetables, meat, and milk produced on dredged sediment. As indicated in the site conceptual model (Fig. 5.1), the consumption of contaminated produce is a potential exposure pathway if dredged sediment is used for agricultural purposes. The contaminant concentrations used for the ingestion of dredged sediment were used to model the expected concentrations in vegetables, meat, and milk. Models for estimating plant and animal uptake are the same as those used in the irrigation scenario (Tables E.18–E.21). Modelled contaminant concentrations in milk, meat, and vegetables are given in Table E.26. The equation and parameter values used to estimate the intake from ingestion of vegetables, meat, and milk produced on dredged sediment are listed in Table E.27.

5.2.3.9 Irrigation scenario

The irrigation scenario assumes that an individual uses surface water from the Clinch River or Poplar Creek in an overhead irrigation system to grow vegetables for his/her family and forage for cows. Surface water is not widely used for irrigation purposes because of the amount of rainfall occurring in eastern Tennessee and the types of crops grown in the area. However, a limited amount of irrigation is used for lawns, pastures, and vegetable gardens due to ease of access and occasional dry periods. In addition, in some instances, irrigation is used to protect crops from damage by frost and freezing temperatures. For these reasons, irrigation cannot be ruled out as a potential exposure pathway. However, irrigation is considered an assessment of future conditions because such activity is limited currently but could increase in the future. Contaminant concentrations are modelled values representing a 30-year buildup period. The exposure pathways associated with the irrigation scenario are shown in Fig. 5.1.

The EPA recommends that 30 years be used as a default lifetime exposure period in human health risk calculations (EPA 1991a). If an individual uses lake water to irrigate crops for 30 years, certain contaminants present in the water may build up in soil. For this reason, the values that are used as concentrations for contaminants in irrigated soil are based on a 30-year accumulation minus losses attributable to leaching, harvesting, and radioactive decay of radionuclides. Therefore, irrigated soil is defined as soil that has been irrigated with water from the Clinch River or Poplar Creek for a period of 30 years. The methodology for calculating the concentrations of contaminants in the irrigated soil and produce is provided in Appendix E. The exposure equations are given in Appendix E for the following exposure pathways: (1) inadvertent ingestion of irrigated soil (Table E.28); (2) dermal contact with

irrigated soil (Table E.29); (3) inhalation of resuspended irrigated soil (Table E.30); (4) external exposure to radionuclides in irrigated soil (Table E.31) ; and (5) ingestion of vegetables, milk, and meat produced on irrigated soil (Table E.34).

The irrigation rate was determined from personal communication with the Roane County Extension Agent. The rate of irrigation in Roane County is approximately 1 in. of water per week during drought conditions. This is equivalent to 3.62 L/day for each square meter of irrigated soil. This irrigation rate is almost twice that reported by the U.S. Department of Agriculture (1970); however, it is assumed that irrigation in the Clinch River or Poplar Creek area occurs for only 3 months per year, and the value reported by the USDA is normalized for year-round irrigation.

The equation for calculating contaminant concentrations in the irrigated soil after a 30-year build–up period are given in Tables E.18–E.21. The water data are the same as those used in the water ingestion and swimming scenarios. The calculated contaminant concentrations for irrigated soil are listed in Table E.32 and E.33.

Irrigation scenario: inadvertent ingestion of irrigated soil. Table E.28 lists the exposure parameters associated with the inadvertent ingestion of irrigated soil. This ingestion occurs as a result of working with the soil as well as from the ingestion of produce contaminated with soil. The parameters used in this exposure equation have been derived from standard intake rates, exposure frequencies, exposure durations, body weights, and averaging times.

Irrigation scenario: dermal contact with irrigated soil. The soil exposure concentrations for dermal contact with irrigated soil are the same as those for the ingestion of irrigated soil. Radionuclides were not evaluated in this scenario because the health risk from external exposure to the radionuclides in the soil was assumed to be much greater than the risk from dermal absorption of the radionuclides. Pathway–specific intake parameters are listed in Table E.29.

Irrigation scenario: inhalation of resuspended particles from irrigated soil. Table E.30 lists the exposure parameters associated with the inhalation of resuspended particles resulting from wind-generated dust. The concentration term used in this equation is a modelled value. The parameters used in this exposure equation have been derived from standard intake rates, exposure frequencies, exposure duration, body weights, and averaging times.

Irrigation scenario: external exposure to irrigated soil. The external exposure equation and pathway-specific intake parameters are listed in Table E.31. The external exposure pathway was limited to an adult exposure because gamma radiation is considered carcinogenic. As explained in Sect. 5.2.2, the calculated risk of adverse carcinogenic health effects for a child would be less than for an adult because of the shorter exposure period.

Irrigation scenario: ingestion of vegetables, meat, and milk grown on irrigated soil. As shown in the site-conceptual model (Fig. 5.1), the consumption of food produced on soil irrigated with river water is a potential exposure pathway. The soil concentrations used in the soil ingestion pathway were used to model the expected concentrations in vegetables, meat, and milk. Equations used for estimating plant and animal uptake were taken from the International Atomic Energy Agency (IAEA 1982) and DOE (1987) and are listed in Tables E.18 through E.21. For inorganics and radionuclides, contaminant–specific uptake coefficients were used to estimate the contaminant concentrations in produce based on the modeled contaminant concentrations in the irrigated soil. Each transfer coefficient represents a ratio of the contaminant concentration in the plant to the concentration in the soil (Table E.35). Therefore, the product of the contaminant concentration in irrigated soil and the transfer

coefficient is the contaminant concentration in the plant. The soil-to-plant elemental transfer coefficients for the reproductive portions of plants as given by Baes et al. (1984) were used to estimate the contaminant concentrations for the ingestion of produce.

The transfer of organic chemicals to plants from soil was calculated using the regression equation:

$$\log B_v = 1.588 - 0.578 \log K_{ow} \tag{5.2}$$

where

B_v = is the transfer coefficient for the chemical, and
K_{ow} = is the chemical's octanol–water partition coefficient (Travis and Arms 1988).

Modelled concentrations of contaminants in milk, meat, and vegetables grown on irrigated soil are listed in Tables E.33 and 34. It is to be noted that in deriving the concentration of contaminants in milk and meat, incidental ingestion of soil and ingestion of surface water by cattle are included in the modelling equations.

5.3 TOXICITY ASSESSMENT

The purpose of toxicity assessment is to evaluate the potential for site contaminants to cause adverse health effects in exposed individuals. It provides, where possible, an estimate of the relationship between the extent of exposure to a particular contaminant and the increased likelihood or severity of adverse health effects as a result of that exposure relative to a baseline. The toxicity assessment generally involves two steps. The first step comprises determining whether exposure to an agent can cause an increase in the incidence of a particular health effect and whether that health effect will occur in humans. The second step involves characterizing the relationship between the received dose of the contaminant and the incidence of adverse health effects in exposed populations.

Data used to discuss the chemical-specific potential health effects in both this section and the Appendix are from human and laboratory animal research and from occupational studies to characterize likely health effects resulting from exposure to the COPCs. Refer to the *BEIAS Toxicity Profiles* report (1994) for further information regarding specific chemicals. Tables 5.6–5.8 summarize the available toxicity information for the Clinch River and Poplar Creek COPCs. Chemical-specific information aimed at providing the reader with general qualitative information about carcinogenic and noncarcinogenic health effects related to those COCs identified in this baseline human health risk assessment (Sect. 5.4) will be presented in Appendix E.

5.3.1 Toxicity Information for Noncarcinogenic Effects

Noncarcinogenic effects are evaluated by comparing an exposure experienced over a specified time period (e.g., 30 years) with a reference dose (RfD) [or reference concentration (RfC)] derived for a similar exposure period. The RfDs available for the COPCs present in the Clinch River are given in Table 5.6. To evaluate the noncarcinogenic effects from exposure to the COPCs in the Clinch River and Poplar Creek, the hazard quotient (HQ) [the ratio of the exposure dose (i.e., intake) to the RfD] is calculated for each COPC. An HQ is used to evaluate exposure to noncarcinogens only and assumes that, below a given level of exposure (i.e., the RfD), even sensitive populations are unlikely to experience adverse health effects. If the exposure level (intake) exceeds this threshold [i.e., if Intake/RfD exceeds one (1.0)], there may be concern for potential systemic health effects. The level of concern does not necessarily increase linearly as the HQ approaches or exceeds unity; the HQ is not a percentage or probability.

Table 5.6. Toxicity information for the Clinch River and Poplar Creek noncarcinogenic COPCs

Chemical	Chronic oral RfD[a,b] (mg/kg-d)	Confidence level[a]	%GI absorp.	%GI source	Chronic oral RfD absorbed[c,d] (mg/kg-d)	Chronic inhal. RfD[a,b,e] (mg/kg-d)	RfD basis (vehicle)[f]	Critical effect[f]	Uncertainty factor[a,f]; Modifying factor
Inorganics									
Antimony	4.0E-04	Low	2.0	BEIAS 1994	8.0E-06	NA	oral	gastrointestinal disorders	UF=1000; MF=1
Arsenic, Inorganic	3.0E-04	Medium	41	BEIAS 1994	1.2E-04	NA	oral	CNS, cardiovascular system, skin	UF=3; MF=1
Beryllium	5.0E-03	Low	1.0	BEIAS 1994	5.0E-05	NA	oral	reduced weight; rickets, lung, skin	UF=100; MF=1
Boron and Borates Only	9.0E-02	Medium	90	BEIAS 1994	8.1E-02	5.7E-03	NA	testicular atrophy, spermatogenic arrest (dog)	UF=100; MF=1
Cadmium (diet)	1.00E-03	High	1.0	BEIAS 1994	1.0E-05	NA	oral	renal toxicity, osteomalacia, osteoporosis	UF=10; MF=1
Cadmium (water)	5.0E-04	High	1.0	BEIAS 1994	5.0E-06	NA	oral	renal toxicity, osteomalacia, osteoporosis	UF=10; MF=1
Chromium VI	5.0E-03	Low	2.0	BEIAS 1994	1.0E-04	NA	oral water	hepatotoxicity, nephrotoxicity, dermatitis	UF=500; MF=NA
Manganese (diet)	1.4E-01	Medium	4.0	BEIAS 1994	5.6E-03	1.4E-05	oral	lethargy, tremors mental disturb-ance, muscle tonus, CNS	UF=1; MF=1

Table 5.6 Toxicity information for the Clinch River and Poplar Creek noncarcinogenic COPCs (continued)

Chemical	Chronic oral RfD[a,b] (mg/kg-d)	Confidence level[a]	%GI absorp.	%GI source	Chronic oral RfD absorbed[c,d] (mg/kg-d)	Chronic inhal. RfD[a,b,e] (mg/kg-d)	RfD basis (vehicle)[f]	Critical effect[f]	Uncertainty factor[a,f]; Modifying factor
Manganese (water)	5.0E-03	Medium	4	BEIAS 1994	2.0E-04	1.4E-05	oral	lethargy, tremors mental disturb-ance, muscle tonus, CNS	UF=1; MF=1
Mercury, Inorganic	3.0E-04	NA	7	BEIAS 1994	2.10E-05	8.6E-05	oral	CNS, kidney, gastrointestinal tract toxicity	UF=1000; MF=NA
Nickel, Soluble Salts	2.0E-02	Medium	27	BEIAS 1994	5.4E-03	NA	oral	nephrotoxicity; reduced weight	UF=100[f]; MF=3[f]
Selenium	5.0E-03	High	44	BEIAS 1994	2.2E-03	NA	oral	methemoglo-binemia, dermatitis	UF=3; MF=NA
Silver	5.0E-03	Low	18	BEIAS 1994	9.00E-04	NA	oral	Argyria	UF=3; MF=1
Vanadium, Metallic	7.0E-03	NA	1	BEIAS 1994	7.0E-05	NA	oral, oral-water	reduced pup weight (rat)	UF=100
Zinc, Metallic	3.0E-01	Medium	20	BEIAS 1994	6.0E-02	NA	oral	gastrointestinal system, kidney, renal function	UF=10; MF=NA
Organics									
Aldrin	3.0E-05	Medium	50	BEIAS 1994	1.5E-05	NA	oral	Liver toxicity (rat)	UF=1000; MF=1
Aroclor-1254	2.0E-05	NA	90	BEIAS 1994	1.8E-05	NA	NA	NA	NA

Table 5.6 Toxicity information for the Clinch River and Poplar Creek noncarcinogenic COPCs (continued)

Chemical	Chronic oral RfD[a,b] (mg/kg-d)	Confidence level[a]	%GI absorp.	%GI source	Chronic oral RfD absorbed[c,d] (mg/kg-d)	Chronic inhal. RfD[a,b,e] (mg/kg-d)	RfD basis (vehicle)[f]	Critical effect[f]	Uncertainty factor[a,f]; Modifying factor
Aroclor-1260	NA	NA	90	BEIAS 1994	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	31	BEIAS 1994	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	31	BEIAS 1994	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	31	BEIAS 1994	NA	NA	NA	NA	NA
bis(2-Ethyl- hexyl)Phthalate	2.0E-02	Medium	19	BEIAS 1994	3.8E-03	NA	oral	increased liver and kidney weight in animals	UF=1000; MF=1
Chlordane	6.00E-05	Low	50	BEIAS 1994	3.0E-05	NA	Oral	Regional liver hypertrophy (rat)	UF=1000; MF=1
Cresol, p-	5.0E-03	Low	65	BEIAS 1994	3.3E-03	NA	Oral	Maternal death, hypactivity, cyanosis, eye discharge, and respiratory system distress (rabbit)	UF=1000;
DDD	NA	NA	70	BEIAS 1994	NA	NA	NA	NA	NA
DDE	NA	NA	70	BEIAS 1994	NA	NA	NA	NA	NA
DDT	5.0E-04	NA	70	BEIAS 1994	3.5E-04	NA	NA	NA	NA

Table 5.6 Toxicity information for the Clinch River and Poplar Creek noncarcinogenic COPCs (continued)

Chemical	Chronic oral RfD[a,b] (mg/kg-d)	Confidence level[a]	%GI absorp.	%GI source	Chronic oral RfD absorbed[c,d] (mg/kg-d)	Chronic inhal. RfD[a,b,e] (mg/kg-d)	RfD basis (vehicle)[f]	Critical effect[f]	Uncertainty factor[a,f]; Modifying factor
Dibenzo(a,h)anthracene	NA	NA	31	BEIAS 1994	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	31	BEIAS 1994	NA	NA	NA	NA	NA

ATSDR = Agency for Toxic Substances and Disease Registry, Public Health Services (1987-1990); NA = No data available or data inconclusive; GI = Gastrointestinal (%GI = percent gastrointestinal absorption); RfD = Reference dose; CNS = Central nervous system.

[a] Based on Integrated Risk Information System (IRIS) (EPA 1994).

[b] Based on Health Effects Assessment Summary Tables (HEAST) (EPA 1993b).

[c] The absorbed RfD = (RfD X %GI absorption); the absorbed RfD is used for dermal pathway calculations. RfD absorbed = RfD (i.e, %GI = 100) when the %GI absorption value is unknown (NA), and when the %GI is greater than 80.

[d] The chronic oral absorbed RfD is used for the dermal contact pathway calculations (RfD oral absorbed = RfD oral x %GI).

[e] RfCs were converted to units of mg/kg-d (i.e., RfD units) by using the inhalation rate and body weight of an adult [i.e., RfC x $20m^3/d$ x (1/70kg) = RfD] (EPA 1989a).

[f] BEIAS (Biomedical and Environmental Information Analysis Section) Toxicity Profiles (BEIAS 1993).

Chronic RfDs are developed for protection from long-term exposure to a chemical (7 years to a lifetime); subchronic RfDs are used to evaluate short-term exposure (2 weeks to 7 years) (EPA 1989a). No short-term or acute exposure scenarios were evaluated as part of this baseline risk assessment. Although exposure to a child was evaluated and the child exposure duration is less than 7 years, subchronic RfDs were not used to evaluate exposure to children because the subchronic RfDs are derived based on an average cohort and do not take into account age-specific physiochemical or physiokinetic processes.

5.3.2 Toxicity Information for Carcinogenic Effects

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as excess cancer risk or, stated differently, cancer incurred in addition to normally expected rates of cancer development in the general population. An excess cancer risk of 1.0E–06 indicates that an individual has a one in a million chance of developing cancer from exposure to this contamination level over a 70-year lifetime.

To evaluate the carcinogenic risk from exposure to Clinch River and Poplar Creek COPCs, the risk is calculated for each COPC [the multiplication of the exposure dose (i.e., CDI and/or dose) by the SF, which is a chemical-specific value based on carcinogenic dose-response data]. Because the SFs are the 95th percentile upper confidence limit on the probability of a carcinogenic response, the carcinogenic risk estimate represents an upper confidence bound estimate. Therefore, a 5% probability exists that the actual risk will be higher than the estimate presented, and the actual risk may well be less than the estimate. Slope factors used in the evaluation of risk from exposure to chemicals and radionuclides in the Clinch River and Poplar Creek are listed in Tables 5.7 and 5.8, respectively.

5.3.3 Estimation of Toxicity Values for Dermal Exposure

Oral RfDs and SFs are often adjusted for evaluation of the dermal exposure pathway (EPA 1989a); it is conservative to evaluate both carcinogenic risk and noncarcinogenic hazard to adjust the toxicity values in the manner described in the following discussion. Most RfDs/SFs are expressed as the amount of substance administered per unit time and body weight (administered dose); however, dermal exposure to chemicals in soil and water should be expressed as absorbed doses.

For the dermal assessments in this baseline human health risk assessment, the oral RfD and/or SF for each chemical was adjusted by the percent gastrointestinal absorption efficiency (%GI) for that chemical (EPA 1992). The %GI is known for only a limited number of chemicals; for those chemicals where a %GI is currently not available in the literature, 100% was assumed. For many chemicals, estimates of %GI were based on qualitative information on the rate and extent of GI absorption; rapid or extensive absorption was assumed to be essentially complete, i.e., %GI = 100%. Wide ranges of %GI values can be found for some chemicals and in the absence of chemical-specific absorption data, estimates can be made based on data for related chemical structures. Most organic compounds are readily absorbed (i.e., %GI=100) from the GI tract; for this BHHRA, no adjustments were made to chemicals with %GI $\geq$ 80%.

Table 5.7. Toxicity information for the Clinch River and Poplar Creek carcinogenic COPCs

Chemical	Oral slope factor[a] (kg-day/mg)	%GI absorp.	%GI source	Oral slope factor absorbed[b] (kg-day/mg)	TEF[c]	Inhalation slope factor[a] (kg-day/mg)	EPA class[d]	Type of cancer
Inorganics								
Antimony	NA	2.0	BEIAS 1994	NA	NA	NA	NA	NA
Arsenic, Inorganic	NA	41	BEAIS 1994	NA	NA	5.0E+01	A	skin, liver, bladder, respiratory, gastrointestinal
Beryllium	4.3E+00	1.0	BEIAS 1994	4.3E+02	NA	8.4E+00	B2	breast, bone, uterus, lung
Boron and Borates Only	NA	90	BEIAS 1994	NA	NA	NA	NA	NA
Cadmium (diet)	NA	1.0	BEIAS 1994	NA	NA	6.1E+00	B1	respiratory tract, lung
Cadmium (water)	NA	1.0	BEIAS 1994	NA	NA	6.1E+00	B1	respiratory tract, lung
Chromium VI	NA	2.0	BEIAS 1994	NA	NA	4.1E+01	A	tumors, lung
Manganese (diet)	NA	4.0	BEIAS 1994	NA	NA	NA	D	NA
Manganese (water)	NA	4.0	BEIAS 1994	NA	NA	NA	D	NA
Mercury, Inorganic	NA	7.0	BEIAS 1994	NA	NA	NA	D	NA
Nickel, Soluble Salts	NA	27	BEIAS 1994	NA	NA	NA	D	NA
Selenium	NA	44	BEIAS 1994	NA	NA	NA	D	NA
Silver	NA	18	BEIAS 1994	NA	NA	NA	D	NA
Vanadium, Metallic	NA	1	BEIAS 1994	NA	NA	NA	D	NA
Zinc, Metallic	NA	20	BEIAS 1994	NA	NA	NA	D	NA
Organics								
Aldrin	1.7E+01	50	BEIAS 1994	3.4E+01	NA	1.7E+01	B2	liver carcinoma

Table 5.7. Toxicity information for the Clinch River and Poplar Creek carcinogenic COPCs (continued)

Chemical	Oral slope factor[a] (kg-day/mg)	%GI absorp.	%GI source	Oral slope factor absorbed[b] (kg-day/mg)	TEF[c]	Inhalation slope factor[a] (kg-day/mg)	EPA class[d]	Type of cancer
Aroclor-1254	NA	90	BEIAS 1994	NA	NA	NA	B2	liver, biliary tract, gall bladder
Aroclor-1260[e]	7.7E+00	90	BEIAS 1994	8.6E+00	NA	NA	B2	liver, biliary tract, gall bladder
Benzo(a)anthracene	7.3E-01	31	BEIAS 1994	2.43E+00	0.1	NA	B2	tumors
Benzo(a)pyrene	7.3E+00	31	BEIAS 1994	2.4E+01	1.0	NA	B2	stomach tumors
Benzo(b)fluoranthene	7.3E-01	31	BEIAS 1994	2.4E+00	0.1	NA	B2	tumors
bis(2-Ethylhexyl)-phthalate	1.4E-02	19	BEIAS 1994	7.4E-02	NA	NA	B2	Liver neoplastic nodule and hepatocellular carcinoma
Chlordane	1.3E+00	50	BEIAS 1994	2.6E+00	NA	1.3E+00	B2	(O): Liver carcinoma (mouse); (I): CNS depression
Cresol,p-	NA	65	BEIAS 1994	NA	NA	NA	C	NA
DDD	2.4E-01	70	BEIAS 1994	3.4E-01	NA	NA	B2	Liver tumors (mouse)
DDE	3.4E-01	70	BEIAS 1994	4.9E-01	NA	NA	B2	Hepatocellular carcinoma and hepatoma (mouse)
DDT	3.4E-01	70	BEIAS 1994	4.9E-01	NA	3.4E-01	B2	(O): Liver tumors (mouse, rat)
Dibenzo(a,h)anthracene	7.3E+00	31	BEIAS 1994	2.4E+01	1.0	NA	B2	tumors

Table 5.7. Toxicity information for the Clinch River and Poplar Creek carcinogenic COPCs (continued)

Chemical	Oral slope factor[a] (kg-day/mg)	%GI absorp.	%GI source	Oral slope factor absorbed[b] (kg-day/mg)	TEF[c]	Inhalation slope factor[a] (kg-day/mg)	EPA class[d]	Type of cancer
Indeno(1,2,3-cd)pyrene	7.3E-01	31	BEIAS 1994	2.4E+00	0.1	NA	B2	tumors

NA = No data available or data inconclusive.
TEF = Toxicity equivalency factor.
[a] Based on Integrated Risk Information System (IRIS) (EPA 1994) or Health Effects Assessment Summary Tables (HEAST), (EPA 1993b).
[b] The absorbed oral slope factor is used for the dermal contact pathway calculations; the absorbed oral SF = (SF/%GI).
[c] The oral SFs for these PAHs are derived by multiplying the benzo(a)pyrene oral SF (7.3E+00) by the chemical specific toxicity equivalency factor (TEF) (EPA 1993a).
[d] EPA Weight of Evidence Classification System for Carcinogenicity-used to characterize the extent to which available data indicate that an agent is a human carcinogen: A = human carcinogen; B1 or B2 = probable human carcinogen (B1 indicates that limited data on humans are available and B2 indicates sufficient evidence in animals and inadequate or no evidence in humans); C = possible human carcinogen; D = not classifiable as to human carcinogenicity; E = evidence of noncarcinogenicity for humans.
[e] For these Aroclors, the oral SF (7.7E+00) for polychlorinated biphenyls was used.

Table 5.8. Toxicity information for exposure to the Clinch River and Poplar Creek radionuclide COPCs

Chemical	External exposure slope factor[a,b] (g/pCi-y)	Oral slope factor[a,b] ((pCi)$^{-1}$)	Inhalation slope factor[a,b] ((pCi)$^{-1}$)	ICRP lung class[a,c]	EPA Class[d]	Type of Cancer
Cesium-137+D	2.0E-06	2.8E-11	1.9E-11	D	A	various
Cobalt-60	8.6E-06	1.5E-11	1.5E-10	Y	A	various
Strontium-90+D	0	3.6E-11	6.2E-11	D	A	various

[a] Based on Health Effects Assessment Summary Tables (HEAST) (EPA 1993b).
[b] The radionuclide slope factors include contributions from daughter products.
[c] Lung clearance classification recommended by the International Commission on Radiological Protection (ICRP): Y = year; W = week; D = day; G = gas.
[d] EPA Weight of Evidence Classification System for Carcinogenicity-used to characterize the extent to which available data indicate that an agent is a human carcinogen: A = human carcinogen; B1 or B2 = probable human carcinogen (B1 indicates that limited data on humans are available and B2 indicates sufficient evidence in animals and inadequate or no evidence in humans); C = possible human carcinogen; D = not classifiable as to human carcinogenicity; E = evidence of noncarcinogenicity for humans.

Minor adjustments to the oral RfDs and SFs, used in the dermal assessments only, which favor conservatism, were made for this BHHRA. The oral RfD was multiplied by the %GI/100, and the SF was divided by the %GI/100 to give the absorbed dose RfD and absorbed dose SF, respectively. It should be noted that this approach may result in overly conservative risk estimations. If unacceptable risks are identified for this exposure route, the associated chemicals should be examined in detail to ascertain the credibility of the dermal toxicity value prior to making decisions based on the dermal results.

5.3.4 Chemicals for Which no EPA Toxicity Values are Available

Slope factors and RfDs are not currently available for all chemicals analyzed because (1) their carcinogenic and/or noncarcinogenic effects have not yet been determined, (2) epidemiological studies have proven them not to be carcinogenic and/or toxic, or (3) existing or previously determined toxicity values have since been withdrawn by the EPA. Therefore, several of the COPCs for the Clinch River and Poplar Creek cannot be quantitatively evaluated at the present time. However, literature research has been conducted for most of these chemicals and a qualitative summary of the available information can be found in *Toxicity Profiles for Use in Hazardous Waste Risk Assessment and Remediation* (Energy Systems 1994).

5.3.5 Uncertainties Related to Toxicity Information

The methodology used in developing a noncarcinogenic toxicity value (RfD or RfC) involves identifying a threshold level below which adverse health effects will not occur. The RfD or RfC values are generally based on studies of the most sensitive animal species tested and the most sensitive endpoint measured (unless adequate human health data are available). From these studies, the experimental exposure representing the highest dose level tested at which no adverse effects were demonstrated [the no-observed-adverse-effect level (NOAEL)] was derived; in some cases, only a lowest-observed-adverse-effect level (LOAEL) is available. The RfD or RfC is derived from the NOAEL (or LOAEL) for the critical toxic effect by dividing the NOAEL (or LOAEL) by uncertainty factors. These factors usually are in multiples of 10, with each factor representing a specific area of uncertainty in the extrapolation of the data. An uncertainty factor of 100 is typically used when extrapolating animal studies to humans; additional uncertainty factors are sometimes necessary when other experimental data limitations are found. Because of the large uncertainties (10–10,000) on some RfD/RfC toxicity values, exact/precise safe levels of exposure for humans are not possible.

A two-part evaluation exists for assessing the carcinogenic potential of a chemical: (1) evaluating the likelihood that a chemical is a carcinogen (i.e., a weight-of-evidence assessment) and (2) determining the quantitative dose-response relationship (i.e., potency factor or SF); uncertainties occur with each evaluation. Based on weight-of-evidence studies using human and laboratory animal research, chemicals fall into one of five groups (EPA 1989a, 1993b): (1) Group A, human carcinogen; (2) Group B1, probable human carcinogen based on limited human data; (3) Group B2, probable human carcinogen based on sufficient evidence in animals and inadequate or no evidence in humans; (4) Group C, possible human carcinogen; (5) Group D, not classified as to human carcinogenicity; and (6) Group E, evidence of noncarcinogenicity for humans. The SF for a chemical is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime; it is derived by applying a mathematical model to extrapolate from a relatively high administered dose (to animals) to the lower exposure levels expected for humans. The SF represents the 95th percentile upper confidence limit on the linear component of the slope of the tumorigenic dose-response curve in the low-dose region. A number of low-dose extrapolation models have been developed, and EPA generally uses the linearized multistage model in the absence of adequate information to support other models.

5.3.6 Summary of Toxicity Information

The potential toxicological effects of the COPCs included in the evaluation of the Clinch River and Poplar Creek have been discussed. The majority of the information pertaining to specific contaminants was taken from *Toxicity Profiles for Use in Hazardous Waste Risk Assessment and Remediation* (BEIAS 1994) prepared by the Biomedical and Environmental Information Analysis Section (BEIAS) of the Health Sciences Research Division. However, if no toxicity profile was available from BEIAS for a specific contaminant, then EPA's Integrated Risk Information System (IRIS) database, the *Health Effects Assessment Summary Tables* (HEAST), or library data were used, if available.

Toxicity profiles for contaminants of potential concern for which no toxicity information is currently available is presented in Appendix E. In addition, Appendix E contains toxicity profiles for contaminants for which toxicity information was available that have been determined by the risk characterization (Sect. 5.4) to be chemicals of concern for the Clinch River and/or Poplar Creek.

5.4 RISK CHARACTERIZATION

The purpose of the risk characterization is to integrate and summarize the information presented in the exposure and toxicity assessment; it is the final step in the human health risk assessment process. Potential carcinogenic effects are characterized by estimating the probability that an individual will develop cancer over a lifetime by multiplying projected intakes resulting from exposure to carcinogenic chemicals by chemical–specific dose–response data (i.e., slope factors). This probability is presented as an excess cancer risk (ECR). Potential noncarcinogenic (systemic/toxic) effects are characterized by dividing projected intakes of contaminants by noncarinogenic toxicity values (i.e., reference doses) resulting in an HQ. The numerical excess cancer risk and hazard quotients produced during this phase of the risk assessment process must be interpreted in the context of the uncertainties and assumptions associated with the risk assessment process and with the data upon which the risk estimates are based.

5.4.1 Risk Characterization Approach for Carcinogens

For carcinogens, it is assumed that a small number of molecular events can evoke a change in a single cell that can lead to uncontrolled cellular proliferation and eventually to a clinical state of disease. The hypothesized mechanism for carcinogenesis is referred to as "nonthreshold" or "stochastic" because there is believed to be essentially no level of exposure to a carcinogen that does not pose a finite probability, however small, of generating a carcinogenic response. Because of the way radiation affects cells, radionuclides are considered carcinogens.

To characterize potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure are estimated from projected intakes and chemical–specific dose response information (EPA 1989). The dose response information used for carcinogens in the present risk assessment is in the form of EPA–recommended slope factors (SFs) provided in the HEAST and the Integrated Risk Information System (IRIS) and supplied to the CR–ERP by the Biomedical Information and Analysis Section, Health Sciences Research Division, ORNL. A slope factor is a plausible upper–bound estimate of a response per unit intake of a carcinogen over a lifetime. The slope factors for nonradiological carcinogens convert estimated daily intakes of contaminants averaged over a lifetime (70 years) to an incremental risk of an individual developing cancer. For radionuclides, the slope factors in HEAST convert the total intake or exposure to an incremental risk of developing an excess cancer during a 70–year lifetime. Thirty years is considered a lifetime exposure for an adult (OSWER 1991). In the present risk assessment, only an adult was considered in evaluating the risk of an individual developing

cancer because the parameter values used in the risk assessment equations for an adult are more conservative than those used for a child. Intake routes include ingestion, inhalation, dermal exposure, and, in the case of gamma–emitting radionuclides, external exposure to ionizing radiation.

The excess cancer risk for carcinogens is calculated by multiplying the calculated intake/dose for each contaminant by the appropriate EPA–approved slope factors. This estimate of excess cancer risk represents the potential of an individual developing excess cancer over a lifetime, above and beyond the normal (unavoidable) incidence of developing cancer.

Consideration is given to exposure to multiple chemicals as well as multiple exposure pathways when calculating the risk of an individual developing cancer. This is accomplished via summing excess cancer risks for each chemical both within a given pathway and across pathways within a scenario. The EPA has established a target risk range of 10^{-4} to 10^{-6} (55 FR 46). Where the baseline risk assessment indicates that a cumulative site risk to an individual using reasonable maximum exposure assumptions for either current or future land use exceeds the 10^{-4} lifetime excess cancer risk end of the target risk range, action under CERCLA is generally warranted at the site. For sites where the cumulative site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, action generally is not warranted, but may be warranted if a chemical-specific standard that defines acceptable risk is violated or there are noncarcinogenic effects or an adverse environmental impact that warrants action.

In this risk assessment, pathways of concern relative to carcinogenic risk are those that have a pathway total of greater than 10^{-4}. Within the pathways that have a total risk of greater than 10^{4}, the carcinogenic chemicals of concern are defined as those contaminants whose excess cancer risk is greater than 10^{-6}.

5.4.2 Risk Characterization Approach for Noncarcinogens

For many noncarcinogenic effects, protective mechanisms are believed to exist that must be overcome before an adverse effect is manifested from a chronic exposure to a toxicant. For example, where a large number of cells perform the same or similar function, the cell population may have to be significantly depleted before an effect is seen. A range of exposures exist, from zero to some finite value, that can be tolerated by the organism with essentially no change in expression of adverse effects. This is known as the "threshold" or "nonstochastic" concept.

To characterize potential noncarcinogenic effects from contaminants, the ratio of projected intakes of substances to EPA–approved toxicity values referred to as RfDs is calculated. In this assessment, only long–term, chronic exposures to contaminants are evaluated. A chronic RfD is an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effect during a lifetime (EPA 1989). RfDs used in this document were obtained from the Biomedical and Information Analysis Section, Health Sciences Research Division, Oak Ridge National Laboratory, who in turn, obtained the toxicity values from an on–line search of HEAST and IRIS. Noncarcinogenic effects are not expressed as the probability of an individual suffering an adverse effect as in the case of carcinogens but as a comparison of a daily exposure level averaged over a specified period of time with an RfD. The ratio of the average daily exposure level of a single toxicant to the RfD for that toxicant is defined as an HQ. The sum of more than one HQ for multiple toxicants and/or multiple exposure pathways is called a hazard index (HI). An HQ or an HI > 1 is considered unacceptable. Both a child and an adult were included in the assessment of noncarcinogens because in some instances the parameter values used for a child are more conservative than those used for an adult. Exposure to noncarcinogens can occur via ingestion, inhalation, and dermal contact. For this

risk assessment, pathways of concern for noncarcinogenic effects are defined as those with a HI > 1.0. Within the pathways that have a HI > 1.0, noncarcinogenic chemicals of concern are defined as those with HIs > 0.1.

5.4.3 Risk Characterization Results for Current Conditions

Results of the human health risk assessment for the direct exposure pathways to primary media for current exposure scenarios (Fig. 5.1) are presented in the following order: drinking water ingestion, shoreline use, swimming, fish ingestion, and water fowl ingestion. Brief descriptions of the types of analytes and number of samples in the data bases used in each scenario are given in the following text. Prior to the preparation of the risk characterization tables, the various pathways and contaminants were screened to limit the information presented to only those contaminants that had either an excess cancer risk of greater than 10^{-6} or a hazard quotient of >0.1. This screen was applied to reduce the volume of material generated and to highlight those contaminants and pathways of potential concern. In the case where a chemical had an ECR >10^{-6} or a HQ of >0.1 for one pathway in a given scenario, the excess cancer risk and hazard quotients for that chemical are presented for all pathways within the scenario regardless of the ECR or HQ.

5.4.3.1 Drinking water ingestion scenario

Human health risks for the water ingestion scenario were calculated separately for the Clinch River reaches and the Poplar Creek subreaches. The methods, equations, and parameter values in the human health risk assessment for radiological and nonradiological contaminants in drinking water are listed in Table E.8.

Carcinogenic and noncarcinogenic chemicals of concern for the drinking water ingestion pathway for Reaches 1, 2, 4, and 7 of the Clinch River. Within the Clinch River System, risks were calculated separately for each of the defined reaches (Reaches 1, 2, 4, and 7) and are presented in Table E.36. For the drinking water ingestion pathway, none of the reaches evaluated exhibited a pathway excess cancer risk of greater than 10^{-4}. Thus, no carcinogenic chemicals of concern were identified for the drinking water ingestion pathway for reaches 1, 2, 4, or 7.

Noncarcinogenic hazard indices were calculated for both an adult and a child for the drinking water ingestion pathway. As is evidenced in Table E.37, no noncarcinogenic HIs were > 1.0 for the adult water ingestion pathway for the Clinch River reaches. However, the HIs for the child water ingestion pathway for the Clinch River reaches was >1.0 for each of the Clinch River reaches (Table E.38). Several inorganic contaminants (arsenic, antimony, manganese, and nitrate) were found to have an individual hazard quotient of greater than 0.1 for this pathway. Individually, none of these contaminants have a HQ >1.0 and the HIs for each reach range from 1.0 to 1.5. The chemical that contributes more than 50% of the total HI for each reach is manganese. There are two RfDs currently available for manganese, one for water and one for diet. In evaluating the drinking water ingestion pathway, the RfD for water ingestion of manganese was used. Because unfiltered water samples were used in the evaluation of hazard/risk for the Clinch River and Poplar Creek, the actual hazard from the ingestion of manganese may have been overestimated due to the differential bioavailability of manganese within the system. In addition, the distribution of total and dissolved manganese in the surface water of the Clinch River and Poplar Creek does not vary significantly from reach to reach or between the reference reaches and the study area (see Chap. 3).

Carcinogenic and noncarcinogenic chemicals of concern for the drinking water ingestion pathway for Poplar Creek. Within Poplar Creek, carcinogenic risks were calculated separately for each

of the defined subreaches. For the drinking water ingestion pathway, none of the subreaches exhibited a pathway excess cancer risk of greater than 10-4 (Table E.39). Therefore, no carcinogenic chemicals of concern were identified.

Noncarcinogenic contaminants whose hazard indices (i.e., the sum of the hazard quotients for a particular pathway) exceeded 1.0 are listed in Table E.40 for adults and E.41 for children for each of the Poplar Creek subreaches. With the exception of subreach 3.04 of Poplar Creek, the HIs for the adult drinking water ingestion pathway were less than 1.0 and no chemicals of concern were identified. In subreach 3.04, the HI = 1.0 with manganese contributing ~50% of the total hazard. For the child drinking water ingestion pathway, several inorganic contaminants (arsenic, antimony, manganese) and one organic contaminant (PCB-1254) were found to have an individual hazard quotients of greater than 0.1 for this pathway. In addition, within subreach 3.03, the child's hazard index for nitrate was 0.2 for a child. The two contaminants that were the primary drivers of the noncarcinogenic hazard for subreach 3.01 and 3.04 for this pathway are manganese (52% and 48%, respectively) and PCB-1254 (40% and 29%, respectively). For subreach 3.02, manganese contributed 53%, arsenic 31%, and antimony 15% of the HI. For subreach 3.03, manganese contributed 65%, arsenic 18%, and nitrate 12% of the HI. Each of these chemicals (arsenic, antimony, manganese, nitrate, and PCB-1254) are considered to be chemicals of concern for Poplar Creek surface water.

5.4.3.2 Shoreline use pathways

As discussed previously, near-shore sediment data were used to evaluate the shoreline use pathways. As previously defined, the "near-shore" dataset consists of samples collected at elevations greater than 733 ft. No such data are available for Reaches 1 or 7, therefore, the shoreline use pathways were evaluated for subreaches 2.04 - 4.04 only. The risk characterization results for these subreaches are presented in Tables E.42-E.44.

For the subreaches evaluated, the only subreach with a pathway excess cancer risk of greater than 10^{-4} was subreach 3.02 (Table E.42). The ECR for the inhalation pathway for subreach 3.02 was 1.5 x 10^{-4}. The following chemicals had an ECR $>10^{-6}$: chromium, arsenic, ^{234}U, ^{238}U, and ^{235}U.

The only chemical identified as having a HQ of greater than 1.0 for the adult shoreline use sediment pathways was manganese via the inhalation of resuspended sediment. As is evidenced in Table E.43, the HQ for the inhalation of resuspended manganese is greater than 1.0 for all of the subreaches evaluated. As was discussed in Chap. 3, the distribution of manganese in the Clinch River is significantly higher in subreach 2.04, this is also evidenced in a higher HQ for this subreach. This peak concentration of manganese suggests that the K-700 area at the K-25 site is a potential source of manganese to the system.

For the child shoreline use sediment pathways, the only pathway with a HI >1.0 was the inhalation of resuspended sediment. Once again, manganese was identified in all subreaches as the primary driver of the HIs. For all subreaches evaluated, manganese contributed greater than 97% of the HI.

Barium was also found to have a HQ >0.1 for the child inhalation pathway (Table E.44) for all subreaches except 3.01, 4.01, and 4.02, but its relative contribution to the HI was less than 2%.

5.4.3.3 Swimming pathways

The swimming scenario considers the potential risks of exposure to contaminants in water while swimming in the Clinch River and Poplar Creek (Fig. 5.1). The potential routes of exposure while

swimming are dermal contact and inadvertent ingestion of water. Equations and parameter values used in the human health risk assessment for exposure to carcinogens and noncarcinogens in the pathways of the swimming scenario are given in Tables E.14 and E.15.

Carcinogenic and noncarcinogenic chemicals of concern for the Clinch River swimming pathways. No carcinogenic or noncarcinogenic chemicals of concern were determined for the swimming pathways for the Clinch River surface water.

Carcinogenic and noncarcinogenic chemicals of concern for the Poplar Creek swimming pathways. No carcinogenic chemicals of concern were determined for the swimming pathways for the Poplar Creek surface water. A phthalate ester, di-n-octylphthalate was detected in subreach 3.02 at levels that would result in a HQ of 1.6 for an adult and a HQ of 2.4 for a child via dermal contact (Table E.45 and E.46). However, the frequency of detection for this phthalate ester was 1/12. In general, the phthalate esters are common laboratory contaminants and are extensively used as solvents and as plasticizers of synthetic polymers such as polyvinyl chloride and cellulose acetate (Patnaik, 1992). As a result, the phthalate esters are commonly found as environmental contaminants and are, therefore, not considered to have been introduced to the environment solely as a result of activities on the Oak Ridge Reservation. Therefore, for this baseline risk assessment this phthalate ester is not considered to be chemical of concern. In subreach 3.01, one Aroclor, PCB-1254, was determined to have a hazard quotient of 1.1. This PCB will be considered a contaminant of concern.

5.4.3.4 Fish consumption scenario

Nine contaminants detected in fish fillets produced cancer risks $>10^{-6}$ (Table E.47). All species of fish for which Aroclor–1260, a PCB, was analyzed had calculated cancer risks $>10^{-4}$. The excess lifetime cancer risks for this PCB in catfish and striped bass were $>10^{-3}$. The pesticides (aldrin, chlordane, and 4,4'-DDT) are carcinogenic COCs with cancer risks $>10^{-6}$. In addition, the excess cancer risk for 4,4'-DDE, a chemical compound found only in the environment as a degradation product of 4,4'-DDT was also $>10^{-6}$. At one time, these pesticides were commonly used in residential, farming, and industrial areas; therefore, they are not unique to the ORR but are ubiquitous contaminants in eastern Tennessee streams and reservoirs. The remaining carcinogenic contaminants of condern for fish include two inorganics (arsenic and beryllium) and two radionuclides (^{137}Cs and ^{90}Sr). The highest concentrations of the inorganics are found in largemouth bass and catfish. The radionuclides are associated with the ingestion of catfish. With the exception of the pesticides, aldrin, 4,4'-DDT, and 4,4'-DDE all of the aforementioned contaminants will be retained as carcinogenic contaminants of concern.

Noncarcinogenic chemicals of concern (Tables E.48 and E.49) that contributed to a pathway hazard index of greater than 1.0 included several inorganic contaminants (arsenic, mercury, and selenium), two pesticides (chlordane and 4,4-DDT), and PCB-1254. The highest HQs for the fish pathway were for the ingestion of PCB-1254 and chlordane in catfish and striped/hybrid bass by a child.

In interpreting the risk assessment results for this scenario, one important data limitation must be taken into account. One composite sample of bluegill, a species of fish previously not considered to be an effective bioindicator of PCB contamination based on their feeding habits and relatively low lipid content, was collected and analyzed for PCBs in reach 4 only. The excess cancer risk calculated for PCB-1260 in these bluegill was 9.8×10^{-4}, a number well over the EPA risk range of 10^{-6} to 10^{-4}. Currently, existing fishing advisories for the lower WBR and Melton Hill do not apply to bluegill. The lack of sufficient data for this species of fish warrants further investigation and should be incorporated into any subsequent monitoring of the Clinch River.

Because the fish consumption scenario is a significant pathway relative to risks/hazards in the Clinch River and Poplar Creek, a quantitative uncertainty analysis will be performed for the chemicals of concern for this pathway. The results of the uncertainty analysis are contained in Sect. 5.5.

5.4.3.5 Waterfowl consumption

As was discussed previously, the consumption of Canada Geese was evaluated as a current exposure pathway. The analytes evaluated in the Canada Geese were radionuclides, inorganics, and organics. Calculated risks/hazards for the ingestion of Canada Geese (Tables E.50–52) indicate that no carcinogenic or noncarcinogenic chemicals are of concern for this pathway.

5.4.4 Risk Characterization Results for Future Conditions

5.4.4.1 Irrigation scenario

As was previously discussed in Sect. 5.2, six exposure pathways were evaluated in the irrigation scenario. For all pathways evaluated (ingestion, inhalation, and external exposure to irrigated soil and the ingestion of milk, meat, and vegetables produced on irrigated soils) the excess cancer risks calculated for each pathway for each reach within the Clinch River (Table E.53) and all subreaches within Poplar Creek (Table E.56) were all less than 10^{-4}. As a result, no carcinogenic chemicals of concern were determined for these pathways. The only noncarcinogenic contaminant of concern identified for the adult irrigation pathways for the Clinch River reaches was nitrate (Table E.54) via the ingestion of milk from cattle pastured on irrigated soils. Noncarcinogenic chemicals identified as having an HI>1.0 for the child irrigation pathways for the Clinch River (Table E.55) are (1) nitrate via ingestion of milk, meat, and vegetables, (2) arsenic and antimony via ingestion of leafy vegetables, (3) nickel via ingestion of milk, and (4) acetone via ingestion of vegetables.

The only noncarcinogenic contaminants of concern identified for the adult irrigation pathway for the Poplar Creek subreaches are Di-n-octylphthalate (subreach 3.02) and nitrate (subreach 3.03). As previously discussed in Sect. 5.4.3.3, the frequency of detection was 1/12 and the phthalate esters are commonly found as environmental contaminants and are not considered as contaminants of concern in this risk assesment. Noncarcinogenic chemicals identified as having a HI >1.0 for the child irrigation pathways for the Poplar Creek subreaches are shown in Table E.58. The hazard index for the ingestion of milk by a child for Subreaches 3.01 and 3.04 of Poplar Creek indicated that the current concentrations of PCB-1254 when modelled to a concentration in milk produced by cattle grazing on irrigated soil and two inorganics, nitrate and nickel would result in a hazard quotient of greater than 1.0. The hazard index for the ingestion of vegetables grown in irrigated soil indicated that two inorganics (arsenic and nitrate) and one organic (acetone) would result in a HI = 1.0. Lastly, the HI as calculated for the ingestion of beef cattle pastured on irrigated soils indicates that for subreach 3.03 nitrate concentrations result in a HQ>1.0.

5.4.4.2 Dredging scenario

As was previously discussed in Sect. 5.2, seven exposure pathways were evaluated in the dredging scenario. The deep-water sediment data were aggregated into two datasets for risk assessment purposes. The first dataset evaluates the Clinch River reaches 1 and 7, while the second evaluates the following subreaches: 2.04, 3.01, 3.02, 3.03, 3.04, 4.01, 4.02, 4.03, and 4.04.

The excess cancer risks calculated for direct dredging pathways (ingestion, inhalation, external, and dermal) for Clinch River reaches 1 and 7 were less than 10^{-4} for all pathways except external exposure.

In reach 1, ^{60}Co and ^{137}Cs had excess cancer risks via external exposure of 1.3E-04 and 1.2E-05, respectively (Table E.59). Previous discoveries of ^{60}Co in reach 1 have been traced to the former American Nuclear Corporation (ANC), which was located on Braden Branch Creek. Braden Branch Creek discharges to the Melton Hill Reservoir. The ANC was under the jurisdiction of the U.S. Atomic Energy Commission until 1965 at which time the state of Tennessee assumed jurisdiction. The ANC used ^{60}Co as a radiation source for medical instruments between 1962 and 1970. The ANC site is currently listed on the state of Tennessee's Superfund list.

The excess cancer risks calculated for the meat and vegetable ingestion pathways were less than 10^{-4} for both Clinch River reach 1 and 7. The ingestion of milk was greater than 10^{-4} for Clinch River reach 7 only. In reach 7, four PAHs, and two radionuclides (^{90}Sr and ^{137}Cs) were found to have an excess cancer risk of $>10^{-6}$ (Table E.59).

The noncarcinogenic hazards calculated for the Clinch River reaches 1 and 7 (Table E.60) indicate that for the adult dredging pathways exposure to manganese via the sediment inhalation and vegetable ingestion for reach 7 has a HQ >1.0. For the child dredging pathways, the only direct pathway of concern is the inhalation of manganese from resuspended sediments for reach 7. As is discussed in Chap. 3., the highest average surface sediment concentrations of manganese are found in Reaches 7 (McCoy Branch) and 8 (Walker Branch) suggesting an upstream source. Reach 8 is a reference reach and drains a "clean" watershed. This suggests that there is a natural geologic source of manganese in this area. Therefore, in making remedial decisions regarding manganese as a chemical of concern, the risk managers should determine if the concentrations of manganese are to be considered as indicative of naturally occurring background levels. The noncarcinogenic hazard calculated for the child indirect pathways (Table E.61) indicate that exposure to children via the ingestion of meat, milk, and vegetables would pose a potential threat of noncarcinogenic health effects. The chemicals of concern for these pathways are: 4,4'-DDT (milk), arsenic (milk, meat , and vegetables), mercury (vegetables), chromium (meat and vegetables), nickel (milk and vegetables), selenium (milk and meat), zinc (milk, meat, and vegetables), vanadium (milk), manganese (milk and vegetables).

The excess cancer risks calculated (Table E.62) for the direct exposure pathways (ingestion, dermal, inhalation, and external exposure) for the Clinch River and Poplar Creek subreaches indicated that external exposure to ^{137}Cs and ^{60}Co (subreaches 2.04, 3.04, 4.01, 4.03, and 4.04), ^{238}U (subreach 3.04), and ^{90}Sr (subreach 4.04) would result in an pathway excess cancer risk of >10 . In addition, inhalation of resuspended sediments for subreach 3.04 indicate that concentrations of arsenic, chromium, Cadmium, ^{238}U, and ^{234}U could pose an ECR>10^{-6}.

The indirect pathways (ingestion of milk, meat, and vegetables) evaluated for all of the Clinch River and Poplar Creek subreaches indicated that dredging sediments from the deep-water depositional zones and using them as fill for agricultural purposes would pose unacceptable risks/hazards to the public. The majority of carcinogenic contaminants that contribute to unacceptable excess cancer risks (Table E.62) are PAHs. Polycyclic aromatic hydrocarbons [benzo(a)anthracene, benzo(b)fluoranthene, benzo (k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and ideno(1,2,3-cd)pyrene] are natural products produced by forest fires, microbial synthesis, and anthropogenic activities. The levels of PAHs detected in the deep-water sediments of the Clinch River are well below the concentrations of PAHs detected during the Background Soils Characterization Project. Thus, the PAHs are considered to be indicative of background and are not considered to be chemicals of concern. Therefore, the only carcinogenic chemicals of concern identified for the indirect pathways (Table E.62) in the dredging scenario are beryllium (vegetables), ^{137}Cs (milk), ^{90}Sr (milk, meat, and vegetables), ^{99}Tc (milk and vegetables), ^{234}U (milk), ^{238}U (milk), arsenic (milk, meat, and vegetables), and PCB-1260 (milk, meat, and vegetables).

The noncarcinogenic chemicals of concern for the adult and child dredging pathways for the Clinch River and Poplar Creek subreaches are listed in Tables E.63 and E.64. Twelve inorganics and two organics were found to have hazard quotients greater than 0.1 within those pathways having a hazard index of greater than 1.0.

5.4.5 Special Case—Lead

Measurable concentrations of lead were found in sediment from both the Clinch River and Poplar Creek (Table E.5 and E.6); however, EPA toxicity values (RfDs) for lead are not presently available for risk assessment purposes. Although the concentrations of lead in the sediment samples approximated concentrations in background soils (Energy Systems 1993), lead was included in the risk assessment because of the public's concern with lead toxicity. An EPA uptake/biokinetic model (EPA 1991c) was used to evaluate the health risk from exposure to lead. This model uses site-specific, multimedia input values to estimate levels of lead in blood. Young children are more sensitive to lead toxicity than adults; therefore, the model was used to estimate the blood lead levels for a population of children 0-6 years of age. The critical blood lead level for children is 0.010 mg/dL of blood. EPA Region IV considers the population to be at risk if more than 5% of the children have blood lead levels that exceed the critical value.

The model allows for input of lead concentrations for soil, dust, food, and water. Lead concentrations were available for all environmental media in the Clinch River and Poplar Creek with the exception of fish. In addition, modelled concentrations of lead in milk, meat, and vegetables were included. The model allows the programmer to input concentrations of contaminants in water, but has no field for milk input. Therefore, the assumption was made that children drink equal amounts of water and milk and a simple average of the two values (water and milk) was generated and used as a concentration of lead in water. Alternate dietary sources included data for homegrown vegetables and meat. The model input parameters, however, do not include homegrown meat as an alternate dietary source. Therefore, the concentration of lead in meat (beef) was modeled as game meat using 44% as the average proportion (EPA, 1990) and a reasonable maximum proportion of 75% (EPA, 1993) of beef in the diet as homegrown. The concentration of lead in homegrown vegetables has a specific model input as an alternate dietary source; the average proportion of homegrown vegetables in the diet is 25% and the reasonable maximum proportion is 75% (EPA, 1993). The lead concentrations in sediment were modeled as soil; concentrations of lead in household dust were not provided. As a result, multiple source analysis was used to estimate the concentration of lead in household dust with air and soil being contributing factors. Values for dust were based on a 70% conversion of soil to dust and an air to dust conversion of 100 μg Pb in dust/μg Pb/m^3 of air. Default values were used for the concentration of lead in air (0.1 μg Pb/m^3).

. The model was run using both the average and reasonable maximum consumption of homegrown vegetables and beef. The results (Table 5.9) indicate that with the exception of Reaches 1 and 2, that >95% of children 0-6 years of age would have blood lead levels below the 0.010 mg/dL critical value. Thus, no adverse health effects would be expected as a result of exposure to lead for Reaches 3, 4, or 7. For Reach 1, the probability of the blood lead level exceeding 10μg/dL for both the average and maximum exposure to available lead concentrations was greater than the cutoff level of 5%. The frequency of detection for lead in surface water and sediment within Reach 1 was 2/33 and 2/2, respectively. The frequency of detection for lead in surface water within Reach 1 was 6%, just greater than the cutoff of 5%. The small number of samples that were analyzed for lead in Reach 1 sediments should be considered a limiting factor when evaluating these results. However, lead will be listed as a chemical of concern for Reach 1.

Table 5.9. Lead concentrations for the Clinch River and Poplar Creek baseline human health risk assessment

Location	Sediment (µg/g)	Water (µg/L)	Milk (µg/L)	Water/milk[a] (µg/L)	Vegetable[b] (µg/g)	Meat[c] (µg/g)	Fish (µg/L)	PbB Concentration (µg/dL)[d]		Probability of exceedance (%)[e]	
								Avg.	Max.	Avg.	Max.
Reach 1	39	1.8	34	17.9	0.16	0.40	ND	6.1	7.9	13.64	28.52
Reach 2	36	1.7	19	10.4	0.092	0.23	ND	4.3	5.4	3.45	8.79
Reach 3	26	2.1	14	8.1	0.066	0.16	ND	3.5	4.3	1.16	3.45
Reach 4	28	1.5	15	8.3	0.071	0.18	ND	3.7	4.6	1.56	4.42
Reach 7	24	1.7	13	7.4	0.062	0.15	ND	3.3	4.1	0.92	2.70

[a]Average water and milk consumption combined to estimate the average consumption of liquids.
[b]Average consumption of home-grown vegetables i 25%; the reasonable maximum(worst case) consumption is 40% (EPA 1993).
[c]Average consumption of home-grown beef is 44% (EPA 1989a); the reasonable maximum (worst case) consumption is 75% (EPA 1993).
[d]Geometric mean of blood lead level assuming average (Avg.) or maximum (Max.) consumption of homegrown vegetables and beef.
[e]Probability of the blood lead level exceeding 10 µg/dL assuming average (Avg.) or maximum (Mas.) consumption of home-grown vegetables and beef.

For Reach 2, the probability of the blood lead level exceeding 10μg/dL for the maximum exposure to available lead concentrations at 8.79% was slightly greater than the 5% cutoff. The frequency of detection of lead in sediment was 10/10 while the frequency of detection in surface water was 3/27. Thus, lead will also be considered a chemical of concern for Reach 2.

5.4.6 Risk characterization summary

The two scenarios that posed the greatest risk to the public are the fish consumption and the dredging scenarios. The fish ingestion pathway was the most significant exposure pathway in terms of adverse health effects. Fish contained the only contaminants with cancer risks $>10^{-4}$: the PCB mixture, Aroclor–1260, had excess lifetime cancer risks $>10^{-3}$ for the ingestion of channel catfish and striped/hybrid bass and $>10^{-4}$ for largemouth bass. The number of fish samples and their spatial distribution appear to be sufficient to be representative of PCB concentrations in these three species of Clinch River and Poplar Creek fish.

PCBs are known to be released from the ORR; however, it is well documented that many rivers and reservoirs of eastern Tennessee are contaminated with PCBs (TVA 1988). Although past releases from ORR have contributed to the PCB concentrations found in the Clinch River and Poplar Creek, it has not been established that ORR is the major contributor.

Other carcinogenic compounds found in fish tissue with excess cancer risks within the range of concern included several pesticides (Aldrin, Chlordane, 4,4'-DDE, and 4,4'DDT). These pesticides were widely used until the 1970's when their use and production was banned. The widespread use of these pesticides prior to their being banned has resulted in residual levels of these contaminants in the environment. The source of these contaminants in the Clinch River and Poplar Creek is, therefore, unknown and these chemicals will not be considered in any risk management decisions.

Relatively large releases of radionuclides from the ORR have occurred in the past. However, the only scenarios for which radionuclides pose an unacceptable excess cancer risk are the fish consumption, dredging, and shoreline use scenarios. The excess cancer risks for two radionuclides (^{137}Cs, and ^{90}Sr) detected in fish were greater than 10^{-6}.

For the dredging scenario, several radionuclides posed a risk of greater than 10^{-5} for both the direct and indirect pathways evaluated. Cobalt-60 and ^{137}Cs posed an ECR $> 10^{-6}$ for the external exposure to dredged sediment for reach 1. Three isotopes of uranium- , 234, 235, and 238 posed an excess cancer risk of greater than 10^{-6} for the inhalation of resuspended dredged sediment. In addition to the aforementioned radionuclides, ^{90}Sr and ^{99}Tc were also found to contribute to the excess cancer risk for the indirect exposure pathways evaluated as part of the dredging scenario (milk, meat, and vegetable ingestion). One inorganic (beryllium) and one organic (pentachlorophenol) were also detected in samples from the Clinch River and Poplar Creek. Beryllium poses an excess cancer risk of greater than 10^{-5} for the ingestion of meat and an excess cancer risk of greater than 10^{-6} for the ingestion of vegetables pentachlorophenol was infrequently detected, but poses a greater than 10^{-6} excess cancer risk for the ingestion of milk and vegetables produced on dredge spoils.

Mercury, which has been released in large quantities from facilities at the Y-12 Plant into the Clinch River via EFPC and Poplar Creek, produced HQs >1.0 for the ingestion of bluegill, catfish, and largemouth bass by a child. The hazard quotients for several inorganics (arsenic, mercury, and selenium) detected in fish were also determined to pose a noncarcinogenic hazard, mainly via the ingestion of bluegill and largemouth bass.

The milk, meat, and vegetable pathways in the dredging scenario were the most important pathways in terms of health effects for noncarcinogens and also contributed to unacceptable cancer risks; however, the concentrations that were used to calculate the cancer risks and HQs for these foods were modeled concentrations which have a high degree of uncertainty and are usually conservatively biased.

The results of the drinking water ingestion scenario indicate that multiple noncarcinogenic chemicals (arsenic, antimony, manganese, nitrate, and PCB-1254) pose an unacceptable hazard via direct ingestion.

With the exception of the inhalation of resuspended near-shore sediment, the shoreline use scenario does not pose any unacceptable risk to the public. No chemicals of concern were identified for the swimming pathways nor for dermal contact or external exposure to near-shore sediments. The noncarcinogenic chemicals of concern for the shoreline use scenario via the inhalation of resuspended sediments are: barium and manganese. The carcinogenic chemicals of concern are arsenic, chromium, ^{234}U, ^{235}U, and ^{238}U.

No carcinogenic chemicals of concern were determined for the irrigation scenario. Noncarcinogenic chemicals of concern for this scenario are nitrate, arsenic, antimony, nickel, and acetone.

5.5 QUANTITATIVE UNCERTAINTY ANALYSIS

This section presents the results of a quantitative uncertainty analysis in which Monte Carlo simulation was used to propagate the subjective probability distributions for the parameters involved in the risk assessment into a subjective probability distribution for both the excess lifetime cancer risk for carcinogens and the HI for non-carcinogens. The sampling method used for the Monte Carlo simulation was Latin Hypercube Sampling (LHS).

The inputs required for the Monte Carlo simulations are (1) the subjective probability distributions and (2) uncertainty bounds for each parameter presented in the risk assessment (Appendix E). Using various input distributions, a Monte Carlo simulation provides an estimate of the excess lifetime cancer risk or the hazard index in terms of a subjective probability distribution. From this distribution, a subjective confidence interval for the true but unknown result is obtained. The term "subjective confidence interval" means that the probability distributions specified for the uncertain model parameters were derived using subjective judgment in the absence of directly relevant data. The subjective confidence intervals for the excess lifetime cancer risks and the hazard indices are presented in this section.

In addition to the subjective confidence intervals, the results of a sensitivity analysis are also presented in this section. A sensitivity analysis permits the identification of the parameter having the greatest effect on the total result. In this case, the sensitivity analysis was accomplished by using the square of the Spearman rank correlation coefficients adjusted to 100% (Decisioneering, Inc., 1994). The results obtained for each parameter were compared and ranked according to the amount of influence the parameter had on the uncertainty in the result. The parameters having the greatest effect are considered to be the most sensitive. Although not employed in this analysis, scatter plots of the input parameters and statistical regression techniques are other methods of performing sensitivity analyses. [Descriptions of statistical approaches to sensitivity analysis using regressions of the randomly selected values of the uncertain parameters on the values produced for the model predictions can be found in Iman et al. (1981a; 1981b), IAEA (1989), and Iman and Helton (1991).]

5.5.1 Analysis for the Fisherman Scenario

For the fish ingestion pathway, selected radionuclides and chemicals were identified for use in the quantitative uncertainty analysis. The contaminants given priority for the uncertainty analysis were determined by considering several factors: (1) adequacy of data, (2) contributing sources of contamination, and (3) the risk estimated in the baseline risk assessment. The contaminant was included in the uncertainty analysis if the following conditions were met: if the data were considered adequate, if the contaminant was released by DOE facilities, and if the 10^{-4} risk level was exceeded or if the HQ was above 1 for the child or the adult in the baseline risk assessment. The risk estimates from the baseline risk assessment that meet the above criteria are listed for each contaminant in Table 5.10 for noncarcinogens and Table 5.11 for carcinogens. The contaminants analyzed in the uncertainty analysis for the fish ingestion pathway were ^{137}Cs, Aroclor-1260, Aroclor-1254, chlordane, and methyl mercury.

The uncertainties involved with the slope factors for Aroclor-1260, ^{137}Cs, and chlordane, and with the reference doses for methyl mercury were propagated through the uncertainty analysis.

Table 5.10. Noncarcinogenic chemicals of concern for the fish ingestion pathway

			Risk Estimate	
Pathway	**Contaminant**	**Reach**	**Adult**	**Child**
Bluegill	Mercury	3	1.1	2.8
		4	—	1.2
Largemouth bass	Mercury	2	—	1.8
		3	1.8	4.7
		4	—	2.2
	Chlordane	2	—	2.3
		3	—	2.5
		4	—	2.3
	Aroclor-1254	2	6.8	18
		3	14	35
		4	8.1	21
Catfish	Mercury	4	—	1.9
	Chlordane	1	4.2	11
		2	2.6	6.7
		3	1.2	3
		4	1.6	4.2
	Aroclor-1254	1	4.2	11
		2	24	61
		3	14	35
		4	20	52
Striped/hybrid bass	Chlordane	2	1.8	4.7
		4	1.3	3.5
	Aroclor-1254	2	23	59
		4	18	47

Table 5.11. Carcinogenic chemicals of concern for the fish ingestion pathway.

Contaminant	Pathway	Reach	Risk Estimate
PCB-1260	*Catfish*	1	9.0E-04
		2	2.8E-03
		3	1.9E-03
		4	2.1E-03
	Largemouth Bass	2	4.7E-04
		3	9.2E-04
		4	5.9E-04
	Striped/hybrid Bass	2	1.1E-03
		4	1.9E-03
	Bluegill	4	9.8E-04
Chlordane	*Catfish*	1	1.4E-04
^{137}Cesium	*Largemouth Bass*	2	1.5E-04

5.5.1.1 Subjective confidence intervals obtained for the excess lifetime cancer risk from select radionuclides and carcinogenic chemicals

The uncertainties associated with the parameters in the risk assessment equations for the fish ingestion pathway are discussed in Appendix E. The uncertainties for each parameter were propagated using 500 iterations of LHS to obtain subjective probability distributions for the excess lifetime cancer risk associated with human ingestion of fish from the Clinch River and Poplar Creek which are contaminated with ^{137}Cs, Aroclor-1260, and chlordane. The excess lifetime cancer risks from ^{137}Cs, Aroclor-1260, and chlordane are analyzed for the adult only. From these distributions, the medians, the lower 5% subjective confidence limits (LCLs), and the 95% UCLs were obtained.

The subjective confidence intervals for the excess lifetime cancer risk resulting from the contamination of ^{137}Cs are summarized in Table 5.12. The median risk for ^{137}Cs in largemouth bass is 9.3E-05, and there is 90% confidence that the true but unknown risk lies between 1.5E-05 and 6.2E04.

The subjective confidence interval given in Table 5.12 provides valuable information that can be used to guide decision-making. For example, if a 5% LCL is above a regulatory standard of concern, then remediation is most likely needed. If the 95% confidence limit is below the standard, remediation is most likely not required. If the 95% UCL is above the standard, but the 50th percentile is below the standard, further study should be recommended for those parameters which dominate the overall uncertainty. However, if the 50th percentile is above the standard, further study may still be recommended. The decision as to whether or not to proceed with remediation will be driven by a cost versus benefits analysis. Because the 95% UCL is above the regulatory standard of concern, but the median value is

below the standard, further study should be recommended for those parameters which dominate the overall uncertainty.

Table 5.12. Results obtained for the excess lifetime cancer risk from ^{137}Cesium in the Clinch River and Poplar Creek

Species	Radionuclide	5% Subjective Confidence Limit	Median	95% Subjective Confidence Limit
Largemouth Bass	^{137}Cesium	1.5E-05	9.3E-05	6.2E-04

The subjective confidence intervals for the excess lifetime cancer risk resulting from Aroclor-1260 and chlordane are summarized in Table 5.13. The median risk for Aroclor-1260 in the catfish of Reach 1, for instance, is 2.4E-04; there is 90% confidence that the true but unknown risk lies between 5.6E-05 and 8.4E-04 (or there is 95% confidence that the true but unknown value does not exceed 8.4E-04).

Table 5.13. Results obtained for the excess lifetime cancer risk from select carcinogenic chemical contaminants in the Clinch River and Poplar Creek

Reach	Species	Contaminant	5% Subjective Confidence Limit	Median	95% Subjective Confidence Limit
1	Catfish	Aroclor-1260	5.6E-05	2.4E-04	8.4E-04
	Catfish	Chlordane	1.4E-05	8.6E-05	4.2E-04
	Total Risk*		8.8E-05	3.5E-04	1.2E-03
2	Largemouth Bass	Aroclor-1260	3.1E-05	1.5E-04	5.0E-04
	Catfish	Aroclor-1260	2.1E-04	8.2E-04	2.9E-03
	Striped/Hybrid Bass	Aroclor-1260	7.8E-05	3.2E-04	1.1E-03
3	Largemouth Bass	Aroclor-1260	6.3E-05	2.9E-04	1.0E-03
	Catfish	Aroclor-1260	1.4E-04	5.6E-04	2.1E-03
4	Largemouth Bass	Aroclor-1260	3.9E-05	1.7E-04	5.6E-04
	Catfish	Aroclor-1260	1.6E-04	6.9E-04	2.3E-03
	Striped/Hybrid Bass	Aroclor-1260	1.3E-04	5.8E-04	1.9E-03

* The values for the total risk will not be directly additive because of the random process used for error propagation.

The highest potential excess lifetime cancer risk results from eating fish contaminated with Aroclor-1260. The subjective confidence intervals given in Table 5.13 provide valuable information that can be used to guide decision-making. For example, since the 5% lower confidence limit is above a 10^{-4} life-time

cancer risk for the catfish in Reaches 2, 3, and 4, and for the striped/hybrid bass in Reach 4, it would be recommended that warning signs be posted near these reaches. For all species and reaches studied, the median values for Aroclor-1260 exceed the 10^{-4} life-time cancer risk. Again, these results indicate the need for action (provided that 10^{-4} is to be used as an action limit and that the evidence for carcinogenicity of PCB's in animals is applicable to human populations).

5.5.1.2 Results of the sensitivity analysis for carcinogens

A sensitivity analysis was performed for the "Total Excess Lifetime Cancer Risk" for fish ingestion. The method used for this sensitivity analysis was to square the Spearman rank correlation coefficients of each parameter and normalize them to 100% (Decisioneering, Inc., 1994). From this method, an approximate percentage of the parameter's contribution to the overall uncertainty is obtained. These percentages are referred to as the "sensitivity index" (SI) of the parameter. The higher the SI, the more important the parameter is to the overall uncertainty.

The top sensitivity indices for the total risk resulting from ^{137}Cs contaminated largemouth bass are presented in Table 5.14. The sensitive parameters are ranked according to priority for further study.

Table 5.14. Results obtained for the sensitivity analysis performed for excess lifetime risk from ^{137}Cs contamination associated with the human ingestion of fish from the Clinch River and Poplar Creek

Species	Sensitive Parameter	Sensitivity Index	Rank
Largemouth Bass	I_f: meal/day	35.3 %	1
	Cf: Bq/kg	26.5 %	2
	RCF: risk/Sv	23.6 %	2

The most sensitive parameters for lifetime cancer risk from ^{137}Cs are (1) the number of fish-meals per day, (2) the concentration of ^{137}Cs in largemouth bass for Reach 2, and (3) the risk conversion factor. These results indicate that the uncertainty involved with the excess lifetime cancer risk from the human ingestion of fish from the Clinch River and Poplar Creek would be most effectively lowered by taking local surveys of consumption patterns, etc., rather than further sampling of fish. Such surveys would aid in the development of more definitive estimates of subjective confidence intervals for the number of fish-meals per day, the exposure duration, and the amount of fish eaten per fish-meal. For example, if the number of fish-meals per day were known exactly, then the uncertainty in the overall excess lifetime cancer risk would be decreased by almost a factor of two.

The uncertainty in the overall excess lifetime cancer risk is also very sensitive to the concentration of ^{137}Cs in largemouth bass for Reach 2 and the risk conversion factor. The only method of decreasing the uncertainty of the concentration would be to obtain more fish samples. In addition, until better estimates of the cancer risk at high dose and high dose rate exposures and/or significant data at low dose and low dose rate exposures are obtained, it is unlikely that the uncertainty in the risk conversion factor for radionuclides can be lowered.

The top three sensitivity indices for the total risk resulting from Aroclor-1260 and chlordane contaminated fish are presented in Table 5.15. The sensitive parameters are ranked according to priority for further study.

Table 5.15. Results obtained for the sensitivity analysis performed for the Total Cancer Risk from select carcinogens associated with the human ingestion of fish from the Clinch River and Poplar Creek

Species	Sensitive Parameter	Sensitivity Index	Rank
Catfish (Reach 1)	I_f: meal/day	64.4 %	1
	I_{ar}: kg/meal	12.5%	2
	Aroclor-1260 SF: (mg/kg-day)$^{-1}$	11.8%	2

The most sensitive parameter for the total excess lifetime cancer risk from select carcinogenic chemicals for catfish in Reach 1 are consistent with the risks from other reaches and species. This parameter is the number of fish-meals per day. The overall estimate of uncertainty was moderately sensitive to the amount of fish eaten per meal and the Aroclor-1260 slope factor.

These results agree with the results obtained for the radionuclide analysis. The uncertainty involved with the excess lifetime cancer risk from the human ingestion of fish from the Clinch River and Poplar Creek would be most effectively lowered by taking local surveys of fish consumption patterns, etc., rather than taking further samples of fish.

5.5.1.3 Subjective confidence intervals obtained for the HI from select non-carcinogenic chemicals

The uncertainties associated with the parameters in the risk assessment equations for the fish ingestion pathway are discussed in Appendix E. The uncertainties for each parameter were propagated using 500 iterations of LHS to obtain subjective probability distributions for the health hazard associated with human (adults and children) ingestion of fish from the Clinch River and Poplar Creek which are contaminated with methyl mercury, chlordane, and Aroclor-1254. From these distributions, the medians, the 5% LCLs, and the 95% UCLs were obtained.

The subjective confidence intervals obtained for the health risk to adults from the fish are summarized in Table 5.16. The median HQ for chlordane in the catfish of Reach 1 for adults, for instance, is 1.9; there is 90% confidence that the true but unknown HQ lies between 0.1 and 22.5 (or there is 95% confidence that the true but unknown value does not exceed 22.5). The subjective confidence intervals obtained for the health risk to children from the fish are summarized in Table 5.17. The median HQ for chlordane in the catfish of Reach 1 for children, for instance, is 1.6; there is 90% confidence that the true but unknown HQ lies between 0.1 and 40.7.

The highest potential HI for children occurs from the catfish of Reach 4 with a median of 7.5. There is 95% subjective confidence, given the assumptions used in this analysis, that the true but unknown total HI for children from non-carcinogens in catfish does not exceed 66.6.

The wide ranges of the HQs for chlordane in all of the species are primarily due to the large uncertainty associated with its RfD. The subjective confidence intervals given in Tables 5.16 and 5.17 provide valuable information that can be used to guide decision-making. For example, if a 5% LCL is above a regulatory standard of concern, then remediation is most likely needed. If the 95% UCL is below the standard, remediation is most likely not required. If the 95% UCL is above the standard, but the 50th percentile is below the standard, further study should be recommended for the parameters that dominate the overall uncertainty. However, if the 50th percentile is above the standard, further study may still be recommended, although under some circumstances it may be prudent to proceed with remediation. In all cases, the 95% UCL exceeds an HQ of 1.0 for both adults and children, indicating need for further study.

Table 5.16. Results obtained for the hazard quotients for adults from select non-carcinogenic chemical contaminants in the Clinch River and Poplar Creek

Reach	Species	Contaminant	5% Subjective Confidence Limit	Median	95% Subjective Confidence Limit
1	Catfish	Chlordane	0.1	1.9	22.5
	Catfish	Aroclor-1254	0.1	0.7	4.8
	Total HI[a]		0.3	3.0	23.7
2	Largemouth bass	Mercury	0.1	0.8	8.0
	Largemouth bass	Chlordane	0.1	1.6	18.6
	Largemouth bass	Aroclor-1254	0.1	1.0	6.9
	Total HI[a]		0.7	4.5	25.8
	Catfish	Chlordane	0.1	1.1	13.0
	Catfish	Aroclor-1254	0.5	4.2	28.8
	Total HI[a]		1.0	6.1	38.8
	Striped/hybrid bass	Chlordane	0.1	0.8	9.0
	Striped/hybrid bass	Aroclor-1254	0.4	3.2	24.6
	Total HI[a]		0.8	4.7	31.3
3	Bluegill	Mercury	0.1	1.2	12.2
	Largemouth bass	Mercury	0.2	1.7	19.5
	Largemouth bass	Chlordane	0.0	0.4	4.5
	Largemouth bass	Aroclor-1254	0.3	1.9	15.5
	Total HI[a]		0.8	5.2	31.8
	Catfish	Chlordane	0.0	0.5	5.4
	Catfish	Aroclor-1254	0.2	1.9	14.0
	Total HI[a]		0.5	2.8	18.5
4	Bluegill	Mercury	0.0	0.4	4.7
	Largemouth bass	Mercury	0.1	0.8	8.9
	Largemouth bass	Chlordane	0.0	0.4	4.3
	Largemouth bass	Aroclor-1254	0.2	1.2	8.2
	Total HI[a]		0.5	3.1	17.0
	Catfish	Mercury	0.1	1.5	17.5
	Catfish	Chlordane	0.1	0.7	7.6
	Catfish	Aroclor-1254	0.5	3.6	29.2
	Total HI[a]		1.1	6.8	48.1
	Striped/hybrid bass	Chlordane	0.0	0.6	6.4
	Striped/hybrid bass	Aroclor-1254	0.3	2.7	19.4
	Total HI[a]		0.6	3.7	25.2

[a]The values for the total risk will not be directly additive because of the random process used for error propagation.

Table 5.17. Results obtained for the hazard quotients for children from select non-carcinogenic chemical contaminants in the Clinch River and Poplar Creek

Reach	Species	Contaminant	5% Subjective Confidence Limit	Median	95% Subjective Confidence Limit
1	Catfish	Chlordane	0.1	1.6	40.7
	Catfish	Aroclor-1254	0.1	0.6	5.0
	Total HI[a]		0.3	3.0	44.1
2	Largemouth bass	Mercury	0.1	0.9	8.8
	Largemouth bass	Chlordane	0.1	1.3	32.2
	Largemouth bass	Aroclor-1254	0.1	1.0	8.5
	Total HI[a]		0.7	5.2	38.8
	Catfish	Chlordane	0.1	1.0	22.8
	Catfish	Aroclor-1254	0.6	4.3	31.8
	Total HI[a]		1.0	6.7	44.1
	Striped/hybrid bass	Chlordane	0.0	0.7	14.9
	Striped/hybrid bass	Aroclor-1254	0.5	3.3	26.5
	Total HI[a]		0.8	5.0	35.8
3	Bluegill	Mercury	0.1	1.2	13.2
	Largemouth bass	Mercury	0.2	1.9	20.0
	Largemouth bass	Chlordane	0.0	0.4	7.6
	Largemouth bass	Aroclor-1254	0.3	2.1	15.5
	Total HI[a]		1.0	5.7	35.4
	Catfish	Chlordane	0.0	0.4	8.7
	Catfish	Aroclor-1254	0.3	2.0	15.3
	Total HI[a]		0.5	3.0	20.9
4	Bluegill	Mercury	0.1	0.4	5.1
	Largemouth bass	Mercury	0.1	0.9	9.9
	Largemouth bass	Chlordane	0.0	0.3	7.4
	Largemouth bass	Aroclor-1254	0.2	1.2	9.3
	Total HI[a]		0.6	3.5	20.6
	Catfish	Mercury	0.1	1.3	33.4
	Catfish	Chlordane	0.0	0.6	12.9
	Catfish	Aroclor-1254	0.5	3.8	26.4
	Total HI[a]		1.1	7.5	66.6
	Striped/hybrid bass	Chlordane	0.0	0.5	11.0
	Striped/hybrid bass	Aroclor-1254	0.4	2.7	20.6
	Total HI[a]		0.7	4.0	29.2

[a] The values for the total risk will not be directly additive because of the random process used for error propagation.

5.5.1.4 Results of the sensitivity analysis for select non-carcinogens

A sensitivity analysis was performed for each "Total Hazard Index" for each species of fish. The top sensitivity indices for the total HI in largemouth bass in Reach 3 for adults are presented in Table 5.18. The sensitive parameters are ranked according to priority for further study.

Table 5.18. Results obtained for the sensitivity analysis performed for the Total HI from select non-carcinogen contamination associated with the adult ingestion of fish from the Clinch River and Poplar Creek

Species	Sensitive Parameter	Sensitivity Index	Rank
LMB (Reach 3)	*I*: meal/day	62.3 %	1
	Mercury RfD: mg/kg-day	14.2%	2
	Aroclor-1254 RfD: mg/kg-day	10.1 %	2
	Im: kg/meal	6.3%	3

The two most sensitive parameters for the total HI from large mouth bass are the number of fish-meals per day and the RfD for Aroclor-1254 and methyl mercury. These results indicate that the uncertainty involved with the total HI from the human ingestion of fish from the Clinch River and Poplar Creek would be most effectively lowered by taking local surveys of consumption patterns and by further analysis of the RfD for PCBs and methyl mercury, rather than further sampling of fish. The uncertainty in the overall HI was almost dominated by the number of fish-meals per day.

A parameter that does not show up as a sensitive parameter is the contaminant concentration in fish. The statistical analyses that were performed on the data show a relatively small uncertainty for the majority of the contaminants and reaches. In most cases, the uncertainty seems too small (1.09 uncertainty factor). Because of these small uncertainty estimates that are not consistent with the standard deviations which would be expected, the concentration of the contaminant in fish should also be considered as a parameter for future study.

5.5.1.5 Conclusions for the fish ingestion pathway

The following conclusions can be drawn from the quantitative uncertainty analysis on the risk of adverse health effects resulting from the ingestion of select radionuclide- and chemical-contaminated fish from Clinch River and Poplar Creek.

- Because the total hazard quotients for all contaminants and fish exceeds the recommended level of 1.0 at the 95% subjective confidence limit as well as at the median value in many cases for children and adults, further study of the toxic effects from chlordane, Aroclor-1254, and mercury is recommended. The large uncertainty in the hazard quotients for chlordane result in part from the uncertainty in the reference dose.

- The highest potential excess lifetime cancer risk from carcinogenic chemicals results from Aroclor-1260. Because the median values exceed 10^{-4} risk for each of the species and reaches studied for each carcinogen, further study is recommended for chlordane and Aroclor-1260.

- Results of the sensitivity analysis indicate that the overall estimate of uncertainty in the total risk estimates would be most efficiently reduced by taking local surveys to obtain better estimates for the numbers of fish-meals eaten per week and the amount of fish eaten per meal for the avid fisherman.

5.5.2 Analysis for the Dredging Scenario Resulting from Contaminated Deep Sediment

The contaminants given priority for the uncertainty analysis were determined by considering the following factors: (1) adequacy of data, (2) contributing sources of contamination, and (3) the risk estimated in the baseline risk assessment. The contaminant was included in the uncertainty analysis if the following conditions were met: if the data was considered adequate, if the contaminant was released by DOE facilities, and if the 10^{-4} risk level was exceeded or if the HQ was greater than 1 for adults in the baseline risk assessment. The noncarcinogenic contaminant and radionuclide identified on the basis of these criteria for the uncertainty analysis for the dredging pathway was inorganic mercury and ^{137}Cs, respectively. The reaches of concern are shown in Table 5.19.

Table 5.19. Contaminants of concern for the dredging pathway

Pathway	Contaminant	Reach	Risk Estimate	
			Adult	Child
Milk	Mercury	3.04	1.3	13
Meat	Mercury	3.04	2.6	12
Vegetables	Mercury	3.04	7.1	33
External	^{137}Cesium	2.04	2.7E-04	
	^{137}Cesium	3.04	1.0E-04	
	^{137}Cesium	4.03	2.3E-04	

Although concern from Aroclor-1254 is shown in the dredging scenario of the baseline risk assessment calculations, there was insufficient data information to bound the uncertainty in the sediment concentration for this contaminant. This was due in large part to the aggregation of the data into subreaches. Therefore, Aroclor-1254 was not considered in the uncertainty analysis.

5.5.2.1 Subjective confidence intervals obtained from the uncertainty analysis for inorganic mercury

The uncertainties associated with the parameters in the risk assessment equations for the dredging scenario are discussed in Appendix E. The uncertainties for each parameter were propagated using 500 iterations of LHS to obtain subjective probability distributions for the hazard quotient associated with dredging deep sediments from the Clinch River and Poplar Creek that are contaminated with inorganic mercury. From these distributions, the medians, the 5% LCLs, and the 95% UCLs were obtained.

The subjective confidence intervals for the adult are summarized in Table 5.20, and the subjective intervals for children are presented in Table 5.21. The median risk for the ingestion of milk from mercury, for instance, is 0.09, there is 90% confidence that the true but unknown risk lies between 0.01 and 2.25 (or there is 95% confidence that the true but unknown value does not exceed 2.25).

Table 5.20. Results obtained for the excess health risk to adults from select noncarcinogenic contamination in deep sediments of the Clinch River and Poplar Creek

Reach	Pathway	Contaminant	5% Subjective Confidence Limit	Median	95% Subjective Confidence Limit
3.04	Milk	Mercury	0.01	0.09	2.25
	Meat	Mercury	0.59	5.89	287.27
	Leafy Vegetables	Mercury	0.24	2.35	68.10
	Non-Leafy Vegetables	Mercury	0.13	1.96	43.95

Table 5.21. Results obtained for the excess health risk to children from select noncarcinogenic contamination in deep sediments of the Clinch River and Poplar Creek

Reach	Pathway	Contaminant	5% Subjective Confidence Limit	Median	95% Subjective Confidence Limit
3.04	Milk	Mercury	0.05	0.48	18.48
	Meat	Mercury	1.54	15.28	338.69
	Leafy Vegetables	Mercury	0.61	5.99	126.11
	Non-Leafy Vegetables	Mercury	0.24	3.57	74.18

The subjective confidence intervals given in Table 5.20 and Table 5.21 provide valuable information that can be used to guide decision-making. For example, if a 5% LCL is above a regulatory standard of concern, then remediation is most likely needed. If the 95% UCL is below the standard, remediation is most likely not required. If the 95% UCL is above the standard, but the 50th percentile is below the standard, further study should be recommended for those parameters which dominate the overall uncertainty (milk pathways). However, if the 50th percentile is above the standard, further study may still be recommended. The decision as to whether or not to proceed with remediation will be driven by a cost versus benefits analysis.

5.5.2.2. Results of the sensitivity analysis for the dredging scenario for inorganic mercury

A sensitivity analysis was performed for the different pathways. The method used for this sensitivity analysis was to square the Spearman rank correlation coefficients of each parameter and normalize them to 100% (Decisioneering, Inc., 1994). From this method, an approximate percentage of the parameter's contribution to the overall uncertainty is obtained. These percentages are referred to as the SI of the parameter. The higher the SI, the more important the parameter is to the overall uncertainty.

The top sensitivity indices for the risk from dredging deep sediments in the Clinch River and Poplar Creek which are contaminated with inorganic mercury are presented in Table 5.22. The sensitive parameters are ranked according to priority for further study.

Table 5.22. Results obtained for the sensitivity analysis performed for total excess health risk from mercury contamination associated with the dredging scenario from the Clinch River and Poplar Creek

Pathway	Sensitive Parameter	Sensitivity Index	Rank
Milk	$B_{v,\,past}$	30.1%	1
	F_m	25.0%	2
	RfD (mercury)	19.9%	3
	C_{sed}	14.1%	4
Meat	$B_{v,\,past}$	36.9%	1
	RfD (mercury)	23.8%	2
	C_{sed}	16.5%	3
	F_f	12.8%	4
Vegetables	RfD (mercury)	38.5%	1
	B_v	34.2%	1
	C_{sed}	18.5%	2

The top four sensitive parameters for the uncertainty are the uncertainty in the soil-to-plant uptake factor for pasture, the RfD for mercury, the milk and meat uptake factors, and the sediment concentration data. Uncertainty in the estimate of risk for inorganic mercury in deep sediments (if the deep sediment is dredged) could be dramatically reduced with more information pertaining to these parameters. A very large source of uncertainty for the transfer factors is the lack of knowledge about the solubility of mercury and lack of knowledge about its chemical form.

5.5.2.3 Subjective confidence intervals obtained from the uncertainty analysis for ^{137}Cs

The uncertainties associated with the parameters in the risk assessment equations for the dredging scenario are discussed in Appendix E. The uncertainties for each parameter were propagated using 500 iterations of LHS to obtain subjective probability distributions for the excess lifetime cancer risk associated with dredging deep sediments from the Clinch River and Poplar Creek that are contaminated with inorganic mercury. From these distributions, the medians, the 5% LCLs, and the 95% UCLs were obtained.

The subjective confidence intervals for the adult are summarized in Table 5.23. The median risk for the external exposure from ^{137}Cesium, for instance, is 1.1E-04, there is 90% confidence that the true but unknown risk lies between 1.0E-05 and 7.2E-04 (or there is 95% confidence that the true but unknown value does not exceed 7.2E-04).

Table 5.23. Results obtained for the excess health risk to adults from ^{137}Cs contamination in deep sediment of the Clinch River and Poplar Creek

Reach	Pathway	Contaminant	5% Subjective Confidence Limit	Median	95% Subjective Confidence Limit
2.04	External	^{137}Cesium	1.0E-05	1.1E-04	7.2E-04
3.04	External	^{137}Cesium	6.1E-06	8.1E-05	4.7E-04
4.03	External	^{137}Cesium	9.6E-06	5.2E-05	2.4E-04

The subjective confidence intervals given in Table 5.23 provides valuable information that can be used to guide decision-making. For example, if a 5% LCL is above a regulatory standard of concern, then remediation is most likely needed. If the 95% UCL is below the standard, remediation is most likely not required. If the 95% UCL is above the standard, but the 50th percentile is below the standard, further study should be recommended for those parameters which dominate the overall uncertainty (Reaches 3.04 and 4.03). However, if the 50th percentile is above the standard, further study may still be recommended (Reach 2.04). The decision as to whether or not to proceed with remediation will be driven by a cost versus benefits analysis.

5.5.2.4. Results of the sensitivity analysis for the dredging scenario for ^{137}Cs

A sensitivity analysis was performed for the different pathways. The method used for this sensitivity analysis was to square the Spearman rank correlation coefficients of each parameter and normalize them to 100% (Decisioneering, Inc., 1994). From this method, an approximate percentage of the parameter's contribution to the overall uncertainty is obtained. These percentages are referred to as the SI of the parameter. The higher the SI, the more important the parameter is to the overall uncertainty.

The top sensitivity indices for the total risk from dredging deep sediments in the Clinch River and Poplar Creek which are contaminated with ^{137}Cs are presented in Table 5.24. The sensitive parameters are ranked according to priority for further study.

Table 5.24. Results obtained for the sensitivity analysis performed for total excess health risk from ^{137}Cs contamination associated with the dredging scenario from the Clinch River and Poplar Creek

Pathway	Sensitive Parameter	Sensitivity Index	Rank
External (Reach 2.04)	C_{sed} (sediment concentration)	38.4%	1
	RCF (Risk Conversion Factor)	21.2%	2
	D_1 (dilution factor)	9.6%	3
External (Reach 3.04)	C_{sed} (sediment concentration)	38.5%	1
	RCF (Risk Conversion Factor)	22.2%	2
	λeff	10.7%	3
External (Reach 4.03)	RCF (Risk Conversion Factor)	31.7%	1
	External Exposure Frequency	15.3%	2
	λeff	14.4%	2

The top three sensitive parameters for the uncertainty are the uncertainties in the: (1) ^{137}Cs concentration data, (2) the risk conversion factor (RCF), and (3) the external exposure frequency. The uncertainty in the estimate of the excess lifetime cancer risk would be most effectively reduced by taking additional samples in order to reduce the uncertainty in the sediment concentration.

5.5.2.5. Conclusions for the dredging scenario

The uncertainty analysis conducted for the dredging scenario verifies the results of the baseline risk assessment (i.e., that ^{137}Cs and mercury in the deep sediment are contaminants of potential concern). Further study is recommended for both contaminants. Additional sediment samples would improve the uncertainty associated with the risk estimates of both contaminants. Finally, caution should be used when interpreting the estimates of the HQ for inorganic mercury because of the lack of knowledge about the solubility of mercury in deep sediment.

5.6 DEVELOPMENT OF REMEDIAL GOAL OPTIONS

The EPA (Region IV) has requested that each baseline risk assessment include a section which outlines the remedial goal options (RGOs) for the chemicals and media of that have been identified. Typically, this sections includes both ARARs and health-based cleanup goals, but for the purpose of this report the ARARs have been presented in Chap. 4.

Remedial goal options are chemical-specific, medium-specific numerical concentration limits that are identified for all contaminants and all pathways found to be of concern during the baseline human health risk assessment process. Remedial goal options are not the first or the final set of clean-up levels in the CERCLA process, but can be viewed as modified preliminary remediation goals based on site characterization and the baseline risk assessment findings.

Remedial goal options for the Clinch River and Poplar Creek were established based on the exposure parameters and equations used to perform the risk assessment. No modifications were made to the parameter values. Risk/hazard-based concentrations were back-calculated for each chemical and pathway identified as a concern and are presented in Tables 5.25–5.31. For the carcinogenic chemicals of concern, the RGOs were calculated based on an ECR of 10^{-4}, 10^{-5}, and 10^{-6}. For the noncarcinogenic chemicals of concern, the RGOs were calculated based on an individual hazard quotient of 0.1, 1.0, and 10. The purpose of the RGOs is to provide the risk managers with the maximum risk-related media level options on which to develop remedial alternatives.

Table 5.25. Remedial goal options for the carcinogenic chemicals and pathways of concern for soil for the dredging scenario

Pathway	Chemical	RGOs based on an ECR = 10-4	RGOs based on an ECR = 10-5	RGOs based on an ECR = 10-6	Units of measure
External exposure	^{60}Cobalt	4.60E+00	4.60E-01	4.60E-02	pCi/g
	^{137}Cesium	7.84E+00	7.84E-01	7.84E-02	pCi/g
	^{238}Uranium	2.29E+02	2.29E+01	2.29E+00	pCi/g
Inhalation of resuspended sediments	Arsenic	6.34E+01	6.34E+00	6.34E-01	mg/kg
	Cadmium	5.19E+02	5.19E+01	5.19E+00	mg/kg
	Chromium	7.73E+01	7.73E+00	7.73E-01	mg/kg
	^{234}Uranium	1.27E+02	1.27E+01	1.27E+00	pCi/g
	^{238}Uranium	1.43E+02	1.43E+01	1.43E+00	pCi/g
Ingestion of milk produced by cattle pastured on dredged sediments	^{137}Cesium	4.18E+01	4.18E+00	4.18E-01	pCi/g
	^{90}Strontium	2.48E+01	2.48E+00	2.48E-01	pCi/g
	^{99}Technetium	1.58E+03	1.58E+02	1.58E+01	pCi/g
	^{234}Uranium	8.49E+02	8.49E+01	8.49E+00	pCi/g
	^{238}Uranium	5.90E+02	5.90E+01	5.90E+00	pCi/g
	Arsenic	3.01E+02	3.01E+01	3.01E+00	mg/kg
	Pentachlorophenol	3.45E+01	3.45E+00	3.45E-01	mg/kg
	PCB-1260	3.10E-02	3.10E-03	3.10E-04	mg/kg

Table 5.25 (continued)

Pathway	Chemical	RGOs based on an ECR = 10-4	RGOs based on an ECR = 10-5	RGOs based on an ECR = 10-6	Units of measure
Ingestion of beef grazed on pasture forage produced on dredged sediments	^{137}Cesium	7.64E+01	7.64E+00	7.64E-01	pCi/g
	^{90}Strontium	8.67E+01	8.67E+00	8.67E-01	pCi/g
	Arsenic	1.01E+02	1.01E+01	1.01E+00	mg/kg
	PCB-1260	1.10E-01	1.10E-02	1.10E-03	mg/kg
Ingestion of vegetables produced on dredged sediments	^{137}Cesium	3.50E+02	3.50E+01	3.50E+00	pCi/g
	^{99}Technetium	6.80E+01	6.80E+01	6.80E+00	pCi/g
	^{90}Strontium	2.80E+01	2.80E+01	2.80E+00	pCi/g
	Arsenic	1.24E+02	1.24E+01	1.24E+00	mg/kg
	Pentachlorophenol	3.75E+02	3.75E+01	3.75E+00	mg/kg
	PCB-1260	1.87E+01	1.87E+00	1.87E-01	mg/kg

Table 5.26. Remedial goal options for the carcinogenic chemicals and pathways of concern for near-shore sediment for the shoreline use scenario

Pathway	Chemical	RGOs based on an ECR = 10-4	RGOs based on an ECR = 10-5	RGOs based on an ECR = 10-6	Units of measure
Shoreline use: inhalation	Arsenic	1.27E+02	1.27E+01	1.27E+00	mg/kg
	Chromium	1.55E+02	1.55E+01	1.55E+00	mg/kg
	^{234}Uranium	2.53E+02	2.53E+01	2.53E+00	pCi/g
	^{235}Uranium	2.73E+02	2.73E+01	2.73E+00	pCi/g
	^{238}Uranium	2.86E+02	2.86E+01	2.86E+00	pCi/g

Table 5.27. Remedial goal options for the carcinogenic chemicals and pathways of concern for fish tissue for the fish ingestion scenario

Pathway	Chemical	RGOs based on an ECR = 10-4	RGOs based on an ECR = 10-5	RGOs based on an ECR = 10-6	Units of measure
Fish Ingestion	Arsenic	2.10E-01	2.10E-02	2.10E-03	mg/kg
	Beryllium	7.34E-02	7.34E-03	7.34E-04	mg/kg
	PCB-1260	4.10E-02	4.10E-03	4.10E-04	mg/kg
	Chlordane	2.43E-01	2.43E-02	2.43E-03	mg/kg
	^{137}Cesium	5.58E+00	5.58E-01	5.58E-02	pCi/g
	^{90}Strontium	3.16E+00	3.16E-01	3.16E-02	pCi/g
	4,4'-DDE	9.28E-01	9.28E-02	9.28E-03	mg/kg
	4,4'-DDT	9.28E-01	9.28E-02	9.28E-03	mg/kg
	Aldrin	1.86E-02	1.86E-03	1.86E-04	mg/kg

Table 5.28. Remedial goal options for soil for the noncarcinogenic chemicals and pathways of concern for the dredging scenario

Pathway	Chemical	Adult			Child		
		RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)	RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)
Inhalation of resuspended sediment	Barium	1.94E+04	1.94E+03	1.94E+02	4.36E+03	4.36E+02	4.36E+01
	Manganese	1.94E+03	1.94E+02	1.94E+01	4.36E+02	4.36E+01	4.36E+00
Ingestion of milk produced by cattle pastured on dredged sediment	Arsenic	5.58E+03	5.58E+02	5.58E+01	6.22E+02	6.22E+01	6.22E+00
	Barium	1.57E+05	1.57E+04	1.57E+03	1.68E+04	1.68E+03	1.68E+02
	Boron	1.81E+04	1.81E+03	1.81E+02	1.94E+03	1.94E+02	1.94E+01
	Cadmium	8.63E+02	8.63E+01	8.63E+00	9.24E+01	9.24E+00	9.24E-01
	Chromium	5.37E+05	5.37E+04	5.37E+03	5.75E+04	5.75E+03	5.75E+02
	Mercury	1.92E+02	1.92E+01	1.92E+00	2.05E+01	2.05E+00	2.05E-01
	Molybdenum	1.75E+03	1.75E+02	1.75E+01	1.88E+02	1.88E+01	1.88E+00
	Nickel	9.90E+02	9.90E+01	9.90E+00	1.06E+02	1.06E+01	1.06E+00
	Selenium	2.98E+02	2.98E+01	2.98E+00	3.20E+01	3.20E+00	3.20E-01
	Silver	3.99E+04	3.99E+03	3.99E+02	4.28E+03	4.28E+02	4.28E+01
	Vanadium	8.14E+03	8.14E+02	8.14E+01	8.72E+02	8.72E+01	8.72E+00
	Zinc	7.22E+03	7.22E+02	7.22E+01	7.73E+02	7.73E+01	7.73E+00
	4,4'-DDT	3.00E+01	3.00E+00	3.00E-01	3.21E+00	3.21E-01	3.21E-02
	PCB-1254	2.46E+00	2.46E-01	2.46E-02	2.64E-01	2.64E-02	2.64E-03

Table 5.28 (continued)

Pathway	Chemical	Adult			Child		
		RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)	RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)
Ingestion of beef grazed on pasture forage produced on dredged sediments	Arsenic	1.95E+03	1.95E+02	1.95E+01	4.17E+02	4.17E+01	4.17E+00
	Chromium	6.67E+03	6.67E+02	6.67E+01	1.43E+03	1.43E+02	1.43E+01
	Manganese	7.53E+05	7.53E+04	7.53E+03	1.61E+05	1.61E+04	1.61E+03
	Mercury	1.01E+02	1.01E+01	1.01E+00	2.16E+01	2.16E+00	2.16E-01
	Selenium	3.34E+02	3.34E+01	3.34E+00	7.15E+01	7.15E+00	7.15E-01
	Vanadium	3.96E+04	3.96E+03	3.96E+02	8.48E+03	8.48E+02	8.48E+01
	Zinc	8.07E+03	8.07E+02	8.07E+01	1.73E+03	1.73E+02	1.73E+01
	PCB-1254	8.71E+00	8.71E-01	8.71E-02	1.87E+00	1.87E-01	1.87E-02
Ingestion of vegetables produced on dredged sediments	Arsenic	2.40E+03	2.40E+02	2.40E+01	5.14E+02	5.14E+01	5.14E+00
	Boron	2.67E+04	2.67E+03	2.67E+02	5.72E+03	5.72E+02	5.72E+01
	Cadmium	9.00E+02	9.00E+01	9.00E+00	1.93E+02	1.93E+01	1.93E+00
	Chromium	1.40E+04	1.40E+03	1.40E+02	2.99E+03	2.99E+02	2.99E+01
	Manganese	1.27E+04	1.27E+03	1.27E+02	2.72E+03	2.72E+02	2.72E+01
	Mercury	3.61E+01	3.61E+00	3.61E-01	7.74E+00	7.74E-01	7.74E-02
	Molybdenum	1.77E+03	1.77E+02	1.77E+01	3.79E+02	3.79E+01	3.79E+00
	Nickel	1.38E+04	1.38E+03	1.38E+02	2.95E+03	2.95E+02	2.95E+01

Table 5.28 (continued)

Pathway	Chemical	Adult			Child		
		RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)	RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)
	Silver	8.99E+02	8.99E+01	8.99E+00	1.93E+02	1.93E+01	1.93E+00
	Zinc	2.72E+04	2.72E+03	2.72E+02	5.82E+03	5.82E+02	5.82E+01
	PCB-1254	4.64E+01	4.64E+00	4.64E-01	9.94E+00	9.94E-01	9.94E-02

Table 5.29. Remedial goal options for the noncarcinogenic chemicals and pathways of concern for near-shore sediment for the shoreline use scenario

Pathway	Chemical	Adult			Child		
		RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)	RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)
Inhalation of resuspended sediment	Barium	3.88E+04	3.88E+03	3.88E+02	8.73E+03	8.73E+02	8.73E+01
	Manganese	3.88E+03	3.88E+02	3.88E+01	8.73E+02	8.73E+01	8.73E+00

Table 5.30. Remedial goal options for the noncarcinogenic chemicals and pathways of concern for water

Pathway	Chemical	Adult			Child		
		RGOs based on a HQ of 10 (mg/L)	RGOs based on a HQ of 1 (mg/L)	RGOs based on a HQ of 0.1 (mg/L)	RGOs based on a HQ of 10 (mg/L)	RGOs based on a HQ of 1 (mg/L)	RGOs based on a HQ of 0.1 (mg/L)
Ingestion of milk produced by cattle pastured on soil irrigated with surface water	Nitrate	2.54E+01	2.54E+00	2.54E-01	2.72E+00	2.72E-01	2.72E-02
	Nickel	3.91E+00	3.91E-01	3.91E-02	4.19E-01	4.19E-02	4.19E-03
	PCB-1254	7.61E-03	7.61E-04	7.61E-05	8.16E-04	8.16E-05	8.16E-06
Ingestion of vegetables irrigated with surface water	Arsenic	3.14E-01	3.14E-02	3.14E-03	6.73E-02	6.73E-03	6.73E-04
	Nitrate	1.93E+02	1.93E+01	1.93E+00	2.72E+00	2.72E-01	2.72E-02
Ingestion of beef drinking surface water	Nitrate	9.47E+01	9.47E+00	9.47E-01	2.03E+01	2.03E+00	2.03E-01
Direct ingestion of untreated surface water	Antimony	1.46E-01	1.46E-02	1.46E-03	6.26E-02	6.26E-03	6.26E-04
	Arsenic	1.10E-01	1.10E-02	1.10E-03	4.69E-02	4.69E-03	4.69E-04
	Manganese	5.11E+01	5.11E+00	5.11E-01	2.19E+01	2.19E+00	2.19E-01
	Nitrate	5.84E+02	5.84E+01	5.84E+00	2.50E+02	2.50E+01	2.50E+00
	PCB-1254	7.30E-03	7.30E-04	7.30E-05	3.13E-03	3.13E-04	3.13E-05

Table 5.31. Remedial goal options for the noncarcinogenic chemicals and pathways of concern for fish tissue

Pathway	Chemical	Adult			Child		
		RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)	RGOs based on a HQ of 10 (mg/kg)	RGOs based on a HQ of 1 (mg/kg)	RGOs based on a HQ of 0.1 (mg/kg)
Ingestion fish tissue	Arsenic	4.06E+00	4.06E-01	4.06E-02	1.56E+00	1.56E-01	1.56E-02
	Mercury	4.06E+00	4.06E-01	4.06E-02	1.56E+00	1.56E-01	1.56E-02
	Selenium	6.76E+01	6.76E+00	6.76E-01	2.61E+01	2.61E+00	2.61E-01
	Chlordane	8.11E-01	8.11E-02	8.11E-03	3.13E-01	3.13E-02	3.13E-03
	4,4'-DDT	6.76E+00	6.76E-01	6.76E-02	2.61E+00	2.61E-01	2.61E-02
	PCB-1254	2.7E-01	2.7E-02	2.7E-03	1.04E-01	1.04E-02	1.04E-03

6. BASELINE ECOLOGICAL RISK ASSESSMENT REPORT

The purpose of this ecological risk assessment is to provide an estimate of ecological risks due to contaminants in the Clinch River Operable Unit (CR OU). The CR OU includes Poplar Creek embayment, McCoy Branch embayment, and the Clinch River adjacent to and below the DOE's ORR (Fig. 3.1). The ecological risk assessment is structured in terms of the standard paradigm for risk assessment (NRC 1983, Risk Assessment Forum 1992). It begins with a problem formulation phase that defines the contaminant sources, the receiving environment, and the assessment endpoints. Then, for each endpoint, there is an analytical phase consisting of exposure assessment and effects assessment and a risk characterization that combines the components of the analysis phase.

6.1 ECOLOGICAL PROBLEM FORMULATION

The problem formulation consists of the description of the relevant features of the environment, description of the sources of contamination, identification of ecological endpoints, and summarization of that information in terms of a conceptual model of the hazard posed by the contaminants to the endpoint biota.

6.1.1 Environmental Description

The environment considered in this assessment is the Clinch River adjacent to and downstream of the ORR including the embayments of Poplar Creek and McCoy Branch. A general description of this system is provided above (Chap. 2). It consists of the Clinch River arm of Watts Bar Reservoir, the lower portion of Melton Hill Reservoir, Poplar Creek embayment up to the confluence of the East Fork, and the McCoy Branch embayment up to . The reservoirs are narrow and relatively fast flowing (Chap. 3). Because there is no floodplain, there are currently no known contaminated terrestrial systems. A contaminated terrestrial ecosystem would be created under the baseline dredging case, but the simple assessment performed for that hypothetical case does not include site-specific ecological characteristics. The federal and state-listed threatened or endangered (T&E) species and other state-listed rare or declining species are listed in Appendix J.

6.1.2 Sources

The proximate sources considered in this assessment are the contaminated media in the CR OU: water, sediment, and fish tissues. The ultimate sources of the contaminants are the DOE's operations of the ORR including waste disposal, spills, and use of chemicals such as pesticides in the environment and other upstream sources. The intermediate sources are the streams that drain the ORR, all of which are tributaries of the Clinch River. McCoy Branch has been contaminated by coal ash and potentially by other currently undefined materials deposited in Rogers Quarry. Poplar Creek has been contaminated by releases from Y-12 to EFPC (particularly mercury), by various contaminants released by the K-25 plant directly to the embayment, and by various contaminants released by the cities of Oliver Springs and Oak Ridge, and by other sources in the Poplar Creek watershed. Although the DOE's operations did not contribute all of the contaminants in the Clinch River or Poplar Creek, the assessment must characterize the overall risks to the biota, not simply the risks that would have occurred if the DOE emissions had been released to a pristine environment.

COPECs for ecological risks have been identified in previous screening assessments (Suter 1991, Cook et al. 1992, Blaylock et al. 1993). However, because the number of COPECs was large for all

media, the revisions that have occurred in the ecological screening benchmarks, and the new contaminant concentration data that have been added, all contaminants are rescreened against benchmarks for this assessment.

6.1.3 Ecological Endpoints

The problem formulation must identify both the assessment endpoints, which are explicit statements of the characteristics of the environment that are to be protected, and the measurement endpoints, which are quantitative summaries of a measurement or series of measurements that are related to effects on an assessment endpoint.

6.1.3.1 Assessment endpoints

The following assessment endpoints for aquatic and terrestrial risks have been selected for this assessment.

- Reduction in species richness or abundance or increased frequency of gross pathologies in fish communities resulting from toxicity.
- Reduced species richness or abundance of benthic macroinvertebrate communities resulting from toxicity.
- Reduction in abundance or production of piscivorous wildlife populations resulting from toxicity.
- Reduction in abundance or production of flying insectivorous wildlife populations resulting from toxicity.
- Reduction in production of terrestrial plant communities resulting from toxicity.
- Reduction in abundance or production of terrestrial wildlife populations resulting from toxicity.
- Reduction in viability or fecundity of individuals of any threatened or endangered species resulting from toxicity.

The ecological assessment endpoints have been selected based on DQO meetings that included representatives of the DOE, EPA Region IV, and TDEC. The selected endpoints are explained below.

1. The fish community is considered to be an appropriate endpoint community because it is ecologically and societally important, susceptible, and has a scale appropriate to the site. The fish community is ecologically significant since much of the energy flow in temperate reservoirs passess through fishes and fishes are a major nutrient reservoir in those systems; its societal importance is due to recreational fisheries. In addition, the scale is appropriate because most of the fish species in the CR OU move within an area smaller than the OU.

2. The benthic invertebrate community is considered to be an appropriate endpoint community because they are highly susceptible, and have a scale appropriate to the site. This community is highly susceptible because of its association with the sediment, which is the repository of most of the COPECs. In addition, the insects and crustaceans that dominate this community are sensitive to a variety of contaminants. Because these organisms are sedentary, their scale is highly appropriate to the scale of the site.

3. Piscivorous wildlife are considered to be an appropriate endpoint trophic group because they are highly susceptible and have a scale appropriate to the site. Two of the contaminants of potential concern, PCBs and mercury, biomagnify in aquatic food webs leading to high levels of exposure in piscivorous wildlife. Mink have been shown to be highly sensitive to the toxic effects of PCBs and mercury in toxicity tests. Reproduction of piscivorous birds has been shown to be highly sensitive to PCBs. Prior

screening assessments have shown that there is a potential for toxic exposures of wildlife to a variety of contaminants in Watts Bar Reservoir (Suter 1991, Cook et al. 1992). Although populations of piscivorous wildlife are not as clearly associated with the OU as the aquatic communities, they forage within an area smaller than the Clinch River arm (at least during the breeding season) so the scale is appropriate. The chosen endpoint populations are mink and great blue heron.

4. Flying insectivorous wildlife (i.e., bats and birds that catch insects on the wing) are considered to be an appropriate endpoint trophic group because they are susceptible and have a scale appropriate to the site. Two of the contaminants of potential concern, PCBs and mercury, accumulate in sediments and biomagnify in food webs leading to potentially high levels of exposure in wildlife that feed on benthic invertebrates. Certain species of swallows and bats tend to forage over open water and feed on the emergent stages of aquatic insects. Although populations of insectivorous wildlife are not as clearly associated with the OU as the aquatic communities, they forage within an area smaller than the Clinch River arm (at least during the breeding season) so the scale is appropriate. The chosen endpoint populations are the little brown bat and the rough-winged swallow.

5. The terrestrial plant community is considered to be an appropriate endpoint community because it is ecologically important, susceptible, and has a scale appropriate to the site. Since the plant community is responsible for primary production it is ecological significant. This community is susceptible because it would be directly exposed to the contaminants in the dredge spoil. Finally, the scale is appropriate because plants are immobile and because a distinct plant community would develop on dredge spoil deposited on land.

6. EPA Region IV recommended that the ecological risk assessment for animals in the dredge spoil scenario be based on the human health assessment garden model with a herbivorous wildlife species substituted for the human (Lynn Wellman, personal communication to Glenn Suter, November 2, 1993). The chosen representative species is the eastern cottontail.

7. T&E species are, in general, too rare to be ecologically significant, and may not be particularly susceptible or clearly associated with the site. However, they have high societal and policy importance. Because of the particular societal value placed on these organisms, as reflected in the Endangered Species Act, the endpoint properties for these species are any toxic effect that would reduce survivorship or fecundity of individuals of listed species that currently occur on the OU or may occur in the future. State and federally listed T&E species that occur in the region are listed in Appendix J. Their treatment in this assessment are as follows:

- Terrestrial plants are not currently exposed to contaminants in this OU. Because there is no basis for estimating risks to particular plant species and because the available plant toxicity data for effects on individual plants, the results of the assessment of dredge spoil phytotoxicity (Sect. 6.7) are applicable to T&E plants.
- Four species of fish-eating birds are listed (bald eagle, double-crested cormorant, black-crowned night heron, and osprey). Of these, the osprey was chosen for specific assessment because it nests in the OU (Sect. 6.4). The others are assumed to be represented by the osprey.
- None of the T&E terrestrial birds have food habits that would significantly expose them to contaminants in the OU.
- Four T&E bat species occur in the area. The gray bat was chosen to represent this group because if forages over water and therefore is likely to be more heavily exposed to contaminants than the others (Sect. 6.5).

- The only T&E mammal other than bats with food habits that could lead to significant exposure is the river otter. Otters do not currently occur on the OU but are expected to reoccupy the area in the future.
- Several T&E species of riverine molluscs (mussels and snails) are listed. These species are assumed to be represented by the assessment of risks to the benthic invertebrate community, particularly by the toxicity tests with the native mussel *Anodonta imbecillis* (Sects. 3.4.5 and 6.3).
- A state listed aquatic turtle (Cumberland slider) and salamander (hellbender) may occur in the OU. Toxic effects on these species can not be assessed with existing data. Therefore it must be assumed that the assessment of risks to fish will serve to protect these species as well.

In addition to defining the assessment endpoints in terms of environmental entities (e.g., the fish community) and a properties of those entities (e.g., species richness), it is necessary to identify a level of effect on those properties. The level of effect is used to help determine how much sampling is needed during the DQO process and to provide a benchmark for comparison of estimates of effects obtained through different lines of evidence. A 20% or greater reduction in one of the endpoint properties measured in the field or a 20% reduction in survivorship, growth, or reproduction in a toxicity test is considered to be potentially significant. The figure 20% used in the definition of ecological assessment endpoints is based on an analysis of U.S. EPA and Tennessee regulatory practice; it was adopted by the FFA parties in a DQO process (Ashwood et al. 1994) and incorporated into the plan for ecological risk assessment for the ORR (Suter et al. 1994).

6.1.3.2 Measurement endpoints

Three basic types of effects data are potentially available to serve as measurement endpoints: results of biological surveys, toxicity tests performed on media from the CR OU, and toxicity test endpoints for chemicals found in the CR OU. Measurement endpoints are presented below for each assessment endpoint.

Fish

Biological Survey Data (a) Species richness and abundance from TVA reservoir surveys and fish community surveys conducted for this assessment. These measurement endpoints are assumed to be direct estimates of that assessment endpoint.

Biological Indicators Data (b) Frequencies of gross pathologies are a direct measure of one aspect of the assessment endpoint. (c) Measures of fish fecundity in largemouth bass and bluegill provide an indication of the potential contribution of reproductive toxicity to community effects. (d) Measures of the levels of physiological and histological condition in largemouth bass and bluegill help to confirm that exposures have occurred and may suggest mechanistic connections between exposure and effects on the fish community.

Media Toxicity Data (e) Reductions in growth and survivorship of larval fathead minnows and in fecundity and survivorship of *Ceriodaphnia dubia (C. dubia)* in 7 day tests of ambient water. (f) Reductions in hatching and larval survival and increases in terata in Japanese medaka (*Oryzias latipes*) eggs and larvae exposed to ambient water from shortly after fertilization to 48 hours post-hatch. (g) The *Daphnia magna (D. magna)* test of water overlying ambient sediments (discussed below) may be indicative of toxicity to epibenthic fish or to early life stages of benthic spawning fish. Responses that are statistically significantly different or are inhibited by 20% or greater relative to control or reference waters are assumed to be indicative of waters that are toxic to fish.

Single Chemical Toxicity Data (h) Chronic toxicity thresholds for freshwater fish expressed as chronic EC20s or Chronic Values (CVs). These test endpoints correspond to the assessment endpoint for this community. That is, the sensitivity distribution of the test species is assumed to

approximate the distribution of CR OU species, and exceedence of the CVs and EC20s are assumed to correspond to 20% or greater reductions in abundance, with some uncertainty.

Benthic invertebrates

Biological Survey Data (a) Species richness and abundance of benthic invertebrates reported from the TVA reservoir surveys and surveys performed by the TVA for this assessment. These measurement endpoints are assumed to be direct estimates of the assessment endpoint for this community.
Media Toxicity Data (b) Reductions in survival of an amphipod [*Hyalella azteca (H. azteca)*] in 10 day exposures to whole sediment. (c) Reductions in survival of a cladoceran (*C. dubia*) in 48 hour exposures to sediment pore water. (d) Reductions in survival and fecundity of another cladoceran (*D. magna*) in 12 to 14 day exposures to water overlying sediment. Responses that are statistically significantly different or are inhibited by 20% or greater relative to reference sediments are assumed to be indicative of sediments that are toxic to benthic biota.
Single Chemical Toxicity Data (e) Chronic toxicity thresholds for freshwater invertebrates expressed as chronic EC20s or CVs. These test endpoints correspond to the assessment endpoint for this community. That is, the sensitivity distribution of the test species is assumed to approximate the distribution of CR OU species, and exceedence of the CVs and EC20s are assumed to correspond to 20% reductions in population abundance or greater, with some uncertainty. (f) Toxic concentrations in ambient sediments reported by the State of Florida. Two types of values were extracted from that data set. First, thresholds for modification of benthic invertebrate communityproperties based on co-occurrence analyses, which are assumed to correspond to the assessment endpoint. Second, thresholds for lethality in toxicity tests of contaminated sediments, which are also assumed to correspond to the assessment endpoint effect, but with greater uncertainty due to the extrapolation to the field.

Piscivorous wildlife

Biological Survey Data (a) Reproductive success of great blue herons at rookeries on Poplar Creek embayment and in Melton Hill Reservoir relative to reference rookeries. Assuming that each colony constitutes a population, this is a direct measure of the assessment endpoint for avian piscivores.
Media Toxicity Data (b) Reproductive success, survivorship, and pathologies in mink fed diets containing various proportions of fish from Poplar Creek embayment. The reproductive success and survivorship test endpoints are assumed to correspond to effects on individual mink with implications for populations. An extrapolation must be made to populations if effects on individuals are estimated to occur.
Single Chemical Toxicity Data (c) Chronic toxicity thresholds for contaminants of concern in birds and mammals with greater weight given to data from long-term feeding studies with wildlife species. Preference was given to tests that included reproductive endpoints. After allometric scaling for the endpoint species, these test endpoints are assumed to correspond to effects on individuals that could result in exceedence of the population-level assessment endpoint. An extrapolation must be made to populations if effects on individuals are estimated to occur.

Flying insectivorous wildlife

Biological Survey Data None.
Media Toxicity Data None.
Single Chemical Toxicity Data (a) Chronic toxicity thresholds for contaminants of concern in birds and mammals with greater weight given to data from long-term feeding studies with wildlife

species. Preference was given to tests that included reproductive endpoints. After allometric scaling for the endpoint species, these test endpoints are assumed to correspond to effects on individuals that could result in exceedence of the population-level assessment endpoint. An extrapolation must be made to populations if effects on individuals are estimated to occur.

Terrestrial plants

Biological Survey Data None.
Media Toxicity Data None.
Single Chemical Toxicity Data (a) EC20s for growth or production of vascular plants or equivalent chronic toxicity thresholds for contaminants of concern in soil. These test endpoints are assumed to correspond to the assessment endpoint for this community. That is, the sensitivity distribution of the test species is assumed to approximate the distribution of species that would colonize Clinch River dredge spoil, exceedence of the test endpoints is assumed to correspond to 20% reductions in abundance or productivity, with some uncertainty, and a distinct plant community is assumed to occur on a spoil disposal area.

Terrestrial wildlife

Biological Survey Data None.
Media Toxicity Data None.
Single Chemical Toxicity Data (a) Chronic toxicity thresholds for contaminants of concern in mammals with greater weight given to data from long-term feeding studies with wildlife species. Preference was given to tests that included reproductive endpoints. After allometric scaling for the endpoint species, the eastern cottontail, these test endpoints are assumed to correspond to effects on individuals that could result in exceedence of the population-level assessment endpoint. Since a distinct population is assumed to occur on a spoil disposal area, exceedence of the benchmarks is assumed to correspond to significant effects.

Threatened and endangered species

Biological Survey Data Except for osprey reproduction, no surveys of abundance or production of other T&E species were conducted. (a) The reproductive success of osprey nesting in the OU is assumed to be a direct measure of the assessment endpoint for that species. (b) The surveys of taxonomically and trophically related species described above are used as evidence to help estimate risks to the T&E species.
Media Toxicity Data (c) T&E species of aquatic animals, benthic invertebrates, or piscivorous mustellids are assumed to be represented by the test species used in the water, sediment, and fish tissue toxicity tests as described above.
Single Chemical Toxicity Data (d) The same chronic toxicity thresholds for contaminants of concern in invertebrates, fish, birds and mammals used as measurement endpoints for other species are used with the T&E species but are interpreted in the risk characterization so as to provide the higher level of protection specified in the assessment endpoint.

6.1.4 Conceptual Models

Two baseline cases are assessed in the RI (Chap. 1). The current baseline case is the state of the CR OU as it now exists and would continue to exist if no remedial actions are taken and the system is not significantly altered. That is, contaminants occur in the sediments and enter the OU from the ORR and from upstream, but no dredging is allowed without authorization. The hypothetical future dredging case

involves unregulated dredging of sediments and disposal of the spoils on land. The ecological conceptual models presented here elaborate on those cases by defining the ecological receptors and their modes of exposure.

A conceptual model of exposure of the aquatic food web to contaminants for the current baseline case is depicted in Fig. 6.1. All aquatic biota are directly exposed to contaminants in water. They are also externally exposed to radiation from radionuclides in water and sediments. Contaminated allochthonous material is added to the detritus in the system in the form of organic matter exported from the ORR in streams. Detritus and sediments are consumed by benthic invertebrates and detritivorous fish and the benthic invertebrates are exposed directly to the sediments. The food web then transfers contaminants taken up by these routes to top predators and humans.

A conceptual model of exposure of the terrestrial food web in the dredging case is depicted in Fig. 6.2. It is assumed that ecological succession is allowed to occur on the spoil fill. Plants take up contaminants directly from the spoil. Herbivorous wildlife consume the plants, and incidentally ingest some spoil with their food or during grooming.

6.1.5 Organization of the Ecological Risk Assessment

The risks of chemicals to each of the ecological risk assessment endpoints in the current baseline case are assessed separately (Sects. 6.2-6.5). Each includes an exposure assessment, effects assessment, risk characterization, including characterization of uncertainty. Risks from radionuclides are discussed separately (Sect. 6.6) as are risks from unregulated dredge spoil disposal (Sect. 6.7). Finally, ecological risks are summarized and compared to human health risks (Sect. 6.8). The components of the assessment are explained below.

Exposure assessment characterizes the distribution in space and time of the concentrations of contaminants to which organisms are exposed. Risk from undetected chemicals are not assessed, as instructed by the FFA parties (September 1993). Exposure calculations are performed for each subreach. (See Sect. 3.1.1 and Fig. 3.1 for descriptions of the reaches and subreaches.) The concentrations used in the exposure assessment are summarized in Chap. 3.

Effects assessment characterizes the evidence concerning effects of contaminant exposure. The principle lines of evidence concerning effects are biological survey data that indicate the actual state of the receiving environment, media toxicity data which indicate whether the contaminated media are toxic under controlled conditions, bioindicator data which are biochemical and histological indications of the potential mechanisms and causes of effects, and single chemical toxicity data which indicate the toxic effects of the concentrations measured in site media.

Risk characterization is the phase of risk assessment in which the information concerning exposure and the information concerning the potential effects of exposure are integrated to estimate risks (the likelihood of effects given the exposure). Risk characterization in ecological risk assessment is performed by a weight-of-evidence analysis. Procedurally, the risk characterization is performed for each assessment endpoint by (1) screening all measured contaminants against toxicological benchmarks and

CLINCH RIVER CONCEPTUAL MODEL:
AQUATIC FOOD WEB

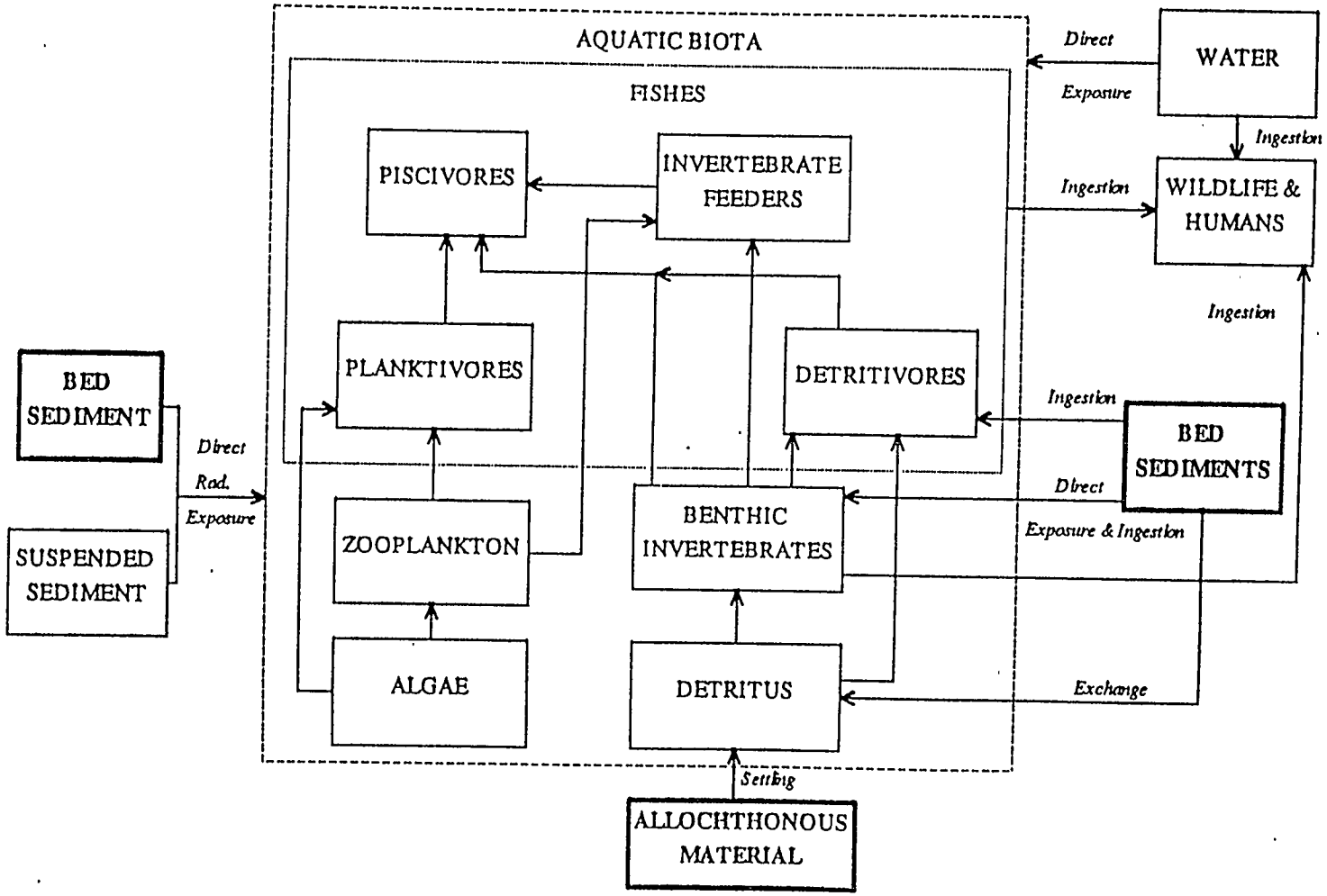


Fig. 6.1. Conceptual model of contaminant sources, transport, and exposure in the aquatic food web. Dark-lined boxes represent sources that may be remediated. Arrows represent routes of transport and exposure, described by italic labels. Unlabeled arrows represent food web transfers by ingestion.

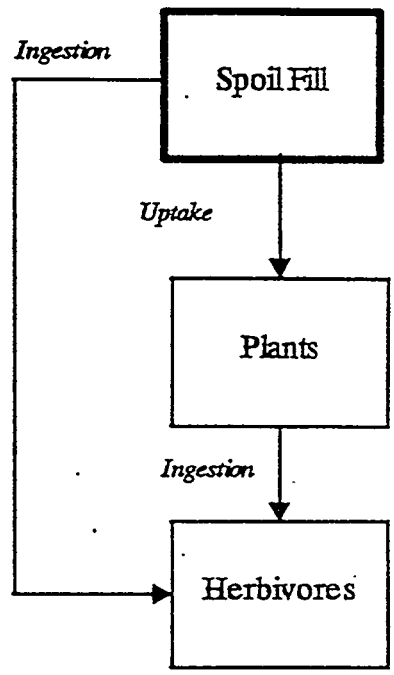


Fig. 6.2. Conceptual model of contaminant sources, transport, and exposure in the terrestrial food web for the baseline dredging case. Dark-lined boxes represent sources that may be remediated. Arrows represent routes of transport and exposure, described by italic labels.

background concentrations, (2) estimating the effects of the contaminants retained by the screening analysis, (3) estimating the toxicity of the ambient media based on the media toxicity test results, (4) estimating the effects of exposure on the endpoint biota based on the results of the biological survey data, (5) logically integrating the lines of evidence to characterize risks to the endpoint, and (6) listing and discussing the uncertainties in the assessment.

6.1.6 Risk Characterization Techniques

Three risk characterization techniques are used to apply literature toxicity information to chemical concentrations measured in CR/PC media. Because all three techniques are common to all endpoints, they are explained here. The techniques are calculation of hazard quotients (HQs), calculation and plotting of sums of toxic units (ΣTU), and comparison of distributions of exposure concentrations to distributions of effects.

HQs are used in the screening phase of the risk assessment to help identify COPECs. They are quotients of the ratios of exposure concentrations divided by ecotoxicological benchmark concentrations. HQs greater than one indicate that a chemical is a COPEC for a particular medium and endpoint, unless other information such as concentrations in upstream samples indicate that it should not be of concern. Because the intent of this analysis is to screen out only chemicals that are clearly not of concern, conservative estimates of exposure [e.g., maxima or 95% upper confidence limits (UCL)] and conservative benchmarks (e.g., NOECs) or suites of benchmarks are used.

After the screening, the COPECs are compared to each other and their distributions across the reaches is examined. Since the relative importance of COPECs is a function of their potential toxicity rather than their concentration, toxicity normalized concentrations or toxic units (TUs) are calculated. This is a common technique for dealing with exposures to multiple chemicals by expressing concentration relative to a standard test endpoint (Finney 1971). TUs are quotients of the concentration of a chemical in a medium divided by the standard test endpoint concentration for that chemical. They are similar to HQs except that a common test endpoint is used rather than conservative benchmarks because TUs are used for comparative purposes rather than to draw conclusions. The expression of concentration and the test endpoint vary among media; for water they are the upper 95% confidence limit concentration and the 48 hour EC50 for *D. magna*. If the TU for a chemical equals one, the interpretation is that the aquatic community in that reach is exposed to a conservatively estimated average concentration sufficient to kill or immobilize *Daphnia* within 48 hours. The chemicals that constitute a major component of toxicity (i.e., TUs > 0.01) are plotted for each negative reference reach and OU subreach for water, sediment, and wildlife intake (e.g., Fig. 6.3). The height of the plot at each subreach is the ΣTU for that medium and subreach. This value can be conservatively interpreted as the total toxicity-normalized concentration and therefore as a relative indication of the toxicity of the medium in that subreach. In addition, the ΣTU is commonly assumed to estimate the absolute toxicity of the medium. That is, if the ΣTU equals one, then the endpoint effect (e.g., *Daphnia* acute lethality) will occur. This will be the case if all of the chemicals have the same mode of action. For heterogeneous chemical mixtures it is a likely to be a conservative assumption because combined toxic effects of chemicals in environmental samples have been found to be additive or less than additive (Alabaster and Lloyd 1982). Because the test endpoints are chosen for their consistency rather than their relationship to an assessment endpoint, the plots of TUs are heuristic, providing an indication of the relative toxicity of sites and the relative contributions of chemicals to that toxicity.

Inferences about the risk posed by the COPECs is based on the distribution of concentrations relative to the distribution of effects. Distributions provide a better basis for inference than point estimates because they allow consideration of variance in concentration over space or time and of sensitivity across species, measures of effects, media properties, or chemical forms. In all cases, risk is a function of the overlap between the exposure and effects distributions, but the interpretation depends on the data that are used.

- In the case of exposure of fish to chemicals in water, the exposure distributions are distributions of aqueous concentrations over time and the effects distributions are distributions of sensitivities of species to acutely lethal effects (e.g., LC50s) and chronically lethal or sublethal effects (CVs). Overlap of these two distributions indicates the approximate proportion of the time when aqueous concentrations of the chemical are acutely or chronically toxic to a particular proportion of aquatic species. For example, 10% of the time copper concentrations in Reach 4.01 are at levels chronically toxic to 80% of aquatic animals and acutely toxic to 30% of aquatic invertebrates (Fig. F2.2).
- In the case of exposure of benthic invertebrates to sediment pore water, the exposure distributions are interpreted as distributions over space since sediment composition varies little over the period in which samples were collected, but samples were distributed in space within reaches. The effects

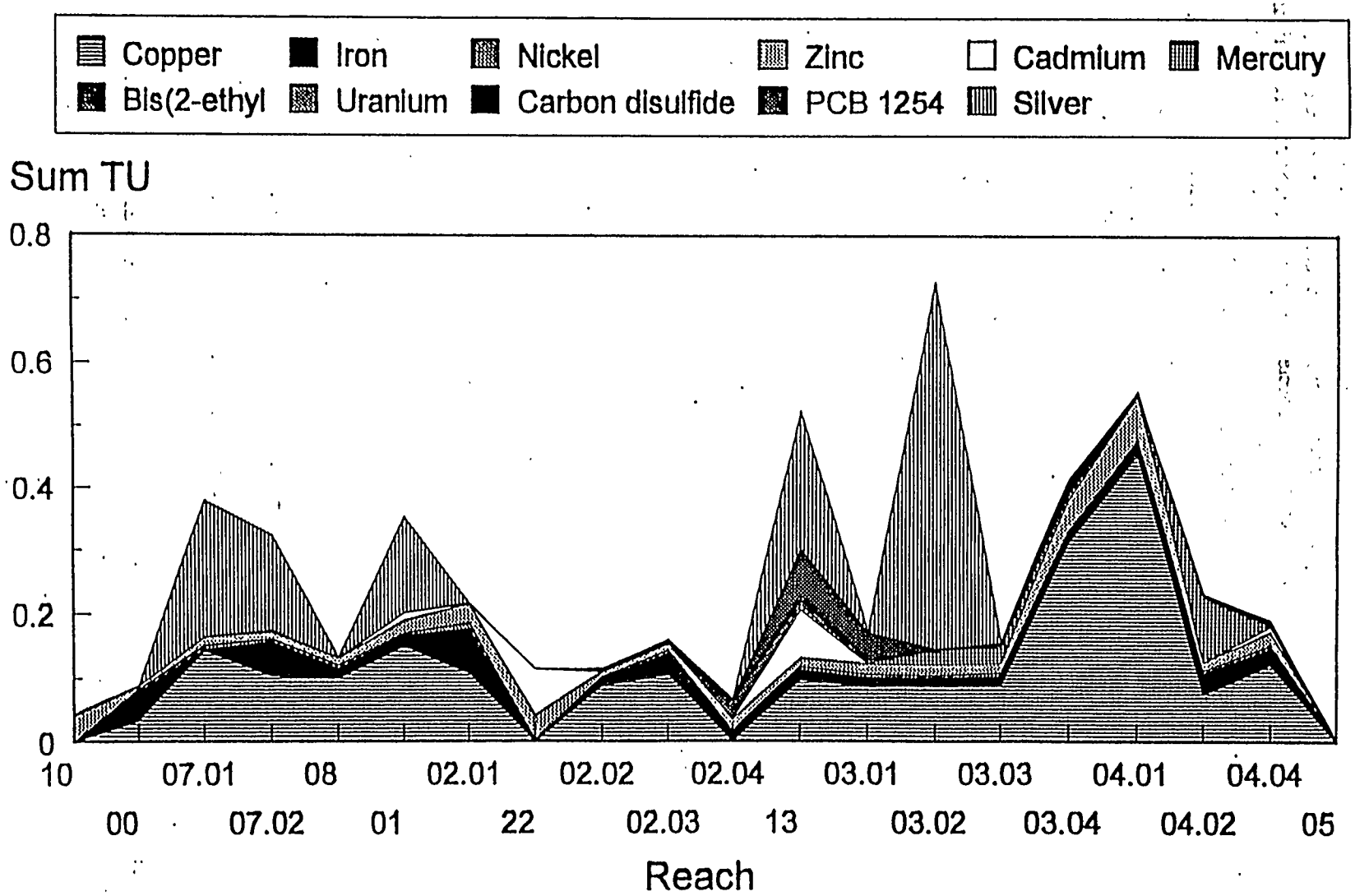


Fig. 6.3. Plot of concentration of COPECs normalized to toxic units (TU). The upper contour of the graph is the sum of TU for the reaches.

distributions are the same as for surface water. Therefore, overlap of the distributions indicates the proportion of locations in the reach where concentrations of the chemical in pore water are acutely or chronically toxic to a particular proportion of species. For example, copper concentrations in sediment pore water from more than 90% of locations in Reach 4.04 are below chronically toxic concentrations for more than 90% of aquatic animal species (Fig. F3.6).

- In the case of exposure of benthic invertebrates to chemicals in whole sediment, the exposure distributions are, as with pore water, distributions in space within reaches. Two effects distributions are presented for each sediment COPEC: a distribution of concentrations reported to be thresholds for reductions in benthic invertebrate community parameters in various locations, and a distribution of concentrations reported to be thresholds for lethal effects in toxicity tests of various sediments. If we assume that the effects data set are drawn from studies of a random sample of sediments so that the CR/PC sediments can be assumed to be a random draw from the same distribution, and if we assume that the two types of reported effects are independent estimates of the threshold for significance for this endpoint, then the effects distributions can be treated as distributions of the probability that the chemical causes significant toxic effects on the CR/PC benthic community. Overlap of the exposure and effects distributions represents the probability of significant toxic effects on benthic communities in a given proportion of locations in a reach. For example, copper concentrations in whole sediment from less than 20% of locations in Reach 3.02 are above the concentration at which there is a 50% likelihood of toxic effects on benthic invertebrates (Fig. F3.9b).
- In the case of wildlife exposure to chemicals in food and water, the exposure distributions are distributions of total intake rate of the chemical across individuals in the populations. The distributions are obtained by the Monte Carlo simulation using the distributions of observed concentrations in water and various food items. If we assume that the members of a population occurring in each modelled area independently sample the water and food items, then the proportions of the exposure distributions represent estimates of the proportion of a population receiving a particular intake rate. In keeping with practice in wildlife toxicology, the effects are treated as point estimates (i.e., NOAEL and LOAELs). Therefore, the intersection of these points with the exposure distributions represent estimates of the proportion of the exposed population with exposure levels less than the NOAEL and LOAEL. For example, less than 1% of the members of a rough-winged swallow colony located in Reach 3.02 would receive a dose rate greater than the LOAEL (Sect. 6.5).
- The case of T&E wildlife is a little different from that of other wildlife species. Risks to these species are assessed at the organism level, so the exposure models represent exposure of individuals within their foraging areas. Therefore, the exposure distribution is a distribution of the likelihood of various exposure rates to individuals foraging in the specified areas. Effects are specified by the same point estimates as with other wildlife. Therefore, the intersection of the point estimates of effects with the exposure distributions represent the likelihood that an individual will have an intake rate less than the NOAEL and LOAEL. For example, the likelihood that the osprey foraging exclusively in Reach 3.02 will receive a dose rate greater than the LOEL is greater than 50% (Sect. 6.4).

These risk characterization techniques apply to one line of evidence, the concentrations of chemicals in ambient media. Other interpretation techniques applied to other lines of evidence are more specific to the endpoint, so they are not summarized here. However, for all endpoints the risk characterization ultimately depends on weighing of all of the lines of evidence.

6.1.7 Background, Reference, and Operable Unit Reaches

OU reaches are those that are potential candidates for remediation based on the findings of this RI. They are the Clinch River adjacent to and downstream of the ORR (Reaches 1, 2, & 4) and the Poplar Creek embayment (Reach 3). Interpretation of the chemical concentrations and biological characteristics of an OU are made by comparison to reference reaches. These include positive reference reaches which are identified *a priori* to be sources of contamination. They are the streams draining the ORR (Reaches 20-22). Positive reference reaches are used to indicate where contaminants in the OU may have come from and what sorts of biological effects occur in more highly contaminated areas. There are also negative reference reaches that are upstream of the OU on the Clinch River (Reach 0) and Poplar Creek (Reach 13). These reaches were believed *a priori* to be relatively uncontaminated and are at least not contaminated by DOE releases. They are used to indicate what chemicals in the OU may have come from upstream and what sorts of biological conditions exist in the absence of exposure to DOE releases. It should be noted that the negative reference reaches do not constitute background conditions. Both the CR/PC are influenced by chemical releases and physical disturbances associated with municipalities, agriculture, and other activities in their watersheds. As a result, chemical concentrations in the OU reaches can not be screened against background.

The reaches are described in Sect. 3.1.1. and a map is available in Fig. 3.1.

6.2 RISKS TO FISH

6.2.1 Exposure Assessment for Fish

6.2.1.1 Aqueous exposures

Fish are exposed primarily to contaminants in water. Contaminants in water may come from upstream aqueous sources including the ORR, exchange of materials between the surface water and contaminated sediments, or exchange of contaminants between the biota and the water column. The consensus of the scientific community and of the EPA Office of Water is that aquatic biota should be assumed to be exposed to the dissolved fraction of the chemicals in water, because that is the bioavailable form (HECD 1992, Prothro 1993). However, the EPA Region IV, prefers to use total concentrations as conservative estimates of the exposure concentration. Therefore, both dissolved phase and total concentrations of metals are used in the exposure assessment for fish.

Because water in the OU is likely to be more variable in time than space, due to the rapid replacement of water, the mean water concentration within a subreach is an appropriate estimate of the chronic exposure experienced by fishes. The upper 95% confidence bound on the mean is an appropriately conservative estimate of this exposure for use in the contaminant screening. However, the distribution of observed concentrations is used to estimate risks.

Some fish spend most of their lives near the sediment and the eggs and larvae of some fish (particularly sunfish and black bass) develop at the sediment water-interface. These epibenthic species and life stages may be more highly exposed to contaminants than is suggested by analysis of samples from the water column. The water samples collected 1 m above the sediments by the contaminant remobilization task (Sect. 3.3) provide an estimate of this exposure. However, those samples were not found to contain significantly higher chemical concentrations (Sect. 3.3), so they were combined with the other samples. Another exposure that is relevant to this route is the exposure of *D. magna* to water above sediment in one of the sediment toxicity tests (Sect. 3.3).

6.2.1.2 Fish body burdens

Although nearly all toxicity data for fishes is expressed in terms of aqueous concentrations, fish body burdens potentially provide an exposure metric that is more strongly correlated with effects (McCarty and Mackay 1993). This is particularly likely to be the case for chemicals that bioaccumulate in fish and other biota to concentrations greater than in water. For such chemicals dietary exposure may be more important than direct aqueous exposures and concentrations that are not detectable in water may result in high body burdens in fish. Three contaminants that were determined to be COPECs in prior assessments of the CR OU bioaccumulate in that manner: mercury, PCBs, and selenium. Only mercury and PCBs are considered in this assessment, because selenium was not found to be significantly elevated in the data used in the RI (Chap. 3). Since the individual body burden measurements correspond to an exposure level for an individual fish, the maximum value is used for screening purposes and the risk estimate is based on the distribution of individual observations for each measured species. Measurements were performed on muscle (fillet), carcass (residue after filleting), or whole fish. Since whole fish measurements are most commonly used in the literature, whole fish concentrations either measured directly or reconstructed from fillet and carcass data are used (Sect. 6.4).

6.2.2 Effects Assessment for Fish

6.2.2.1 Single chemical aqueous toxicity

The screening benchmarks for aquatic biota are taken from Suter and Mabrey (1994). Because there are no standard screening benchmarks, sets of alternative benchmarks (described in Table 6.1) were calculated for each chemical. The benchmark preferred by the regulatory agencies is the chronic NAWQC, but they are available for relatively few industrial chemicals. Secondary chronic values (SCV), which are conservative estimates of chronic NAWQC, were calculated for chemicals that do not have NAWQC. Other benchmarks are included to provide greater assurance of detecting all COPECs.

NAWQC that are functions of water hardness are corrected for site-specific conditions. For purposes of screening, conditions were chosen that would constitute reasonable maximum toxicity, defined as conditions that would persist for seven days. This was a hardness of approximately 100 mg/L. The minimum, mean, and maximum hardness in the Clinch River are 105, 122, and 132 and in Poplar Creek are 68, 114, and 162.

Toxicity profiles are presented in Appendix F for COPECs. The toxicity profiles summarize the existing toxicity information for each chemical including concentrations causing acute lethality and chronic lethal and sublethal effects, and physical-chemical conditions that modify toxicity. For chemicals with hardness-dependent criteria, test endpoints were corrected to 100 mg/L hardness using the EPA's formula unless the test water was between 80 and 120 mg/L hardness.

6.2.2.2 Fish body burdens

There are no standard benchmarks for effects on fish of internal exposures. The body burdens associated with effects in toxicity tests and field studies and body burdens found at other sites are discussed below. To be consistent with EPA practices in calculating CVs, thresholds for toxic effects are expressed as geometric means of body burdens measured at the NOEC and LOEC. Only mercury and PCBs were considered because they are the COPECs known to significantly bioaccumulate in fish through dietary exposure.

Table 6.1. Descriptions of the ecotoxicological screening benchmarks for aquatic biota. More details are presented by Suter and Mabrey (1994).

Benchmark	Abbreviation	Description
Acute National Ambient Water Quality Criteria	NAWQC_ACU	Current national criteria for protection of aquatic life from lethal effects in episodic exposures.
Chronic National Ambient Water Quality Criteria	NAWQC_CHR	Current national criteria for protection of aquatic life from lethal and sublethal effects in extended exposures. Criteria for uses of aquatic life (i.e., fish consumption) are not included.
Secondary Acute Value	S_ACU_V	Values estimated with 80% confidence to not exceed the unknown acute NAWQC. Used when data are inadequate to calculate the acute criterion.
Secondary Chronic Value	S_CHR_V	Values estimated with 80% confidence to not exceed the unknown chronic NAWQC. Used when data are inadequate to calculate the chronic criterion.
Lowest Chronic Value for fish	LCV_FISH	The lowest value, from acceptable fish chronic toxicity tests, of the geometric mean of the Lowest Observed Effect Concentration (LOEC) and the No Observed Effect Concentration (NOEC).
Lowest Chronic Value for daphnids	LCV_DAPH	The lowest value, from acceptable daphnid chronic toxicity tests, of the geometric mean of the LOEC and the NOEC.
Lowest Chronic Value for non-daphnid invertebrates	LCV_ND	The lowest value of the geometric mean of the LOEC and the NOEC from acceptable chronic toxicity tests of non-daphnid invertebrate species.
Lowest Plant Value	LCV_AQPL	The lowest value from an acceptable daphnid chronic toxicity test of the geometric mean of the LOEC and the NOEC.
Lowest Test EC20 for Fish	LTV_FISH	The lowest value, from acceptable fish chronic toxicity tests, of the lowest concentration causing at least a 20% reduction in the weight of young per female or the weight of young per egg.
Lowest Test EC20 for Daphnids	LTV_DAPH	The lowest value from an acceptable daphnid chronic toxicity test of the lowest concentration causing at least a 20% reduction in the product of survivorship, growth, and fecundity.

Mercury. Estimates of body burdens of mercury that constitute a threshold for toxic effects on fish range from 0.66 mg/kg to 5.6 mg/kg wet weight. The lower figure is the geometric mean of body burdens in fathead minnows showing significant reproductive effects and those of fish showing no significant effects in a chronic test of mercuric chloride that included dietary exposures (Snarski and Olson 1982). The higher figure is the geometric mean of body burdens associated with reproductive effects and no significant effects in exposures of brook trout to methyl mercury (McKim et al. 1976). Mercury concentrations in sunfish from streams in the vicinity of the ORR that were not mercury contaminated ranged from 0.06 to 0.11 mg/kg wet weight (Southworth et al. 1994). Concentrations in reservoirs that do not receive ORR effluents ranged from 0.03 to 0.13 mg/kg wet weight with the highest concentrations in Norris Reservoir (Southworth et al. 1994).

PCBs. Estimates of body burdens of PCBs that constitute thresholds for toxic effects in fish are presented in Table F1.11. They are presented on a whole-body basis, and, when possible, on a lipid normalized basis. There is a very large range of values that have been reported to constitute thresholds for toxic effects in toxicity tests, including one incredibly low value for lake trout. When possible, studies of the species (or closely related species) in which body burdens were measured will be used.

6.2.2.3 Ambient water toxicity

Methods and results of toxicity tests of ambient water are presented in Sect. 3.7. The tests employed include the standard 7-d tests of growth and survival in fathead minnow larvae and fecundity and survival of *C. dubia*, and an early life stage test with Japanese medaka eggs and larvae. Because these subchronic tests were developed for testing effluents and ambient waters rather than pure chemicals, their relationship to levels of contaminant exposure must be related to the patterns of contamination of the OU and reference reaches and related to effects levels for individual contaminants in other tests (Sect. 6.2.2.1).

6.2.2.4 Fish community survey

Analysis of fish population and community survey data provides a direct measure of impacts of human activities on aquatic ecosystems. These data can provide an additional line of evidence relating to potential impacts of DOE operations on the Clinch River. Two sources of data were available for this assessment: (1) data from TVA's Reservoir Vital Signs Monitoring Program, and (2) data from the Clinch River System collected for the ER Program using the same sampling techniques. These data are described in Appendix F8.

6.2.2.5 Fish bioindicators

Two of the classes of bioindicators discussed in Sect. 3.5.4 are sufficiently associated with effects on fish to be used as measures of effects and show a sufficiently large and consistent variance relative to exposure of fish to the DOE sources to be of interest for estimating risks. They are histopathology and reproductive indicators. The relationship of these indicator responses to levels of exposure to the contaminants are poorly specified, so they must be related to the patterns of contamination of the OU and reference reaches in the risk characterization.

6.2.3 Risk Characterization for Fish

6.2.3.1 Single chemical aqueous toxicity

Screening aqueous exposures against benchmarks

All chemicals detected in whole or filtered water were screened against benchmarks. This was done by dividing the 95% upper confidence bound (UCB) concentration by each of the aqueous screening benchmarks (Table F2.1). Chemicals that exceeded any benchmark (i.e., the quotient of UCB/ASB was greater than 1) were examined further to determine whether they were credible COPECs (Table 6.2). Chemicals that exceeded benchmarks were eliminated as COPECs if they met any of the following criteria.

- They are metals, do not exceed benchmarks in filtered samples, and are not associated with an identifiable source. Such metals are deemed to be associated with background particulate material which is not bioavailable.
- They exceed a highly conservative benchmark and the exceedence occurs at all or nearly all locations and not in particular association with an identifiable source. The benchmark is deemed to be effectively below background and too conservative for this use.
- They are detected in only one or two samples per reach, those detects constitute 5% or less of the total samples, the detections are only in unfiltered water, and they are not associated with any identifiable source. Such detections are deemed to be anomalies and not relevant to risks to aquatic biota.

A second step in the screening process involved determining the relative contribution of the COPECs to the distribution of toxicity across reaches. This was done by converting the concentrations to equivalent toxicity normalized concentrations and then plotting the values for each reach or subreach (Fig. 6.3, see also Fig. 3.1 for locations of subreaches). The standard toxic value used in the normalization is the *D. magna* EC50, the only test endpoint that is available for all of the aqueous COPECs. Concentration in TUs was calculated as:

$$TU = UCB/EC50$$

If the combined toxic effects of the COPECs are concentration additive, then, if the sum across chemicals of TU is greater than 1, one would expect acute lethality to *Daphnia*. ΣTU values greater than 0.2 are suggestive of chronic toxic effects. The ΣTU graph reveals that toxicity is likely to be high in subreaches 3.04 and 4.01, primarily due to copper. Silver, is detected only in Reaches 7, 1, 13, and 3.02, but, because the detection limit is high relative to its toxicity, where it is detected it is a large contributor to ΣTU. The relatively high total toxicity in Reach 13 in Poplar Creek upstream of the reservation and the diversity of chemicals contributing to that toxicity, is a surprising result.

Exposure - effects profiles for aqueous exposures

For each COPEC, the distribution of observed concentrations is compared to the distribution of toxic concentrations for aqueous fish and invertebrates. If sufficient toxicity data exist, the empirical distribution functions are presented graphically. Toxicity information is drawn from the toxicity profiles (Appendix F).

Table 6.2. Results of screening of chemicals that exceed benchmarks in whole or filtered water for COPECs

Chemical	COPEC	Reason for Inclusion or Rejection
Aluminum	No	Exceeds chronic NAWQC in all reaches and acute NAWQC in 18, 21, and 22 in whole water but no benchmarks in dissolved phase. Hence, the exceedences are due to filterable particulate Al which is ubiquitous and not bioavailable.
Barium	No	Exceed the SCV, but no other benchmark, in both whole and filtered water in all reaches. The SCV for Ba is apparently below background due to the conservative factors used in its derivation.
Boron	No	Exceeds the LTV Daphnids, but no other benchmarks, in whole and filtered water in all reaches. That benchmark is apparently below the local background due to the compounding of effects across life stages in its derivation.
Cadmium	Yes	Dissolved phase Cd from 13 and 22 exceeds chronic NAWQC and from 1 and 4.04 exceeds CVs.
Cobalt	No	Detected in only whole samples and in only one sample from 1, 2.02, 18, and 22 and on only 2 out of 18 samples in 21. Deleted because it is rarely detected and never in a bioavailable form.
Copper	Yes	Exceeds several benchmarks including the chronic NAWQC in filtered water from 4.01.
Cyanide	No	Detected in only 1/20 filtered samples from 20 and not in whole water there. That detect is deemed to be an anomaly.
Iron	Yes	Exceeds Daphnid LCV in filtered samples from 0, 2, 4, and 7.
Mercury	Yes	Exceeds fish LCV in filtered water from 4.02 and whole water from 3.04.
Nickel	Yes	Exceeds Daphnid and plant LCVs in filtered water from 2.01, 2.03, 3.01, 3.03, 4.04, 7.01, 8, and 13.
Silver	Yes	Exceeds the fish LCV in filtered water from 1, 3.02, 7.01, 7.02, and 13, and the daphnid LCV in 3.02.
Thallium	No	Not detected in filtered water but detected in a single whole water sample out of 48 samples from 1 at a concentration that exceeds several benchmarks. Deleted because anomalous and not bioavailable.
Uranium	Yes	Exceeds the SCV in filtered water from 2.02, 3.02, 3.03, and 3.04.
Zinc	Yes	Exceeds fish and plant LCVs in filtered water from 4.01.
Bis (2-ethylhexyl) phthalate	Yes	Exceeds multiple benchmarks in filtered water from 1, 2, 3, 4, and 13 and in whole water from 7 and 10.
Carbon disulfide	Yes	Exceeds the SCV in whole water from 2.04 and 3.03.
PCB 1254	Yes	Exceeds the plant LCV and SCV in whole water from 3.01, 3.04, and 13.

Bis(2-ethylhexyl)phthalate. The highest concentrations and greatest frequencies of detections of bis(2-ethylhexyl)phthalate are in Reach 13. However, the distribution of concentrations there and in other reaches is poorly defined because detections are rare and often occur at concentrations equal to or less than the limits of detection in other samples. The maximum concentration in filtered water from Reach 13 (0.23 mg/L) exceeds the CV for rainbow trout and the two highest concentrations exceed the species mean CV for *D. magna*. The maximum whole water concentration is lower than filtered water, exceeding only the *D. magna* CV. The only other sample exceeding reported toxic concentrations is the single detect from subreach 2.04 which barely exceeds the *D. magna* CV. Hence the risk to aquatic biota in the OU from bis(2-ethylhexyl)phthalate appears to be negligible.

Carbon disulfide. Carbon disulfide was seldom detected in this study. The highest observed concentration, which is from Reach 13, is approximately a factor of 100 lower than the lowest observed toxic concentration. The exceedence of the SCV in the screening assessment is attributable to the large safety factors used with minimal data sets. Hence, there appears to be negligible risk to aquatic biota from carbon disulfide

Cadmium. The distributions of ambient cadmium concentrations and aqueous test endpoints are shown in Fig. F2.1. The ambient concentrations are dissolved phase concentrations in the subreaches in which Cd was detected (22, 13, 4.04, and 1). Because Cd was detected in only one sample from each subreach, the single concentrations are depicted as 100th percentile points. The highest Cd concentrations exceeded more than half of CVs (CVs for two cladoceran genera) and the chronic NAWQC, but these were the Poplar Creek upstream Reach (13) and the White Oak Creek embayment (22) which is a source, not a component of the OU. The two detected values in the OU (Reaches 1 and 4.04) were below the NAWQC but above one cladoceran CV in 4.04 and both cladoceran CVs in 1. Because Cd was not detected more than once in any reach and the detected values in the OU barely exceed CVs for members of a highly sensitive family of zooplanktors, it appears to pose negligible risk to aquatic biota.

Copper. The distributions of ambient copper concentrations and aqueous test endpoints are shown in Fig. F2.2. The ambient concentrations are dissolved phase concentrations in the subreaches with potentially hazardous levels of Cu (3.04 and 4.01). The toxic concentrations are those presented in the ecotoxicity profile (Table F1.2). The ambient concentrations fall into two phases. Concentrations below 0.01 mg/L display a fairly smooth increase suggestive of a log-normal distribution. The upper end of this phase of the distribution (above the 75th percentile of 4.01 and the 80th percentile of 3.04) exceed the lowest CV (a bluntnose minnow CV for reproductive effects). However, the distributions above the 90th percentile are not continuous with the other points. The break in the curve suggests that some episodic phenomenon causes exceptionally high concentrations. The two points in 4.01 and one in 3.04 that lie above this break exceed approximately 90% of the CVs, approximately 30% of the acute values, and both the acute and chronic NAWQCs. These results are suggestive of a small risk of chronic toxicity from routine exposures, but a high risk of short-term toxic effects of Cu during episodic exposures in lower Poplar Creek embayment and the Clinch River immediately downstream. Toxic concentrations were found in no other subreaches.

Iron. A single iron concentration in Reach 7.02 and in 13 exceed the chronic NAWQC. However, neither concentration exceeds toxic concentrations except for the study from Dave (1984) which simulated dilution of an acidic effluent. Since the NAWQC is also based on acidic effluents, which are not present in releases to this OU, risks to aquatic biota from iron are deemed to be minimal.

Mercury. The distributions of ambient mercury concentrations and aqueous test endpoints are shown in Fig. F2.3. The ambient concentrations are dissolved phase concentrations in the subreaches with potentially hazardous levels of Hg (3.02, 3.03, 3.04 and 13). The toxic concentrations are those

presented in the ecotoxicity profile (Table F1.3). The ambient concentrations fall into two phases. Concentrations below 0.00001 mg/L display a fairly smooth increase within a relatively small range of concentrations. The upper end of this phase of the distribution (above the 85th to 95th percentile) is well below toxic concentrations. However, the observations above this break point are up to a factor of 100 higher and not continuous with the other points. The break in the curve suggests that some episodic phenomenon causes exceptionally high concentrations. The highest observed concentrations in Reaches 3.02, 3.03, and 13 exceed the CV for fathead minnows and approximately equal the CV for *D. magna* (the only two CVs available for inorganic Hg). These results suggest that routine exposures are not toxic, but there is a small risk of short-term toxic effects of Hg during episodic exposures in Poplar Creek. Mercury concentrations in Poplar Creek upstream of the ORR (Reach 13) are routinely lower than those on the ORR, but they are approximately equal to Reach 3 extremes during the episodes. Toxic concentrations were found in no other subreaches, including EFPC (Reach 20.1) which is the presumed source.

Nickel. The distributions of ambient nickel concentrations and of aqueous toxicity test endpoints are shown in Fig. F2.4. Unlike other COPECs, episodic high concentrations of Ni were not detected. Rather, in Reaches 3.03, 3.04, 4.04, 7.02, and 13, Ni concentrations display a relatively smooth increase over approximately an order of magnitude with the very highest concentrations exceeding the CV for *C. dubia*, but no other toxic values. The highest concentrations and highest frequency of exceedences of the CV were observed in Reach 13, upstream of the ORR. These results suggest a small risk to the fish community in the OU due to Ni.

PCBs. The distributions of ambient PCB concentrations and aqueous test endpoints are shown in Fig. F2.5. The ambient concentrations are whole water concentrations in the subreaches in which PCBs were detected (13, 3.01, and 3.04). Because PCBs were detected in only one sample from each subreach, the single concentrations are depicted as 100th percentile points. The sum of PCB 1254 and 1260 in Reach 13 exceeds more than half of the CVs, but that reach is upstream of the ORR. Observed PCB values in water from Reach 3 were well below toxic concentrations.

Silver. The distributions of ambient silver concentrations and aqueous test endpoints is shown in Fig. F2.6. The ambient concentrations are dissolved phase concentrations in the subreaches in which Ag was detected (3.02, 7.01, and 13). Because Ag was detected in only one or two samples per reach, only the upper end of the concentrations are displayed; the remainder of the distributions is undefined. One observed concentration in subreach 3.02, which was more than 10 times the second highest concentration, exceeded the acute NAWQC as well as a *D. magna* EC50, LC50s for two fish (speckled dace and mottled sculpin), and both of the available CVs for Ag (*D. magna* and rainbow trout), but the second highest concentration in that reach was below all toxic levels. The single detected Ag concentration in Reach 13 and the highest of two detects in subreach 7.01 exceeded the rainbow trout CV. These results suggest that Ag poses little risk to the fish communities of the OU. However, the combination of a detection limit that is barely lower than the lowest CV and the small toxicity data set makes interpretation uncertain.

Uranium. None of the observed uranium concentrations fall within a factor of 100 of the lowest reported toxic concentration (a fathead minnow LC50 of 2.8 mg/L), and all but a few observations were more than a factor of 1000 lower. The exceedence of the SCV in the screening assessment is attributable to the large safety factors used with minimal data sets.

Zinc. The distributions of ambient zinc concentrations and aqueous test endpoints is shown in Fig. F2.7. The ambient concentrations are dissolved phase concentrations in the subreach with potentially hazardous levels of Zn (4.01). The toxic concentrations are those presented in the ecotoxicity profile

(Table F1.7). The ambient concentrations fall into two phases. Concentrations below 0.01 mg/L display a fairly smooth increase suggestive of a log-normal distribution. This phase of the distribution (below roughly the 85th percentile) does not exceed any toxic concentrations. However, the distributions above the 90th percentile are not continuous with the other points. The break in the curve suggests that some episodic phenomenon causes exceptionally high concentrations. The two points that lie above this break exceed approximately 15% of the CVs (flagfish and *D. magna*), the very lowest acute values for both fish (cutthroat trout LC50) and invertebrates (*Ceriodaphnia reticulata* EC50), and chronic NAWQC. The highest concentration exceeds the acute NAWQC. These results are suggestive of a small risk of short-term toxic effects of Zn to sensitive species during episodic exposures in the Clinch River immediately downstream of Poplar Creek. Toxic concentrations were found in no other subreaches.

6.2.3.2 Single chemical internal toxicity

Mercury. The only fish with body burdens of mercury that fell within the potentially toxic range were largemouth bass in Reach 3. When fillet/whole body corrections were applied, the concentration in the most contaminated largemouth bass (1.28 mg/kg) exceeded the 0.66 mg/kg concentration that corresponded to a CV for fathead minnows but was well below the value for brook trout (5.6 mg/kg). The median concentration for largemouth bass and all concentrations for bluegill, gizzard shad, and channel catfish were below 0.66 mg/kg, but shad and catfish were not analyzed for mercury in Reach 3. Body burdens in the OU can also be compared to those in EFPC, the primary source of mercury to Poplar Creek and the Clinch River. The fish community at kilometer 13.8 of EFPC has species richness and abundance that approximately equals background. At that site, average mercury concentrations in redbreast sunfish have been in the range of 0.6–1 mg/kg since 1984. Since that range is considerably higher than the median concentration on Reach 3 for largemouth bass (0.29 mg/kg) or bluegill sunfish (0.25 mg/kg), we may conclude that mercury accumulation is unlikely to significantly reduce fish community richness or abundance in the OU. That conclusion, and the marginal exceedence of the lowest benchmark based on laboratory testing, suggest that the risk to fish from accumulation of mercury appears to be quite small.

PCBs. PCB concentrations are highest in channel catfish and in certain positive reference reaches: White Oak Creek (22), Tennessee River (18), and Emory River (6). The highest average whole-body concentrations (estimated from fillets) in the OU are from Reach 2 with median and maxima of 1.9 and 5.7 mg/kg for PCB-1254 and 4.1 and 13.1 mg/kg for PCB-1260. A test of dietary exposure of channel catfish to PCB-1242 found reduced growth and liver hypertrophy at a body burden of 14.3 mg/kg (Hansen et al. 1976). This concentration is approximately half of the median concentration of total PCBs in Reach 22 but much higher than the median in other reaches. It is, however, less than the total PCB concentration in the most exposed individual catfish in Reaches 0, 2, 3, 4, 5, and 18. The test was run with PCB-1242 which should be less toxic than the more highly chlorinated PCBs found in catfish from the OU. However, fingerlings used in the test may be more sensitive than the adult fish analyzed, and the body burdens of fingerlings are unknown.

6.2.3.3 Ambient water toxicity

Two expressions of the results of aqueous toxicity tests are used, the average magnitude of the effects and the frequency of effects that are significant. Test results are deemed significant if the difference between the response of the organisms exposed to water from the OU and organisms in control or reference water is at least 20% (i.e., biologically significant) or if the likelihood that the difference is due to chance is less than 5% (i.e., statistically significant). Test results are related to two expressions of exposure, the location of the sample relative to sources and the relationship between the responses and the concentrations of aqueous COPECs in the tested water. Three responses in two tests

are potentially indicative of toxicity. Mortality of fathead minnow larvae was frequently more than 20% greater than in control water, *Ceriodaphnia* fecundity was occasionally reduced more than 20% relative to control water, and the mortality and frequencies of abnormalities in medaka embryos were frequently more than 20% greater than in control water. The methods and results of these tests are discussed in Sect. 3.3.7. This section analyzes their implications for risks to fish in the OU.

Fathead minnow. Mortality of fathead minnow larvae in Poplar Creek is elevated relative to controls, but mortality in Reach 3 is not appreciably elevated relative to reference Reach 13.06 which is 0.9 miles upstream of any DOE sources (Fig. 6.4). High levels of mortality in Poplar Creek occurred primarily in the April 1994 testing period when water levels were high, suspended particulate levels were high, and hardness was low due to storms (Sect. 3.3). The professional judgement of the individuals who conducted the tests, and who have considerable experience with this test on the ORR, is that the mortality was due to causes other than toxicity, possibly associated with high suspended particulate levels. This judgement is supported by the fact that the proportional increase in fathead minnow mortality relative to controls was statistically significantly positively correlated with total suspended solids levels in samples taken in conjunction with the tests ($\alpha = 0.003$, $r^2 = 0.28$), but not with concentrations of any of the COPECs. However, the water analyses were conducted on only one day, so contaminant concentrations or other conditions on other days of the test do not contribute to the correlations. In sum, these test results do not provide good evidence concerning risks of toxic effects to the fish community of Poplar Creek.

No statistically significant differences in fathead minnow mortality were found in McCoy Branch (Reach 7) water relative to either control or reference water, but in one of the two tests of subreach 7.02, there was a 21% increase in mortality relative to controls (accounting for the 50% significant tests in Fig. 6.4) which corresponded to a 14% reduction relative to reference. The facts that the results are marginal and that the greatest potential effect occurred in the subreach furthest from the source suggest that sources in the McCoy Branch watershed are not causing significant toxicity to fathead minnow larvae.

Ceriodaphnia. Fecundity of *Ceriodaphnia* is enhanced by ambient water relative to controls at most sites (Fig. 6.5). However, one test each in subreaches 3.02, 13.11, and 7.01 had a greater than 20% reduction in fecundity which was also statistically significant (Sect. 3.3). Since effects were greater in the upstream reference Reach (13.11) than in the OU portion of Poplar Creek (3.02) and effects are rare, there is little evidence that DOE sources are causing toxicity to *Ceriodaphnia*. The reduction in fecundity in upper McCoy Branch embayment (Reach 7.01) in August 1994 is large relative to both controls (52%) and reference (59%) and is supported by a small but statistically significant reduction (16%) relative to reference on the other tested date. Hence, although only two tests were run at that site, they both suggest that water from upper McCoy Branch is toxic to *Ceriodaphnia*. Correlation of *Ceriodaphnia* fecundity against concentrations of COPECs does not reveal any contaminants to be potential causes of the variance across reaches in test results.

Medaka. The proportion of medaka embryo tests showing significant increases in mortality or abnormalities is greatest in Poplar Creek embayment (Fig. 6.6 and 6.7). Mean rates of abnormalities were less than 10% in embryos incubated in water from Reaches 7.01, 7.02, 8, 2.01, and 4.01. However, mean rates were greater than 30% in all subreaches of Reach 3, and were greater than 50% in Reach 3.02 (Fig. 6.7). More than 40% of tests conducted in Reach 3 water had abnormality rates that were significant (statistically significant or more than 20% greater than reference) (Sect. 3.3). Proportional reductions in medaka survival were quite erratic because of variance in survival in reference water, but the proportion of tests with significant reductions in survival relative to the reference site (Reach 13.11) consistently increased downstream in Poplar Creek (Fig. 6.6). Hence, Reach 3 water is clearly toxic to medaka embryos relative to upstream water. However, the toxicity observed at 13.06, although less

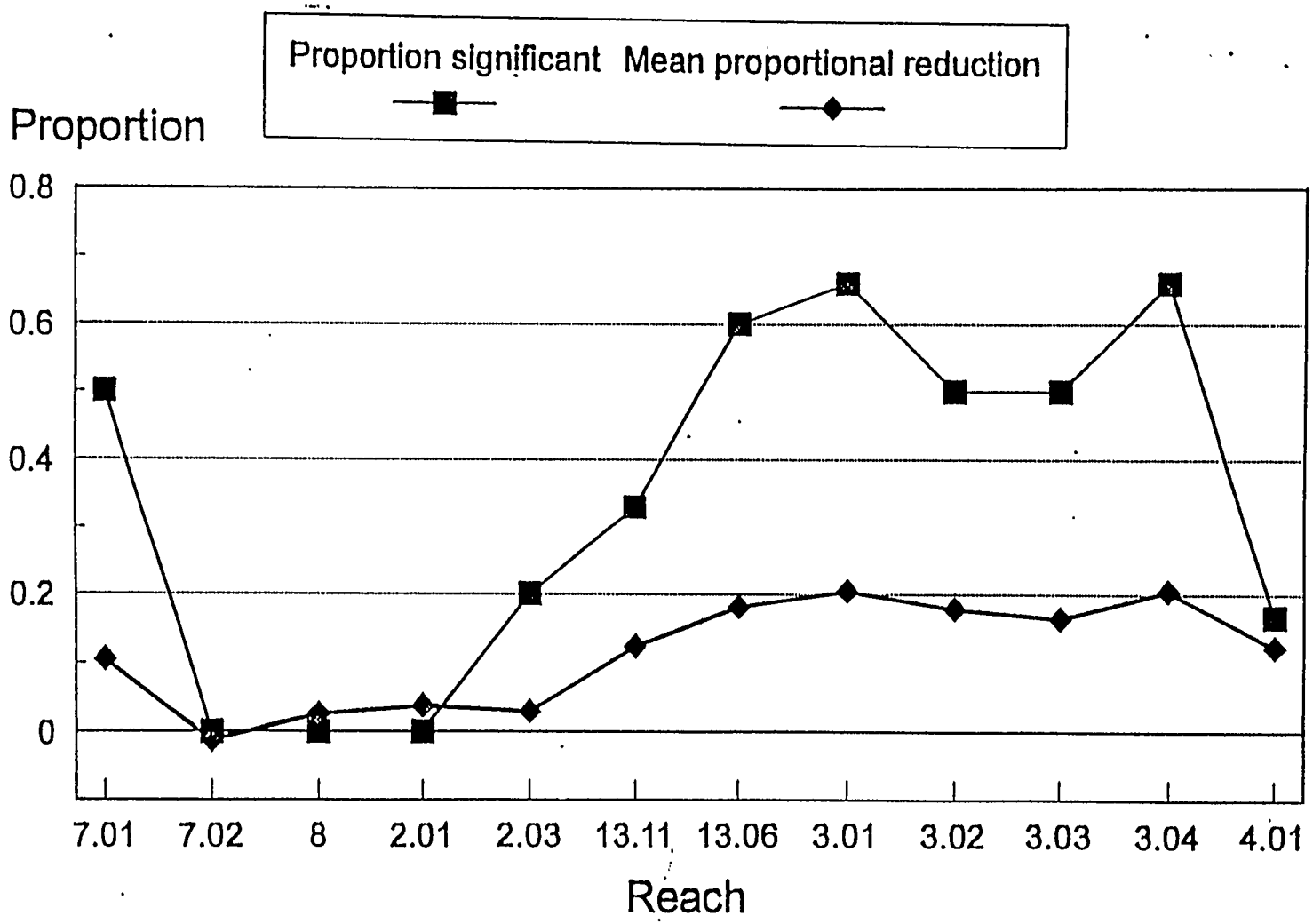


Fig. 6.4. Proportional reduction in fathead minnow larval survival relative to controls and proportion of tests in which survival was statistically significantly decreased relative to controls or was decreased by at least 20% relative to controls (i.e., significantly decreased). Note for comparison the responses in the Clinch River reference subreach (2.01), the far upstream reference reach in Poplar Creek (13.11) and the near upstream reference (13.06).

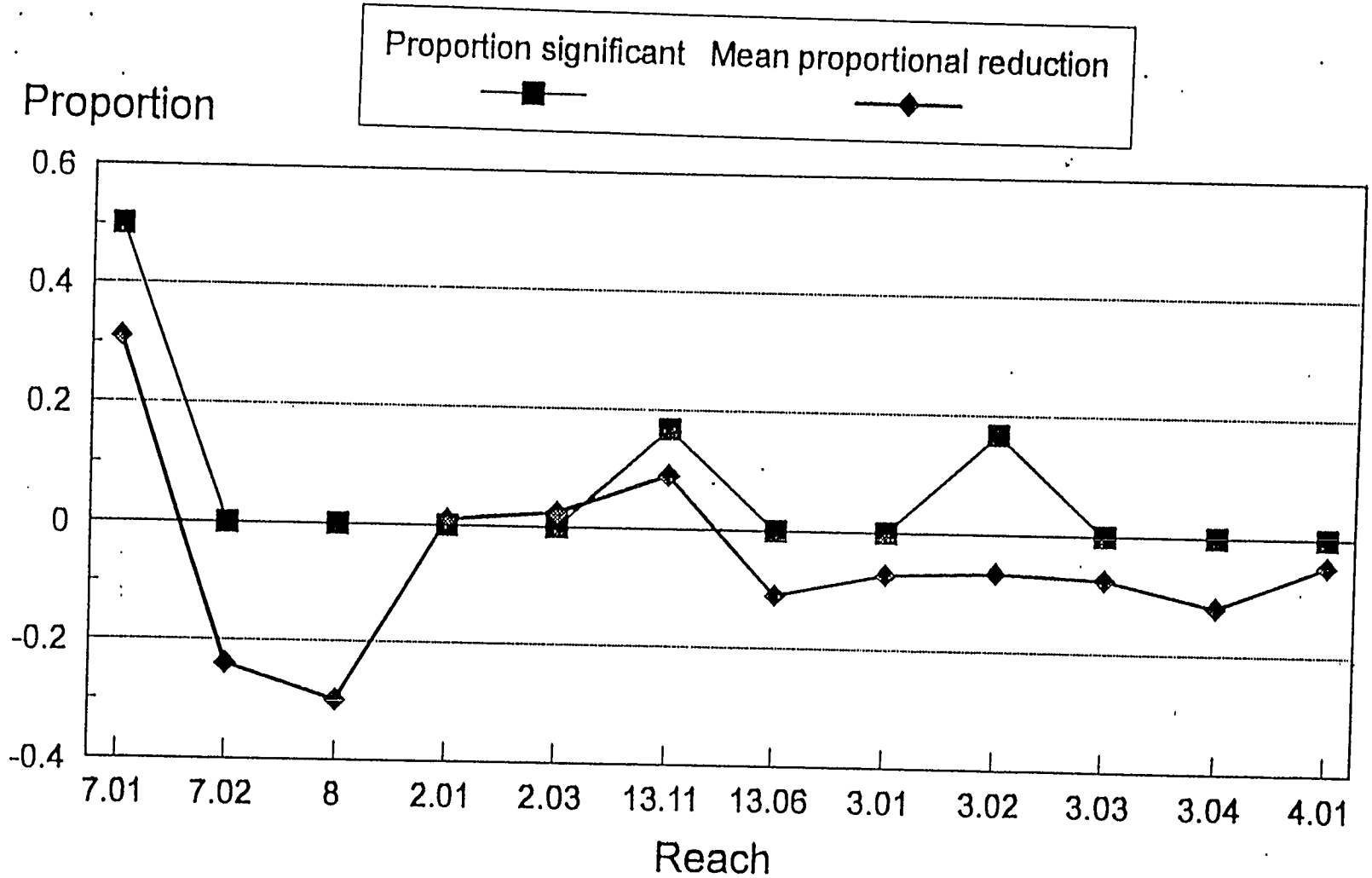


Fig. 6.5. Proportional reduction in *Ceriodaphnia dubia* fecundity relative to controls and proportion of tests in which fecundity was statistically significantly decreased relative to controls or was decreased by at least 20% relative to controls (i.e., significantly decreased). Note for comparison the responses in the Clinch River reference subreach (2.01), the far upstream reference reach in Poplar Creek (13.11) and the near upstream reference (13.06).

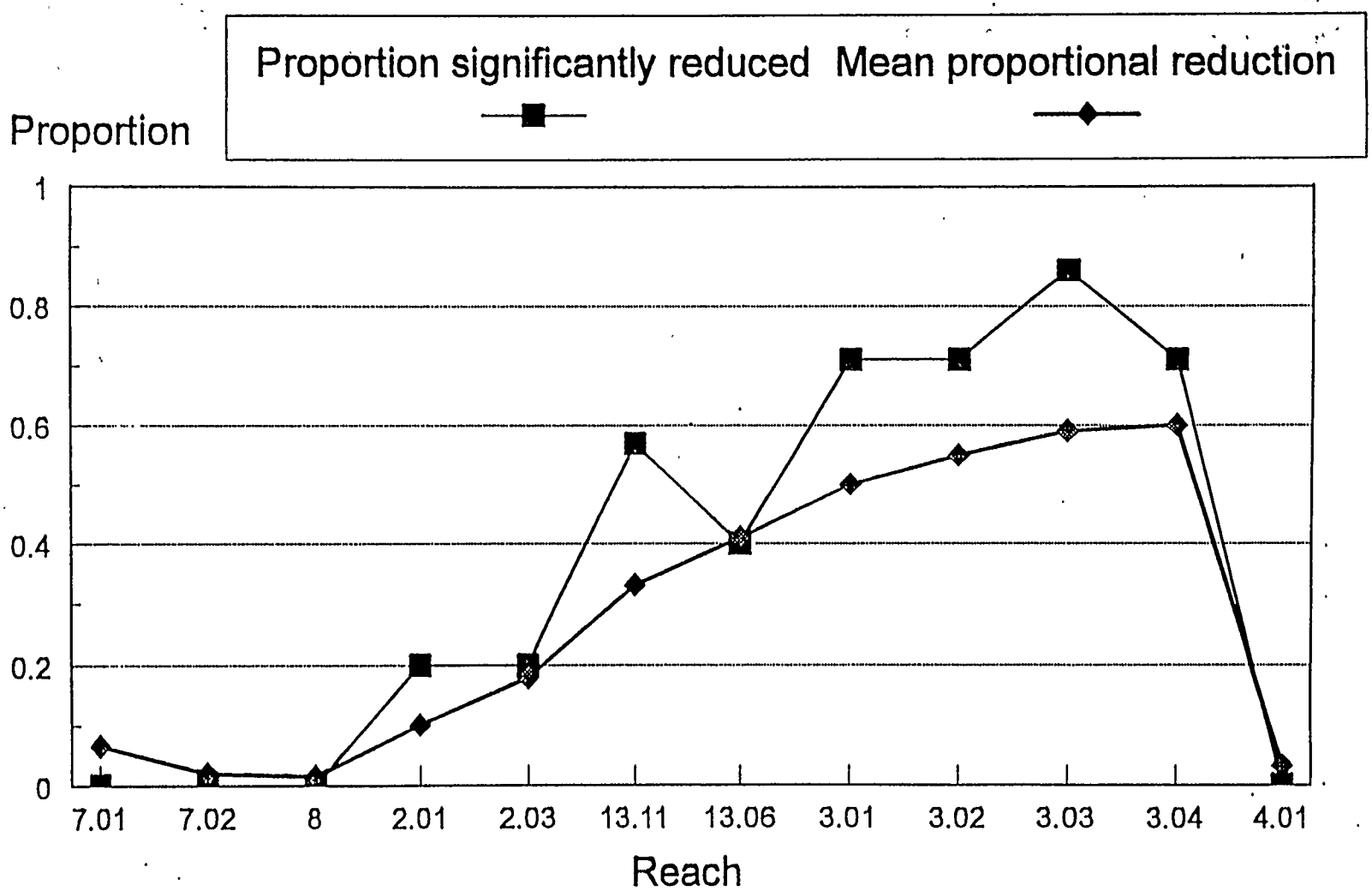


Fig. 6.6. Proportional reduction in survival of medaka eggs relative to controls and proportion of tests in which survival was statistically significantly decreased relative to controls or was decreased by at least 20% relative to controls (i.e., significantly increased). Note for comparison the responses in the Clinch River reference subreach (2.01), the far upstream reference reach in Poplar Creek (13.11) and the near upstream referenc (13.06).

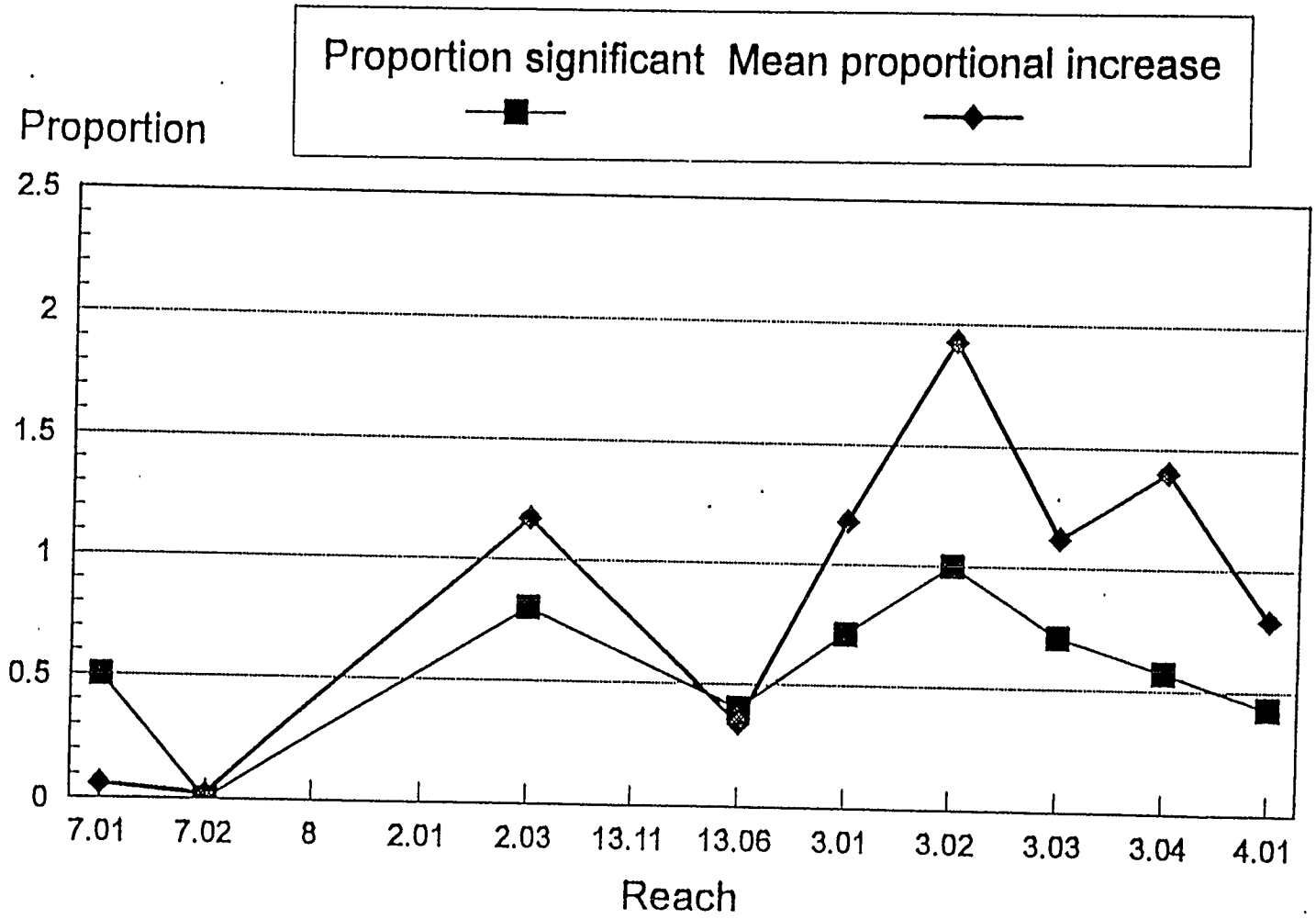


Fig. 6.7. Proportion of abnormal medaka larvae and proportion of tests in which abnormalities were statistically significantly increased relative to reference or were increased by at least 20% relative to reference (i.e., significantly increased). Note for comparison the frequencies of abnormalities in the Clinch River reference subreach (2.01), the far upstream reference reach in Poplar Creek (13.11) and the near upstream reference (13.06).

severe and frequent than in Reach 3, does indicate that some component of the water coming from upstream of the DOE sources contributes to the toxicity. Although one out of two tests in upper McCoy Branch embayment (Reach 7.01) had a reduction in survival that was statistically significantly greater than the reference (Reach 8), survival was an acceptable 84%, and abnormality rates were less than 10%.

The proportional reduction in survival of medaka embryos relative to reference was regressed against concentrations of COPECs and other properties of the water collected in conjunction with the toxicity tests. Medaka survival was statistically significantly correlated with concentrations of nickel ($r^2 = 0.64$), but not other variables. The nickel concentrations in the tests with the highest medaka mortality were less than a tenth of the chronic NAWQC, but approximately equal the *C. dubia* CV for ORR water (0.0106 mg/L [Table F1.7]). Hence, the apparent exposure-response relationship is credible if medaka embryos are at least a sensitive to Ni as *Ceriodaphnia*, if Ni concentrations were higher on other days of the test than on the day when water was analyzed, or if other contaminants present in the test water contributed to the total toxicity. Another limitation of this exposure-response analysis is the fact that, by chance, the three out of seven medaka tests for which the water was analyzed showed the least mortality and abnormalities. Analysis of the more toxic waters would be likely to have shown more clearly the causes of the toxicity to medaka.

Sunfish and Largemouth Bass. To determine the relevance of the medaka embryo test to fish that occur in the OU, a single set of tests was run on embryos of medaka, redbreast sunfish and largemouth bass at six sites (Sect. 3.3.7.3). The bass results were erratic, with considerable variance among pairs. However, the sunfish results support the medaka results in that both showed biologically and statistically significant embryo lethality in subreaches 3.02 and 3.04 (3.01 and 3.03 were not tested) but not in 2.01 or 4.01. However, unlike the medaka, the sunfish showed no significant increase in abnormalities.

Sediment toxicity tests. The toxicity tests performed with sediment pore water and water above sediment showed no toxicity (Sect. 6.3). This result suggests that the epibenthic water inhabited by bottom-dwelling fish and the eggs and larvae of bottom-spawning fish does not pose a particular risk relative to the near surface water that was used in the tests described above.

Summary of aqueous toxicity tests. Of the three aqueous toxicity tests, only the medaka embryo test shows consistent evidence of toxicity. In addition, only nickel concentrations and medaka survival showed a relationship between exposure and response. The lack of response in the two standard tests does not eliminate the possibility of toxic conditions with respect to those test species. The high episodic concentrations of copper, mercury, silver, and zinc described above did not occur during any of the test periods. Of the COPECs, only nickel occurred at its highest concentrations during a test period. Water in Reach 3 is regularly toxic to medaka embryos and is toxic to redbreast sunfish embryos in the one test of that species relative to the reference site. Although the medaka test has not been validated against field survey data like the standard fathead minnow and *Ceriodaphnia* tests, the nature and magnitude of the effects suggest a significant risk to sensitive fish populations in Reach 3 that could be sufficient to significantly affect community properties.

6.2.3.4 Biological indicators

Histopathology. Histopathologies of bluegill liver and spleen were most common in Reaches 3.01, 3.02, and 4.01 (Sect. 3.5.4). The lowest frequencies were in lower Watts Bar (5), the Clinch immediately below White Oak Creek (2.02), and Norris Reservoir (10). The highest frequency of histopathologies were in largemouth bass from Reach 3.02, followed by 2.02 and 4.01. The lowest frequencies were in 5, 10, and, surprisingly, 3.04. Hence, histopathologies are consistently common in Poplar Creek below Mitchell Branch and in the Clinch immediately below Poplar Creek. Of the reaches in the OU,

histological measures were not obtained from 1, 2.03, 2.04, 3.03, 4.02, 4.03, or 7. These histopathologies are characteristic of exposure to PCBs, so had they been absent, that absence would have constituted evidence against PCB toxicity. However, because they are suborganismal effects, their presence does not necessarily imply effects on the fish community. They simply indicate a potential causal link between exposure and higher level effects.

Reproductive indicators. Results of the studies of reproductive indicators are presented in Sect. 3.5.5. These indicators were measured in the OU only in Reaches 2.02, 3.04, and 4.04. At both Reaches 2.02 and 3.04 the gonadosomatic index of male bass was reduced, and in female bass death of oocytes (atresia) increased and fecundity decreased relative to reference fish from Norris Reservoir. Bluegill did not show clear or consistent differences in the indicators that might be related to DOE emissions. Although these indicators can not be interpreted as indicative of effects on the fish community endpoint, they are suggestive of inhibited reproduction in individuals of one species.

6.2.3.5 Biological surveys

The data on fish species richness (Figs. 6.8 through 6.11) show no pattern that can be attributed to a contaminant effect. For both years and gear types, the sampling stations in the Clinch River (Reaches 2.02, 4.01, and 4.04) fall within the range of values for the reference sites: Norris Reservoir (Reach 10) and Watts Bar Reservoir (Reach 5 and Reach 18). As noted in Appendix F8, analysis of fish community composition for reservoirs throughout the Tennessee Valley shows that Norris and Watts Bar are ecologically distinct from each other. Fish abundance and species richness at the mouth of Poplar Creek (Reach 3.04) are similar to abundance and richness in the lower Clinch River and Watts Bar reservoir. However, richness and abundance in the two upstream subreaches, Reach 3.02 and 3.04, are significantly lower than in the Clinch or Watts Bar. Because no reference embayments were included in the survey, no conclusion regarding contaminant effects is possible from this line of evidence. Because of habitat differences, the fish community in Poplar Creek embayment would be expected to differ to some extent from the fish community present in a mainstem river or reservoir.

6.2.3.6 Weight of evidence for fish

The weighing of evidence is performed by asking the following questions concerning each reach in the OU:

1. Is the fish community less species-rich or abundant than would be expected?
2. Do individual fish display injuries that are indicative of significant toxic effects?
3. Is the water toxic to aquatic organisms?
4. Does that water contain chemicals in toxic amounts?
5. Do the fish contain chemicals in toxic amounts?
6. What factors account for apparent discrepancies in the results?
7. What is the likelihood that the fish community is at least 20% less species rich or abundant than it would be in the absence of contamination?

Poplar Creek embayment (Reach 3). Although the evidence is not strong, it is more likely than not that the fish community endpoint is violated. This conclusion is based on the results indicating that the fish in Reach 3 are intermittently exposed to levels of contaminants in water that have been shown to be toxic, that water collected between those episodes is toxic to fish embryos, and that individual fish are experiencing sublethal injuries. Although the relatively depauperate state of the community consistent with significant toxic effects, it is not clearly attributable to toxicity. In addition, it is not clear what chemicals from what sources are the cause of the observed effects. The conclusion is mitigated by the

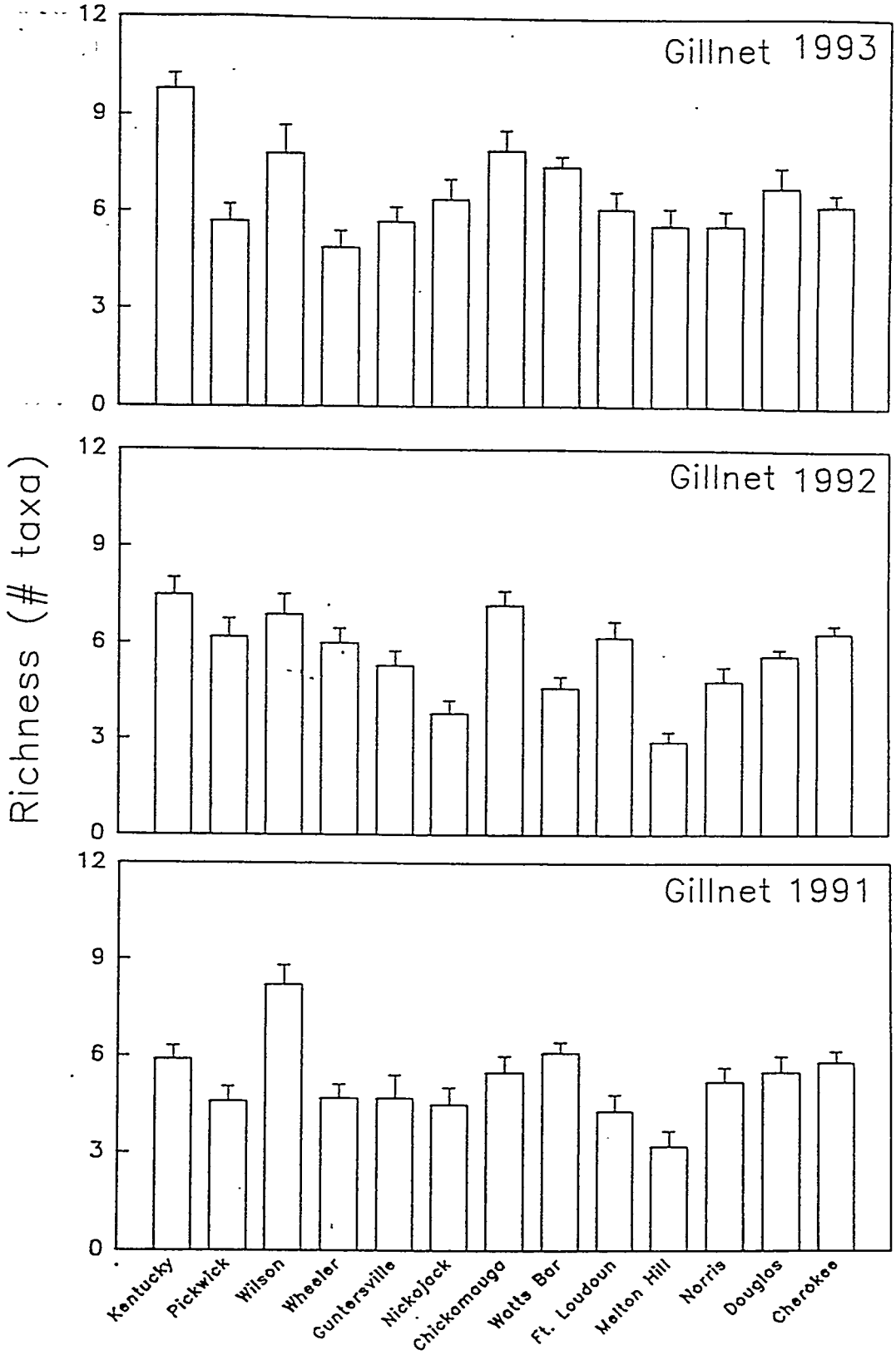


Fig. 6.8. Species richness of fish sampled by gill netting in individual reservoirs in 1991–1993.

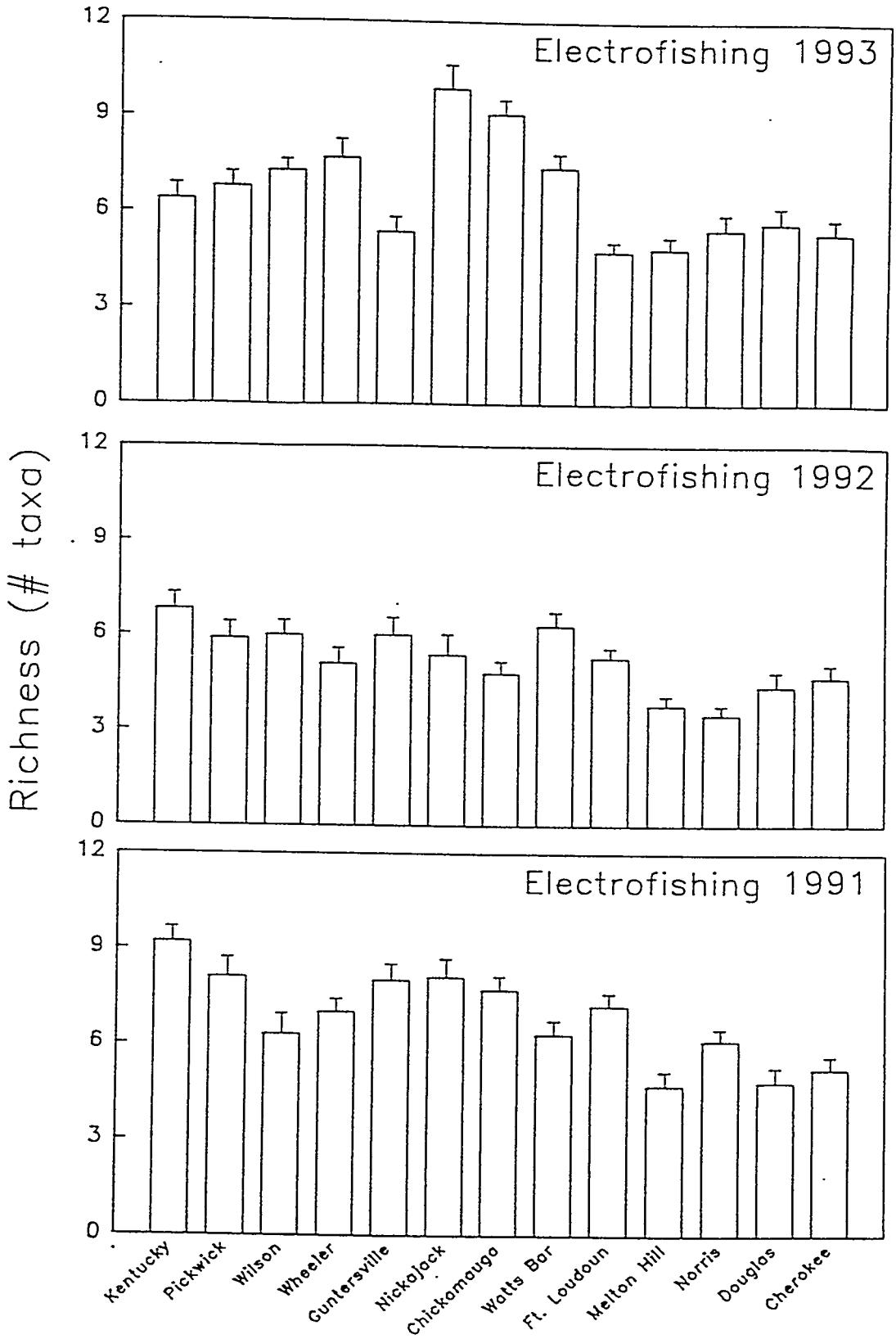


Fig. 6.9. Species richness of fish sampled by electrofishing in individual reservoirs in 1991–1993.

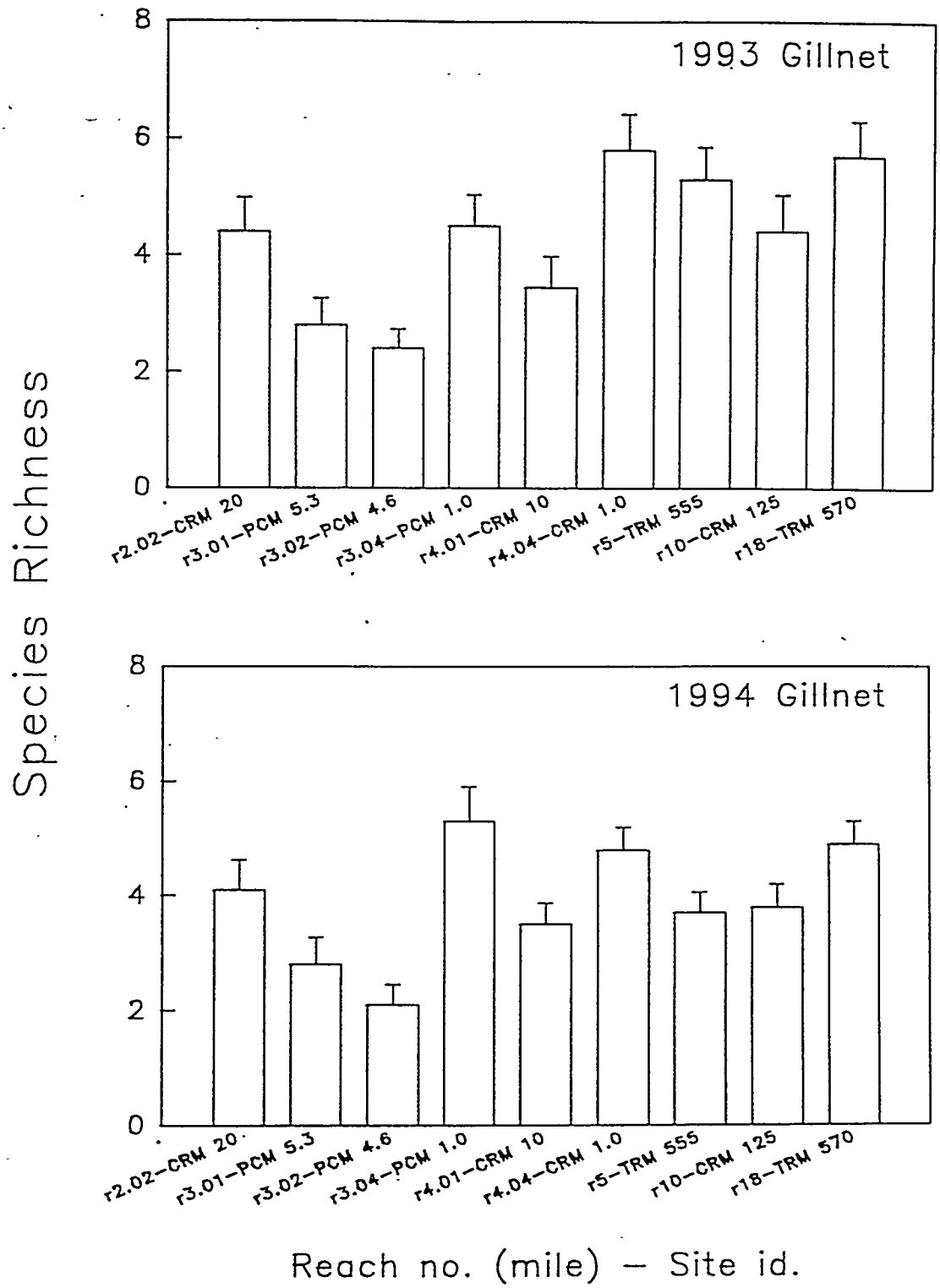


Fig. 6.10. Species richness of fish sampled by gill netting in reaches of the Clinch River/Poplar Creek system and reference reaches in 1993–1994.

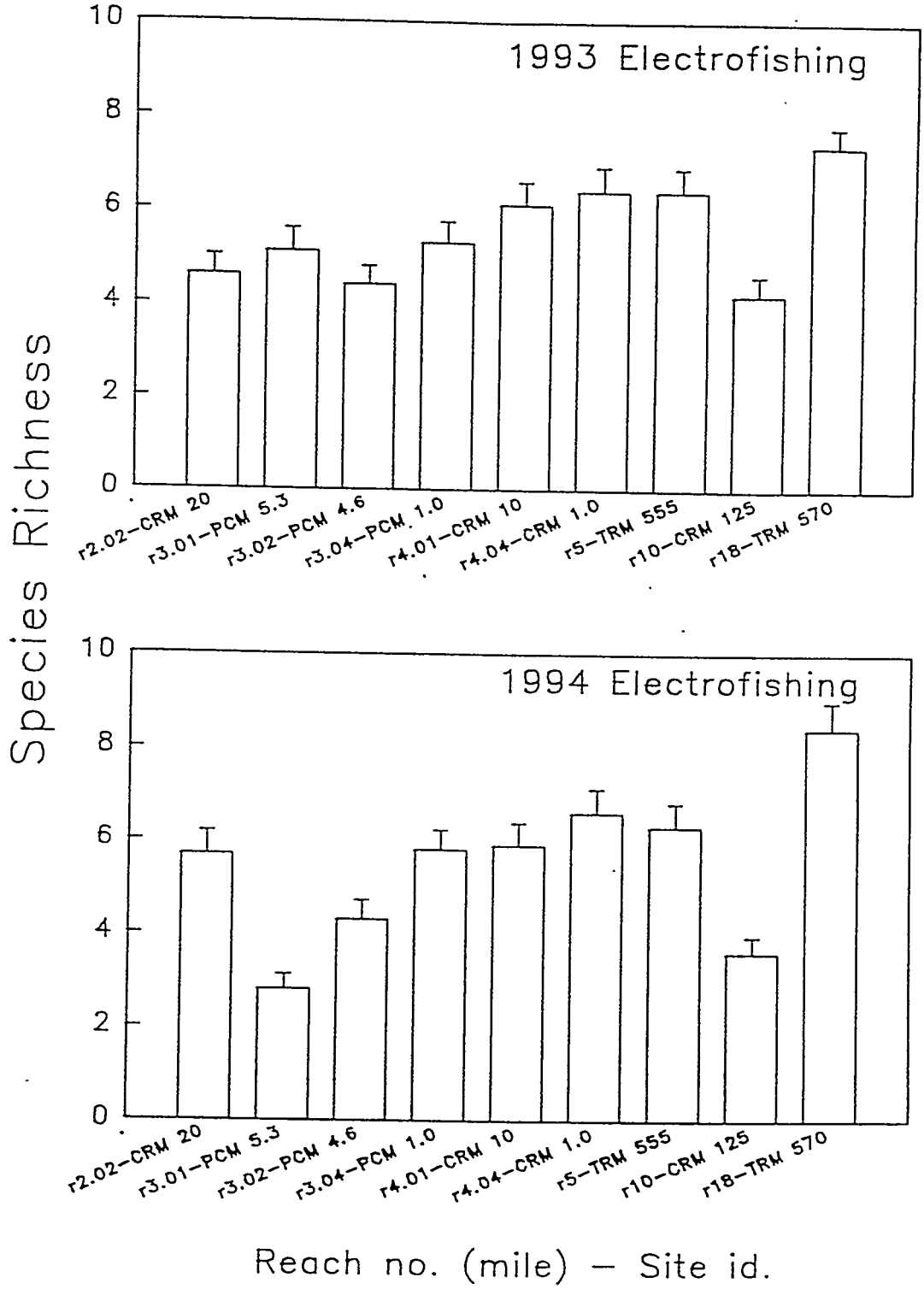


Fig. 6.11. Species richness of fish sampled by electrofishing in reaches of the Clinch River/Poplar Creek system and reference reaches in 1993–1994.

following considerations: the effects of contaminants on the fish community are not severe (i.e., there is not as much as a 50% reduction in community properties), they are not entirely attributable to DOE (Poplar Creek upstream is contaminated and somewhat toxic), and there is a significant chance that effects may be less than the endpoint level. The lines of evidence concerning risks to fish in Poplar Creek embayment (Reach 3) are summarized in Table 6.3, and are discussed below.

If significant toxic effects were occurring, then the community would have fewer species and individuals than other sites, and it does. The fish surveys found that for both collection methods the number of species and the abundance of fish was lower than in reservoir sites other than Norris (a low-productivity reservoir). This could be attributed to contaminants or to relatively poor habitat structure. However, the upper subreach (3.01) has relatively good habitat structure, but when fish were collected there for analysis, the abundance was qualitatively determined to be as low as in other subreaches. Because none of the reference sites are similar embayments, it is not possible to definitively say that the low species richness and abundance is due to habitat, thereby eliminating toxic effects as a cause. Hence, the survey results are consistent with a significant toxic effect, but habitat quality also contributes to an unknown extent.

If significant toxic effects were occurring, then the fish would display suborganismal signs of the toxic effects of the site contaminants, and they do. The elevated histopathology frequencies in 3.01 and 3.02 and reproductive abnormalities are consistent with exposure to PCBs, and possibly other contaminants. However, although they are adverse to individual fish, they do not have clear implications for properties of the fish community because of the compensatory properties that act at the individual, population, and community levels. Therefore, they are indicative of toxicity but not necessarily of significant effects on the community.

If significant toxic effects were occurring, then the water should be toxic, and it is. The water from Poplar Creek was toxic to medaka and sunfish embryos, but apparently not to fathead minnow larvae or *Ceriodaphnia*. However, by chance water was not collected during periods of high contaminant levels, so the lack of clear toxicity in the standard tests does not disprove the occurrence of episodic toxicity to those species. The toxicity to medaka embryos appears to be associated with nickel concentrations.

If significant toxic effects were occurring due to chemicals that bioaccumulate in fish, then concentrations in fish should be as high as those that caused effects in toxicity tests, and for some fish they are. The most highly contaminated channel catfish had whole-body concentrations of PCBs greater than those that were reported to cause reduced growth in that species in the laboratory. However, those results are from tests of young fish so they may not be applicable to the adult fish which were measured.

If significant toxic effects were occurring, then chemicals should be found in water at concentrations that have been shown to be toxic in the laboratory, and on occasion they were. However, because the cause and duration of the episodes is unknown, it is not certain that they actually cause sufficient toxic effects to cause significant decrements in community properties.

Although each of these lines of evidence is consistent with significant toxic effects, each has associated counter arguments. The contribution of contaminants to community properties could be negligible relative to habitat quality. The bioindicators and embryo toxicities may be indicative of effects for which the community may compensate. The toxic effects associated with PCB body burdens may not be relevant to adult fish or may not have community-level consequences. The high contaminant levels may be associated with extremely brief episodes that do not cause significant effects. Hence, no one of the line of evidence is convincing by itself, but the fact that they are all consistent with toxic effects makes it unlikely that the results are all false positives.

Table 6.3. A summary of risk characterization for the fish community in Poplar Creek (Reach 3)

Evidence	Result[a]	Explanation
Biological Surveys	+	Fish community abundance and species richness are both low, but habitat quality may be a causal factor.
Bioindicators	±	Frequencies of histopathologies were elevated in largemouth bass and bluegill, and levels of fecundity and other indicators of reproductive condition were reduced in largemouth bass, relative to reference fish.
Toxicity Tests	+	Water was toxic to medaka and redbreast sunfish embryos, but apparently not to fathead minnows and *Ceriodaphnia*.
Fish Analyses	±	Concentrations in maximally contaminated channel catfish exceed the concentration causing reduced growth and liver pathology in that species, but most concentrations are much lower.
Media Analyses	+	Cu, Hg, and possibly Ni and Ag were detected episodically at toxic concentrations, but average concentrations are nontoxic.
Weight-of-Evidence	+	Although the evidence is not strong, Reach 3 waters appear to pose a significant risk to the fish community from episodes of high metal concentrations and from PCBs which are mostly undetectable in water.

a + indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.
- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.
± indicates that the evidence is too ambiguous to interpret.

Upper Clinch River arm (Reach 2). Although there is evidence of sublethal toxic effects on individual fish in the Clinch River above Poplar Creek but below the Melton Hill dam (Reach 2), the community does not appear to be significantly affected. The lines of evidence concerning risks to fish are summarized in Table 6.4. This reach resembles Reach 3 in that the fish community is relatively depauperate, reproductive indicators differ from reference fishes, and the most contaminated catfish have PCB body burdens that are greater than those causing effects in toxicity tests. However, there is much more fish survey data for this reach and better reference data against which to compare it than in Poplar Creek. Those data allow us to conclude that the fish community properties are approximately what would be expected given the nature of the habitat. In addition, no chemicals were detected at toxic concentrations in Reach 2. Finally, rates of histopathologies were low in largemouth bass and intermediate in bluegill below White Oak Creek (2.02).

Table 6.4. A summary of risk characterization for the fish community in the upper Clinch River arm of Watts Bar Reservoir (Reach 2)

Evidence	Result[a]	Explanation
Biological Surveys	±	Fish community abundance and species richness are both low but not relative to other Clinch R. sites.
Bioindicators	±	Reproductive indicators were modified in largemouth bass below White Oak Creek (Reach 2.02) relative to reference fish.
Toxicity Tests		No toxicity tests were performed with water from the portion of this reach downstream of DOE sources (subreaches 2.02-2.04). Reach 2.01 water was apparently nontoxic.
Fish Analyses	±	Concentrations in maximally exposed channel catfish exceed the concentration causing reduced growth and liver pathology in that species, but most concentrations are much lower.
Media Analyses	-	No chemicals were detected at potentially toxic concentrations.
Weight-of-Evidence	-	The community does not appear to be significantly affected by contaminant exposures.

a + indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.
- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.
± indicates that the evidence is too ambiguous to interpret.

Lower Clinch River arm (Reach 4). Although there are episodically high concentrations of metals and evidence of sublethal toxic effects on individual fish in the Clinch River below Poplar Creek (Reach 4), the community does not appear to be significantly affected. The lines of evidence concerning risks to fish in the Clinch River below Poplar Creek (Reach 4) are summarized in Table 6.5. If significant toxic effects were occurring, then the community would have fewer species and individuals than other sites. This does not appear to be the case on balance. The species richness in 4.04 by both methods of measurement and in 4.01 by electrofishing are similar to potential reference sites. However, in both years the species richness in 4.01 by gill netting is lower than upstream in the Clinch (2.02), downstream (4.04), and lower Poplar Creek (3.04).

If significant toxic effects were occurring, then the fish would display suborganismal signs of the toxic effects of the site contaminants, and they do. Reach 4.01 has the third highest frequency of histopathology for both bluegill and largemouth bass.

If significant toxic effects were occurring, then the water should be toxic, but it is not. The water from 4.01 did not cause significant toxic effects on any species.

If significant toxic effects were occurring due to chemicals that bioaccumulate in fish, then concentrations in fish should be as high as those that caused effects in toxicity tests, and for some

individual fish they are. The most highly contaminated channel catfish had whole-body concentrations of PCBs greater than those that were reported to cause reduced growth in that species in the laboratory. However, those results are from tests of young fish so they may not be applicable to the adult fish which were measured.

If significant toxic effects were occurring, then chemicals should be found in water at concentrations that have been shown to be toxic in the laboratory, and on occasion they were. However, only copper and zinc were found at toxic levels, and, because the cause and duration of the episodes is unknown, it is not certain that they actually cause sufficient toxic effects to cause significant decrements in community properties.

In sum, while it is possible that significant effects on the fish community are occurring, none of the lines of evidence is strong enough to indicate such effects, and the lines of evidence are not sufficiently consistent to indicate such effects based on the weight of evidence.

Table 6.5. A summary of risk characterization for the fish community in the lower Clinch River arm of Watts Bar Reservoir (Reach 4)

Evidence	Result[a]	Explanation
Biological Surveys	-	Fish community abundance and species richness are not atypical.
Bioindicators	±	Frequencies of histopathologies were elevated in 4.01 relative to reference fish.
Toxicity Tests	-	Water from subreach 4.01 is not toxic.
Fish Analyses	±	Concentrations in maximally contaminated channel catfish exceed the concentration causing reduced growth and liver pathology in that species, but most concentrations are much lower.
Media Analyses	+	Cu and Zn were detected episodically at toxic concentrations in subreach 4.01, but average concentrations are nontoxic.
Weight-of-Evidence	-	The community does not appear to be significantly affected by contaminant exposures.

a + indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.
- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.
± indicates that the evidence is too ambiguous to interpret.

McCoy Branch embayment (Reach 7). The lines of evidence concerning risks to fish in the McCoy Branch embayment (Reach 7) are summarized in Table 6.6. Although water from 7.01 is toxic to *Ceriodaphnia*, only two tests were performed so the evidence is not strong. Single measurements of silver and nickel constituted the only evidence of toxicity from chemical analyses. No fish community surveys, bioindicator analyses, embryo toxicity tests, or analyses of fish were conducted. Since there is evidence of toxicity but no chemicals in clearly toxic amounts, the evidence is ambiguous. Significant risks can not be said to occur but can not be excluded.

Table 6.6. A summary of risk characterization for the fish community in McCoy Branch embayment (Reach 7)

Evidence	Result[a]	Explanation
Biological Surveys		The fish community was not surveyed.
Bioindicators		Bioindicators were not measured
Toxicity Tests	±	Water was toxic to *Ceriodaphnia* and possibly fathead minnows in one test each in the upper embayment, but apparently not to medaka. Only two testing periods were conducted.
Fish Analyses		Body burdens were not measured
Media Analyses	-	No chemicals were detected at toxic concentrations except for single values of Ag and Ni.
Weight-of-Evidence	±	Reach 7 has a possibly significant risk to fish, but the evidence is weak.

a + indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.
- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.
± indicates that the evidence is too ambiguous to interpret.

6.2.4 Uncertainties Concerning Risks to Fish

The following issues constitute the major sources of uncertainty in the risk assessment for the fish community.

The nature of the episodic exposures to high chemical concentrations is poorly specified. It is not known whether they are due to episodic releases from the ORR or mobilization of materials in the Poplar Creek system. Also their duration is unknown. Since they represent more than 5% of the samples, it was assumed that their duration is greater than seven days (2% of a year) which is the duration of the EPA's standard tests for chronic effects of effluents and ambient waters. However, if the observed high concentrations are associated with multiple episodes of very short duration, then they may not cause significant toxic effects.

The toxicity of water during the episodes of high exposure are unknown because tests were not conducted during those periods.

The high observed mortality and abnormalities in fish embryos are believed to constitute toxic effects that would result in significant effects on the fish community. However, these tests have not been validated against biological survey data at sites where clear toxic effects are occurring as has been done with the standard 7-d tests.

The relationship of the histopathologies and reproductive indicators to effects on populations and ecosystems is unknown.

The fish community surveys in Poplar Creek are compared to reference communities in the main channel of reservoirs and not to other embayments.

6.3 RISKS TO BENTHIC INVERTEBRATES

6.3.1 Exposure Assessment for Benthic Invertebrates

Two different expressions of sediment contamination are used, whole sediment concentrations and filtered pore water concentrations. The use of pore water is based on the assumption that chemicals associated with the solid phase are largely unavailable and therefore sediment toxicity can be estimated by measuring or modelling the pore water concentration. This is the approach used by the EPA to calculate sediment quality criteria. Whole sediment concentrations do not account for effects of sediment properties on bioavailability. However, they are required by the EPA Region IV and may provide a better estimate of risk for highly particle-associated chemicals.

For purposes of screening chemicals, the appropriate estimate of exposure is a concentration that protects the most exposed organisms. Because benthic invertebrates are relatively immobile and inhabit a medium that changes little over time, the maximum concentration is used. For risk estimation, the estimate of exposure of the community is the percentage of samples exceeding particular effects levels.

The sediment toxicity tests include direct exposure to whole sediment (*H. azteca*), exposure to sediment pore water (*C. dubia*), and exposure to epibenthic water (*D. magna*). It is assumed that the form and bioavailability of chemicals is not altered by sediment collection and handling, so these tests represent exposures in the field.

6.3.2 Effects Assessment for Benthic Invertebrates

6.3.2.1 Single chemical sediment toxicity

Because there are no standard screening benchmarks and sediment quality criteria for only a few chemicals, sets of alternative sediment benchmarks were derived for each chemical (Table 6.7). Whole sediment concentrations are compared to these alternative benchmarks. Pore water concentrations are compared to the ecotoxicological benchmarks for aquatic biota (Table 6.1). The use of multiple benchmarks provides greater assurance of detecting all COPECs. Sediment quality criteria are corrected for site-specific conditions. Sediment benchmarks derived using the equilibrium partitioning method are calculated using location-specific percent organic carbon. As in the aqueous chemical screening (Sect. 6.2.2.1), hardness-dependent criteria are conservatively corrected to 100 mg/L hardness based on the pore water mean across reaches of 134 mg/L and range of 82-160 mg/L.

Toxicity profiles are presented in Appendix F1 for those chemicals that exceed benchmarks. The toxicity profiles summarize the existing toxicity information for each chemical including concentrations causing acute lethality and chronic lethal and sublethal effects, and physical-chemical conditions that modify toxicity. Pore water COPEC concentrations are evaluated using aqueous toxicity data. Most of the available sediment toxicity data are for marine and estuarine systems.The sediment toxicity profiles address primarily freshwater sediment data, which are not included in the ER-Ls and ER-Ms (Long et

Table 6.7. Descriptions of the ecotoxicological screening benchmarks for benthic biota exposed to contaminated sediments. More details are presented by Hull and Suter (1994), Long et al. (1995), and Region IV (1994). The last three benchmarks are used only when none of the first five are available.

Benchmark	Abbreviation	Description
Effects Range-Low	ER_L	The tenth percentile of estuarine sediment concentrations reported to be associated with some level of toxic effects.
Effects Range-Median	ER_M	The fiftieth percentile of estuarine sediment concentrations reported to be associated with some level of toxic effects.
Region IV Benchmark	REG_IV	The higher of two values, the EPA Contract Laboratory Program Practical Quantification Limit (CLP PQL) and the Effects Value which is the lower of the ER-L and the Florida NOEL.
National Sediment Quality Criteria	EPA_SQC01	Sediment quality criteria based on toxicity in water expressed as chronic water quality criteria (recalculated after adding some benthic species) and partitioning of the contaminant between organic matter (1% of sediment by weight) and pore water. Sediment quality criteria were adjusted to the site-specific percent total organic matter content.
Equilibrium Partitioning Benchmark	EQ_PART	Benchmarks derived in the same manner as sediment quality criteria except that the expression of aqueous toxicity is the chronic NAWQC or the Secondary Chronic Value, and location-specific percent organic matter is used.
Ontario Ministry of the Environment Lowest Effect Level	LEL_MOE	Concentrations determined by the Ontario MOE to constitute thresholds for toxic effects in Ontario sediments.
Region V Benchmark	REG_V	A concentration determined to constitute background for sediments in Illinois.
Apparent Effect Threshold	AET	A concentration above which toxic effects occurred at all sites in Puget Sound.

al., 1995). An extensive marine data set was presented in MacDonald (1994). Lethal and community level effects from these sources are presented graphically for most COPECs in Appendix F3.

6.3.2.2 Ambient sediment toxicity

Because there is no dilution series for the sediment toxicity tests, the appropriate exposure-response relationship is the association between the frequency of significant toxic responses and either the concentrations of contaminants in the sediment or the location relative to known sources of contaminants. Responses that are statistically significantly different, or are inhibited by 20% or more relative to reference sediments or control water, are assumed to be indicative of sediments that are toxic to benthic biota. Test responses used in this assessment include reductions in survival of an amphipod (*H. azteca*) in 10-day exposures to whole sediment, reductions in survival of a cladoceran (*C. dubia*) in 48-hour exposures to sediment pore water, and reductions in survival and fecundity of another cladoceran (*D. magna*) in 12- to 14-day exposures to water overlying sediment.

6.3.2.3 Invertebrate community survey

Benthic macroinvertebrate communities were evaluated on two spatial scales. Reservoirs in the study area were compared to other mainstem TVA reservoirs and reaches within the study area were compared to each other. Two sets of benthic macroinvertebrate data were evaluated: TVA Vital Signs Monitoring Program data from thirteen mainstem reservoirs for the years 1992–1994 and ER Program data collected by TVA in 1994 from eight sites in the Clinch River and eight sites in Poplar Creek. These data should be comparable because the same sampling and statistical analysis methods were used for both sets of data. Patterns in community structure across reservoirs were evaluated using canonical discriminant analysis and richness and abundance were analyzed using ANOVA and multiple-comparison tests. Reduction of these endpoints by 20 %, relative to reference sites, would indicate that actual impacts to the benthos are occurring. However, it would be necessary to infer the cause from the distribution of known or suspected sources of contaminants or toxicity. Towards this end, a multiple linear regression analysis was performed to investigate the influence of physical characteristics and contaminant concentrations on benthic community structure. Methods of data collection and analysis are detailed in Appendix F8.

6.3.3 Risk Characterization for Benthic Invertebrates

6.3.3.1 Single chemical sediment toxicity

Screening against benchmarks. Chemicals detected in whole sediments or filtered pore water were screened against benchmarks and evaluated as COPECs. A HQ was calculated for each chemical by dividing the maximum concentration by the sediment (Table F3.1) or aquatic benchmarks (Table F3.2). Chemicals that exceeded any benchmark (e.g., HQ>1) were examined further to determine whether they were credible COPECs (Table 6.8). The criteria for eliminating COPECs were those used for evaluating aqueous COPECs (Sect. 6.2.3.1.1), where filtered and unfiltered water samples correspond to pore water and whole sediment samples, respectively. None of the candidate COPECs could be eliminated without a more detailed evaluation of their distribution among reaches and the relevant effects data.

The ΣTUs for each subreach was calculated to show the relative toxicity of sites and the relative contribution of COPECs to that toxicity. This holistic overview provides a context for the detailed

Table 6.8. Results of screening of chemicals that exceed benchmarks in whole sediments or filtered pore water for COPECs

Chemical	COPEC	Reason for Inclusion or Rejection
Aluminum	YES	Exceeds chronic NAWQC in pore water in Reaches 0, 3.04, 4.01, 4.02, 4.04, 7.02, and 18. Exceeds Daphnid LTV and the LCV of all tested aquatic organisms (plants) at Reach 4.01. A sediment benchmark is not available.
Arsenic	YES	Exceeds the ER_M in whole sediment in Reach 7.01 and the ER-L, LEL_MOE, and/or REG_IV in Reaches 1, 2.04, 7, 8, 10, the three downstream subreaches of 3, and Reach 4. Did not exceed NAWQC or any other aqueous benchmark in any reach.
Barium	YES	Exceeds EPA_REG V background value in all reaches. Exceeds the SCV in pore water in all reaches and the SAV in Reaches 0, 2.01, 2.04, 13, and the three downstream subreaches of 3 and 4, but the Daphnid LCV was not exceeded in any reach.
Boron	YES	Exceeds the Daphnid LTV in pore water in all reaches. That benchmark is apparently below the local background due to the compounding of effects across all life stages in its derivation. Exceeds the SCV in Reach 3.04, but does not exceed this or any other benchmark in any other reach. A sediment benchmark is not available.
Cadmium	YES	Exceeds the ER-L, LEL_MOE, and/or REG_IV in Reaches 1, 3, 4.04, 5, 7.02, and 22. Reported at the detection limit in 1 of 11 pore water samples from 4.04, where it exceeds the LCV and LTV for Daphnids but no other benchmarks.
Chromium	YES	Exceeds the REG_IV in Reaches 3.02, 3.03, 3.04, 4.03, 7.02, and 22 and the ER_L in 3.02, 3.03, and 22, but is less than the ER_M in all reaches. Did not exceed any benchmarks in pore water in any reach.

Table 6.8 (continued)

Chemical	COPEC	Reason for Inclusion or Rejection
Cobalt	YES	Exceeds the SCV and the Daphnid LTV and LCV in pore water in Reaches 3.01, 3.03, 4.03, 4.04, and 13; the SCV in Reaches 0 and 3.02; no other benchmarks in any reach. A sediment benchmark is not available.
Copper	YES	Exceeds the REG_IV and ER-L in Reaches 1, the three downstream subreaches of 3, 4.03, 4.04, 5, 7.02, 10, and 22, but is less than the ER_M in all reaches. Exceeds the chronic NAWQC in pore water in Reach 3.04; the Daphnid LTV and LCV and Aquatic Plant LCV in all reaches; the Fish LCV and/or LTV in 3, 4.01, 4.03, 4.04, 7.01, and 18; and the Non-Daphnid Invertebrate LCV in 3, 4.03, and 4.04.
Iron	YES	Marginally exceeds the LEL_MOE in Reaches 3.03, 4.04, and 7. Exceeds the chronic NAWQC and the Fish LCV in pore water in Reaches 3.02, and 4.04; the Daphnid LTV in all reaches; and the Daphnid LCV in 0, 2, the three downstream subreaches of 3, 4.01, 4.04, and 18.
Lead	YES	Exceeds the REG_IV and/or ER-L in Reaches 0, 1, 2.04, the three downstream subreaches of 3, 4, 5, 7.02, 8, 10, 18, and 22, but is less than the ER_M in all reaches. Detected in 3 of 7 pore water samples from 4.03, but did not exceed any of the seven benchmarks.
Manganese	YES	Exceeds the LEL_MOE in all reaches except 2.01. Exceeds all benchmarks for pore water in all reaches except 2.03.
Mercury	YES	Exceeds the REG_IV and/or ER-L in all reaches except 0, 2.03, and 10, and the ER_M in Reaches 3, 4, 5, 8, 13, and 22. Exceeds the LCV for all aquatic organisms (LCV FISH) in Reaches 3.01, 3.02, and 4.04, but no other benchmarks in any reach.

Table 6.8 (continued)

Chemical	COPEC	Reason for Inclusion or Rejection
Nickel	YES	Exceeds the REG_IV and ER-L in 2.04, 3, 4, 5, 7, 8, 10, 13, and 22, and the ER_M in Reaches 3.02, 3.03, and 3.04. Exceeds the Aquatic Plants and Daphnids LCVs in all reaches except 2.01, and 18; the Fish LCV in 3.01 and 3.02; and the Daphnid and Fish LTVs in 3.01, but no other benchmarks, including NAWQC, in any reach.
Silver	YES	Exceeds the ER-L and/or REG_IV in the three downstream subreaches of 3, 4.04, and 22, and the ER_M in Reaches 3.02, 3.03, and 22. Not detected in pore water in any reach.
Uranium	YES	Detected in pore water in Reaches 3, 4, and 13. Exceeds SCV in 3.02, 3.03, 3.04, and 4.04, the SAV in 3.02, but not the Fish LCV or LTV in any reach. A sediment benchmark is not available.
Zinc	YES	Exceeds the REG_IV in all reaches except 2.01, 2.02, 2.03, and 4.01, the ER_L in 3.02, 4.04, and 5, but not the ER_M in any reach. Exceeds the Aquatic Plant LCV in 3.03 and 4.03; the Fish LCV and LTV and the Daphnid LCV in 4.03; no other benchmarks, including NAWQC, in any reach.
2-Methylnaphthalene	YES	Exceeds the ER_L in Reaches 0, 2.04, 3.02, 3.03, and 3.04, 4, 7.02, and 13; the REG_IV (CLP PQL) in 0, 2.04, 3.02, 3.03, and 13; and the ER_M in 0, and 13. Not detected in pore water in any reach.
4,4'-DDD	YES	Detected in 1 of 2 sediment samples from Reach 1 and exceeds the ER_L and ER_M but not the EQ_PART. Not detected in any reach in pore water but Reach 1 was not sampled.

Table 6.8 (continued)

Chemical	COPEC	Reason for Inclusion or Rejection
4,4'-DDT	YES	Detected in 1 of 2 sediment samples from Reach 1 and exceeds the ER_L, ER_M, and REG_IV, but not the EQ_PART. Not detected in any reach in pore water but Reach 1 was not sampled.
Acenaphthene	YES	Exceeds the ER_L in Reaches 0, 3.02, 3.03, 3.04, 4.01, and 13; does not exceed the REG_IV (CLP PQL), the ER_M, or the EPA SQC01 in any reach. Not detected in pore water in any reach.
Anthracene	YES	Exceeds the EQP_PART in Reaches 3.03, 3.04, and 4.01; the ER_L in 3.02, 3.03, 3.04, and 4.01; but not the REG_IV (CLP PQL) or ER-M in any reach. Not detected in pore water in any reach.
Benzo(a)anthracene	YES	Exceeds the ER_L and/or the REG_IV (CLP PQL) in 3.02, 3.03, and 18, but not the ER_M or the EQ_PART in any reach. Not detected in pore water in any reach.
Benzo(a)pyrene	YES	Exceeds the ER_L and/or the REG_IV (CLP PQL) in 2.04, 3.02, 3.03, 4.03, 4.04, 7, 8, and 13, but not the ER_M in any reach. Not detected in pore water in any reach.
Bis(2-ethylhexyl)phthalate	YES	Detected in sediments in all reaches but did not exceed benchmarks. Exceeds the Daphnid LCV and LTV in 3.03 and 4.01, but not the SAV or SCV.

Table 6.8 (continued)

Chemical	COPEC	Reason for Inclusion or Rejection
Chrysene	YES	Exceeds the REG_IV (CLP PQL) and ER_L in 3.02, 3.03, and 13. Does not exceed the ER_M in any reach. Not detected in pore water in any reach.
Dibenz(a,h)anthracene	YES	Exceeds the ER_L in 3.03, 3.04, and 4.01, but does not exceed the REG_IV (CLP PQL) or the ER_M, which is less than the CLP PQL, in any reach. Not detected in pore water in any reach.
Fluoranthene	YES	Exceeds the REG_IV and/or ER_L in 2.04, 3.02, 3.03, and 18. Does not exceeds the ER_M or EPASQC01 in any reach. Not detected in pore water in any reach.
Fluorene	YES	Exceeds the ER_L in 0, 3.02, 3.03, 3.04, 4.03, and 13, but not the REG_IV (CLP PQL) or the ER_M in any reach. Not detected in pore water in any reach.
Naphthalene	YES	Exceeds the ER_L and/or REG_IV (CLP PQL) in 0, 2.04, 3.02, 3.03, 3.04, and 13, and the ER_M in 13. Not detected in pore water in any reach.
PAHs, Total	YES	Exceeds the REG_IV in Reaches 0, 2.04, 3, 4, 7, 8, 13, and 18; the ER-L in 0, 2.04, 3.02, 3.04, 4.01, 4.04, 7, 8, 13, and 18. Did not exceed the ER-M in any Reach. Not detected in pore water in any reach.

Table 6.8 (continued)

Chemical	COPEC	Reason for Inclusion or Rejection
PCB-1248	YES	Exceeds the ER_L in Reaches 3.02 and 3.04, the ER-M in 3.02, but not the EQ_PART in any reach. Not detected in pore water in any reach.
PCB-1254	YES	Exceeds the ER_L, but not the EQ_PART, in 2.02, 3.02, 3.03, 3.04, 4, and 22. Exceeds the ER_M in 2.02, 3.02, 3.03, 3.04, 4.01, 4.04, and 22. Exceeds several benchmarks, including the SAC and SCV, in pore water in Reach 18.
PCB-1260	YES	Exceeds the ER_L, but not the EQ_PART, in 2.02, 3.02, 3.03, 3.04, 4.01, 4.02, and 4.03. Exceeds the ER_M in 2.02, 3.02, 3.03, 3.04, and 4.01. Not detected in pore water in any reach.
Phenanthrene	YES	Exceeds the ER_L and/or REG_IV (CLP PQL) in 0, 2.04, 3.02, 3.03, 3.04, and 13. Exceeds the ER_M in 13, but does exceed and the EPASQC01 in any reach. Not detected in pore water in any reach.
Pyrene	YES	Exceeds the ER_L in 3.02 and 3.03, but not the ER_M in any reach. Not detected in pore water in any reach.

discussions of exposure-effects that follow. The generic derivation and interpretation of TUs in this assessment is presented in Sect. 6.1.6. The TUs for pore water COPECs were calculated using the same procedure used for the aqueous COPECs (Sect. 6.2.3.1.1). That is, Daphnid EC_{50}s were used as the denominator and they were adjusted to a hardness of 100 mg/L for hardness dependant chemicals (e.g., copper). The ER-L from Long et. al. (1994) was the denominator for most whole sediment COPECs. The AET or REG_V value was used only if an ER-L was not available. TUs were calculated for each COPEC using the maximum concentration in each subreach. These TUs were summed by subreach for the pore water COPECs and whole sediment COPECs. Maximum concentrations may over estimate exposure. The concentrations represented by the maximum may actually be present in only one location in a subreach and the maxima for all COPECs may not occur at the same location. Therefore, ΣTUs were also calculated using median concentrations in pore water and whole sediment to better estimate typical exposures for each subreach. Pore water maximum and median ΣTUs are presented in Figures 6.12 and 6.13, respectively. Both maximum and median ΣTUs for whole sediment exceeded 1.0 at all sites. Therefore, only the more representative median ΣTUs are presented (Fig. 6.14a-d)

Maximum concentrations of COPECs in pore water (Fig. 6.12) appear to be acutely toxic to Daphnids in only four subreaches, including Upper Melton Hill (Reach 0), and potentially chronically toxic to Daphnids (i.e., ΣTU>0.2) in all reaches except 2.03. Manganese is the principle contributor to toxicity in most reaches. Only Reach 4.04 pore water remains acutely toxic to Daphnids when manganese is removed, but the maximum pore water concentrations in all reaches in Poplar Creek and the Lower Clinch River remain chronically toxic to Daphnids. Copper also contributes to toxicity in all reaches. Median concentrations of COPECs are also potentially chronically toxic to Daphnids in most reaches, but acute toxicity is not indicated (Fig. 6.13). Pore water toxicity generally decreases along Poplar Creek (Reaches 13 and 3), but increases along Reach 4.

Maximum and median concentrations of COPECs in whole sediment appear to be toxic in every reach, and every COPEC contributed to the total toxicity (i.e., maximum TU>0.01). To aid interpretation, the median ΣTUs for each of four general categories of COPECs and mercury are presented in Figure 6.14a. The PAH category is the sum of TUs for the individual PAHs, rather than the Total PAH concentration divided by the Total PAH ER-L. Median TUs for individual COPECs are presented in Figs. 6.14b-d. Individual pesticides were not presented because the only pesticides detected were 4,4'-DDD and 4,4'-DDT, which were detected in only one sample from Reach 1. The magnitude of the TUs (e.g., median ΣTUs greater than 50 in several reaches) indicates that the sediments are extremely toxic and/or the effects concentrations (i.e., the ER-Ls) are extremely conservative for these sediments. Even if the absolute magnitude is not accurate the relative magnitudes evince some interesting differences among reaches. For example, pesticides occur in Reach 1 only, mercury appears to be the principle contributor to toxicity in Reach 3, PAHs contribute most in Poplar Creek above East Fork (Reach 13), PCBs are the principle contributors in Reaches 2.02 and 4.04 and significant contributors in Poplar Creek (Reaches 3.02 and 3.04).

Exposure - effects profiles for sediment exposures. For each COPEC, the distribution of observed concentrations in whole sediment and pore water is compared to the distribution of concentrations toxic to aquatic biota. The interpretation of the relationship of these distributions is presented in Sect. 6.1.6. Toxicity information is drawn from the toxicity profiles (Appendix F1). If sufficient toxicity data exist, the empirical distribution functions are presented graphically (Appendix F3). Aqueous effects distributions (Figs. F3.1–F3.5) were derived from standard toxicity test data. Aqueous toxicity data for hardness dependant metals were adjusted to a hardness of 100 mg/l. There is relatively little standardized sediment test data available. Therefore, the distribution of observed concentrations is compared to the ER-L and ER-M from Long et al. (1995) and two effects distributions, community level effects and lethality (Figs. F3.6–F3.16). The effects distributions were derived using the marine and

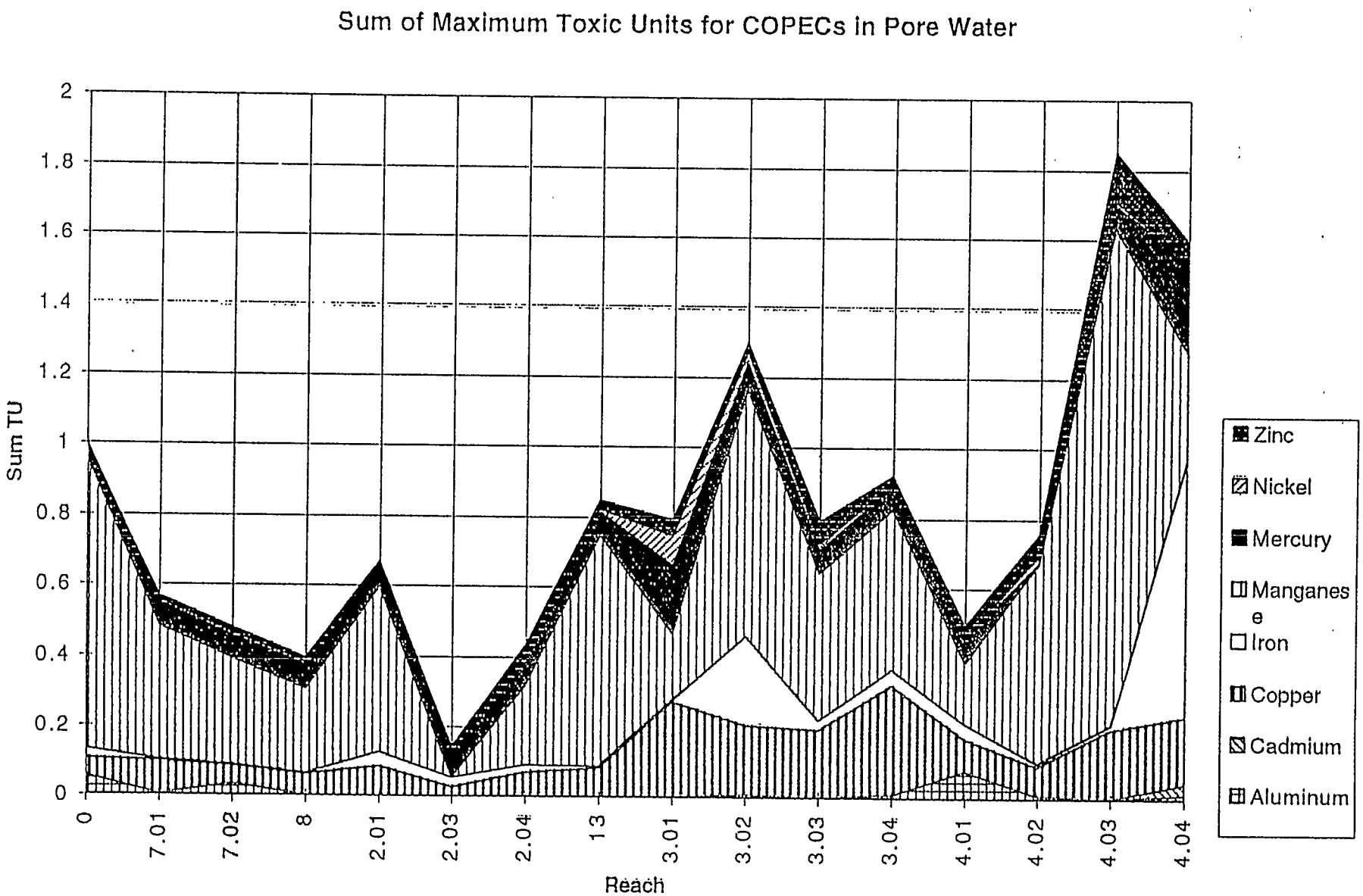


Fig. 6.12. Plot of maximum concentration of pore water COPECs normalized to toxic units (TU). The Upper contour of the graph is the sum of TU for the reaches. Includes COPECs with Maximum TUs greater than 0.01.

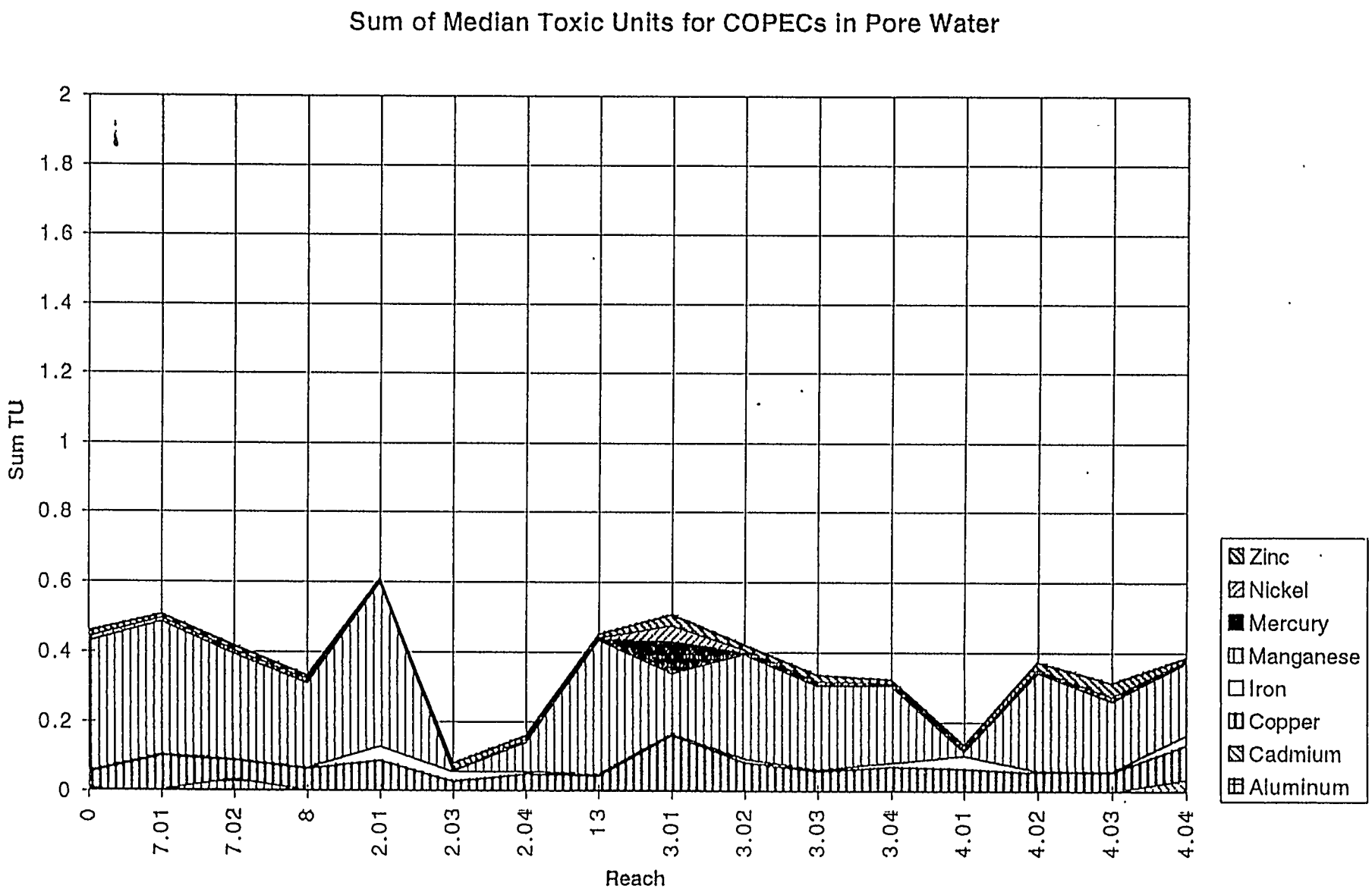


Fig. 6.13. Plot of median concentration of pore water COPECs normalized to toxic units (TU). The Upper contour of the graph is the sum of TU for the reaches. Includes COPECs with Maximum TUs greater than 0.01.

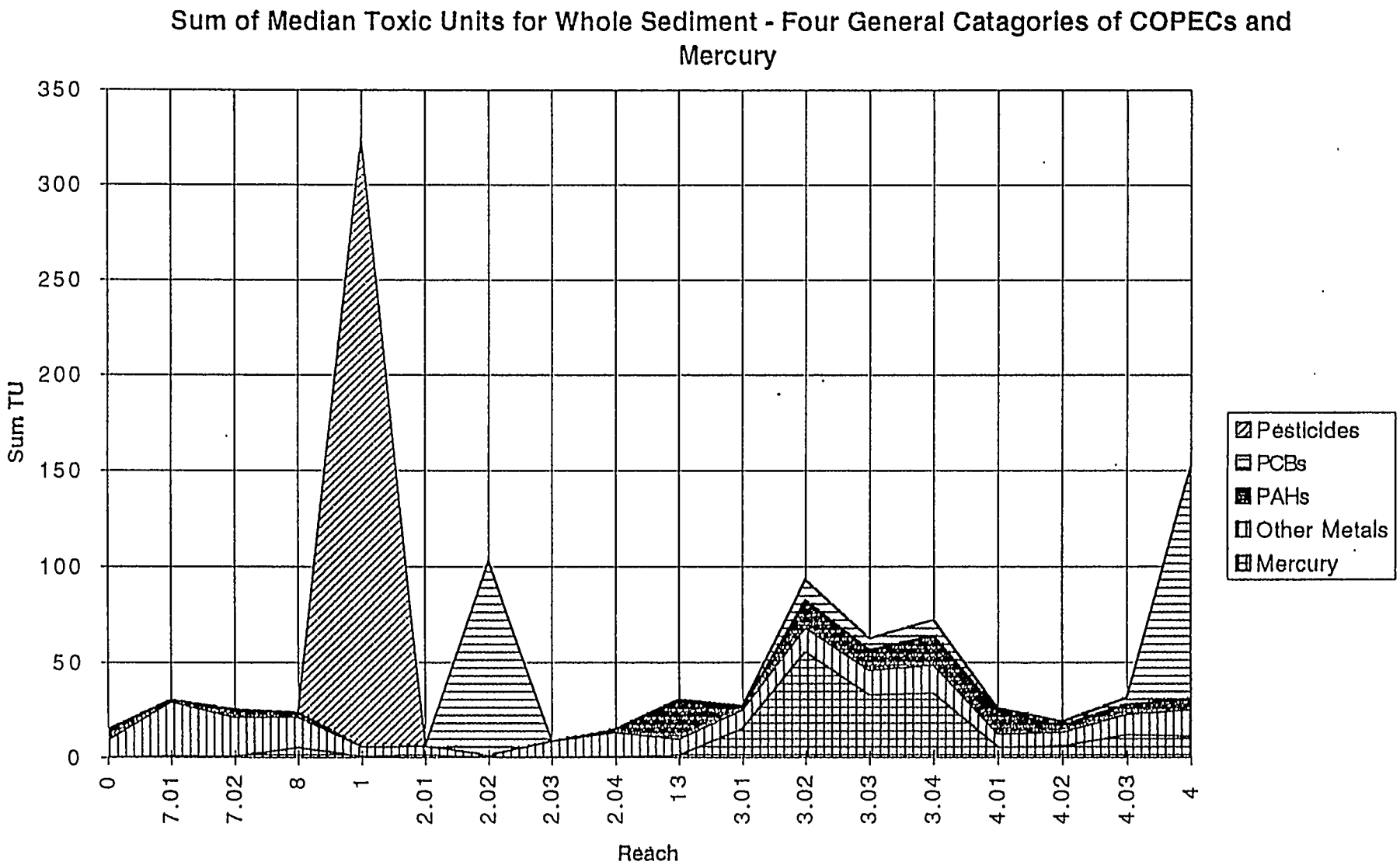


Fig. 6.14a. Plot of median concentration of whole sediment COPECs normalized to toxic units (TU). The Upper contour of the graph is the sum of TU for the reaches. Includes COPECs with Maximum TUs greater than 0.01. This graph (a) is four General Categories of COPECs and mercury.

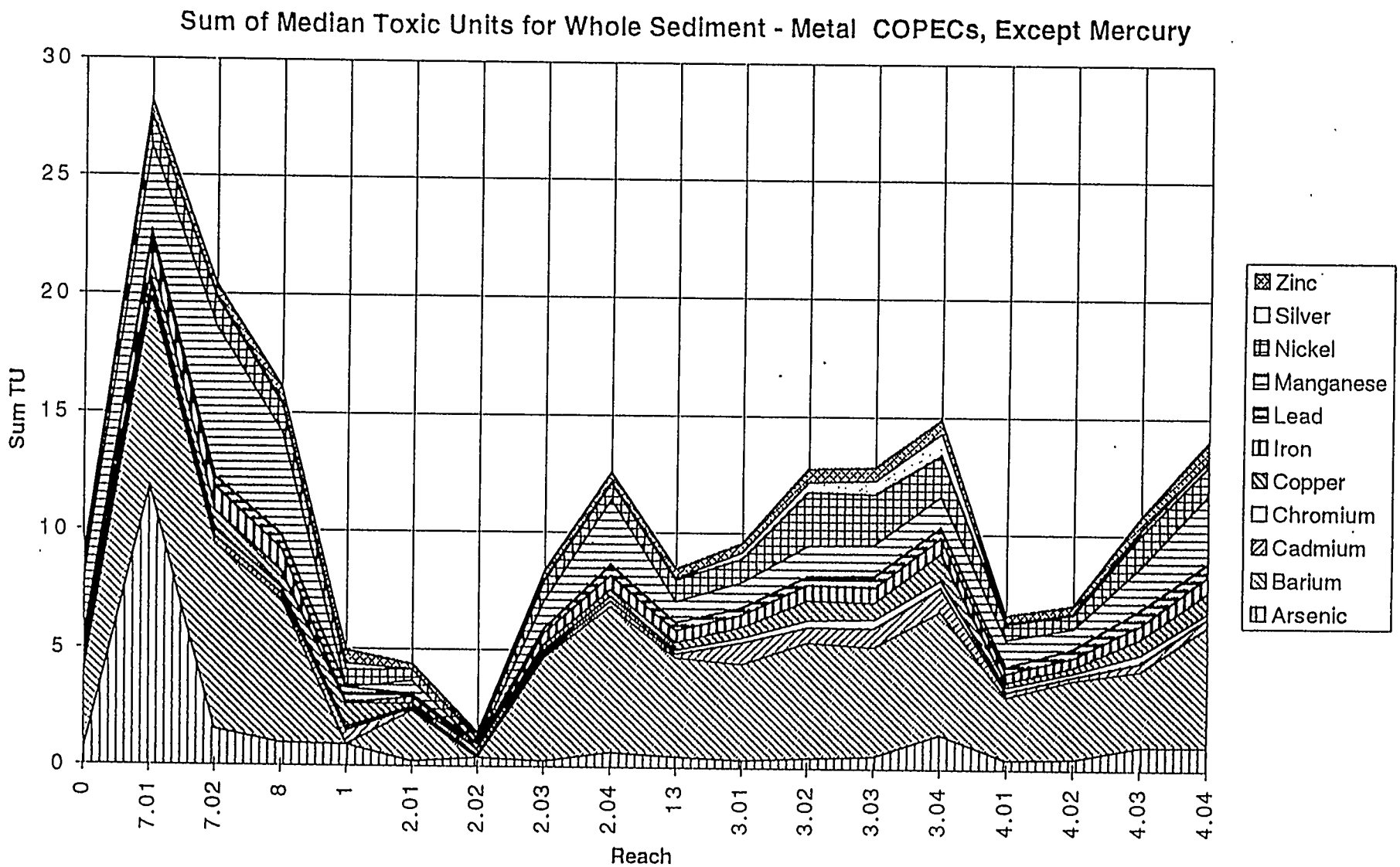


Fig. 6.14b. Plot of median concentration of whole sediment COPECs normalized to toxic units (TU). The Upper contour of the graph is the sum of TU for the reaches. Includes COPECs with Maximum TUs greater than 0.01. This graph (b) is Metal COPECs, Except Mercury.

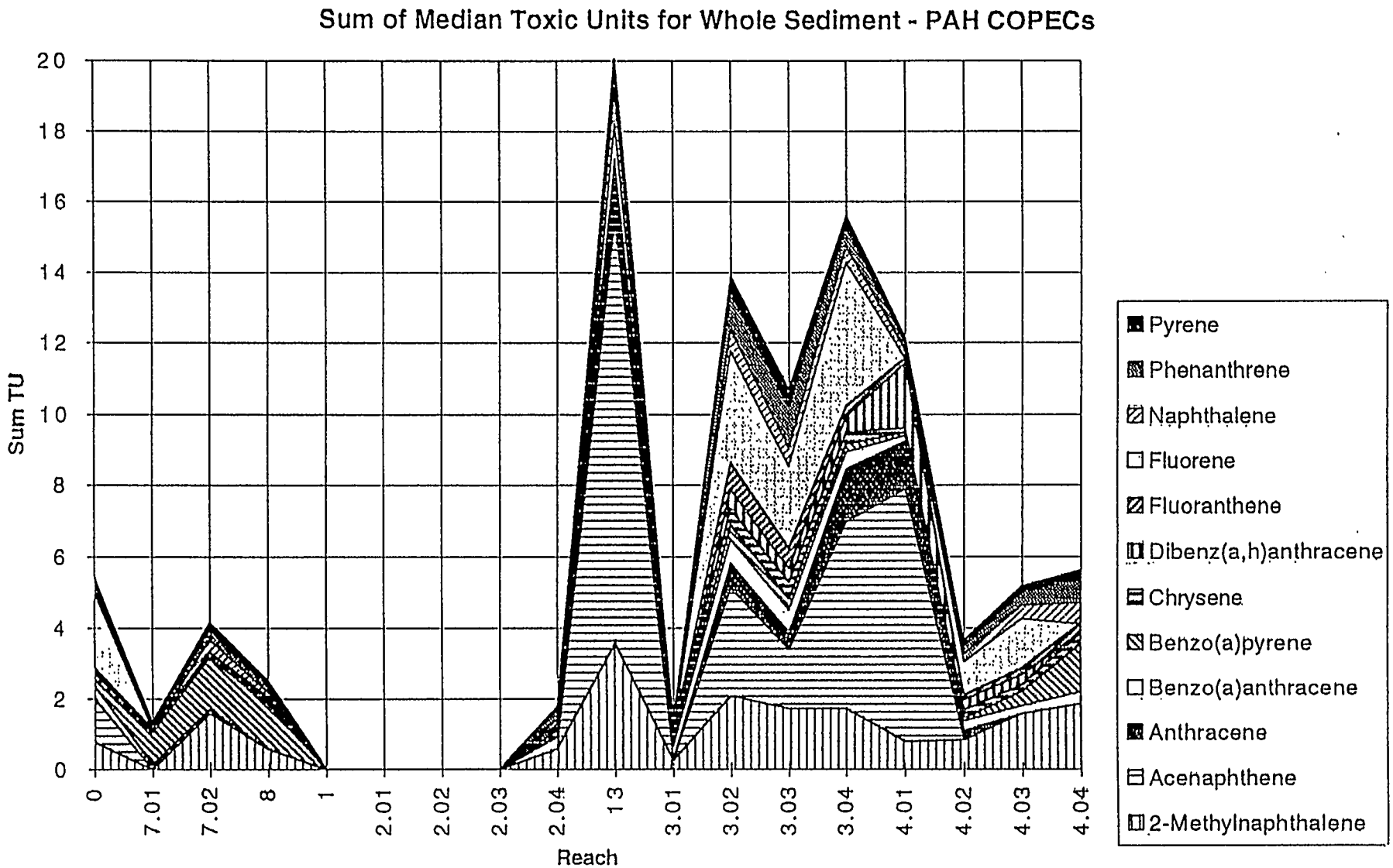


Fig. 6.14c. Plot of median concentration of whole sediment COPECs normalized to toxic units (TU). The Upper contour of the graph is the sum of TU for the reaches. Includes COPECs with Maximum TUs greater than 0.01. This graph (c) is PAH COPECs.

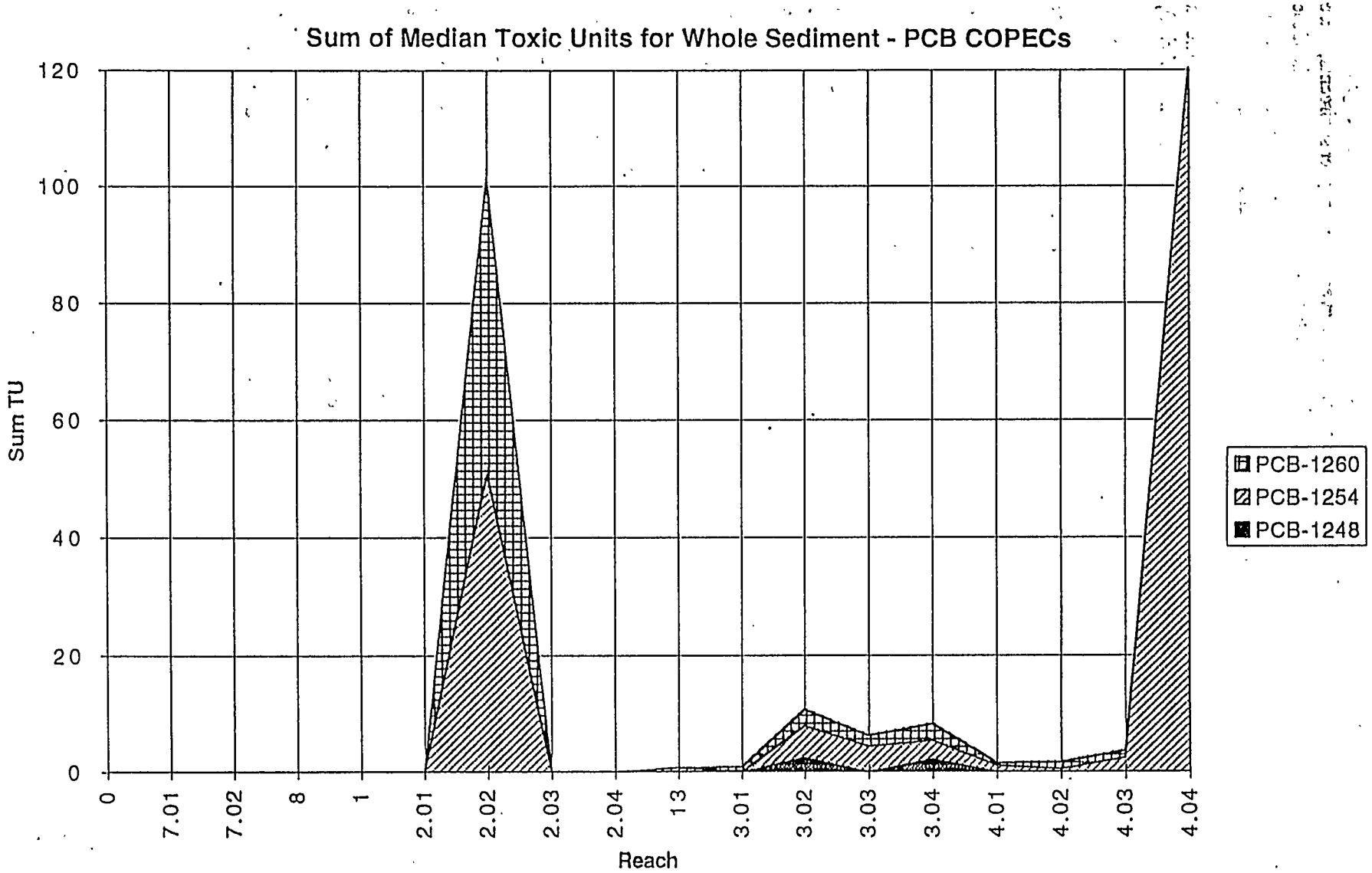


Fig. 6.14d. Plot of median concentration of whole sediment COPECs normalized to toxic units (TU). The Upper contour of the graph is the sum of TU for the reaches. Includes COPECs with Maximum TUs greater than 0.01. This graph (d) is PCB COPECs.

estuarine toxicity data from McDonald et al. (1994) and freshwater data from Long and Morgan (1991). Although data from studies of salt water sediments may not seem relevant to freshwater sediments, these data have been recommended by EPA Region IV (1994). Their use may be justified on the basis of the lack of a high quality data set for freshwater and the apparently small difference in the toxicity of many chemicals between the two media relative to the differences among sites within a medium.

Some level of effect would be expected to rarely occur at concentrations below the ER-L (i.e., a negligible risk), occasional occur at concentrations between the ER-L and ER-M (i.e., a marginal risk), and usually occur at concentrations above the ER-M (i.e., a significant risk). However, the ER-L and ER-M are derived from the Biological Effects Database for Sediments (BEDS), which is an assemblage of data from studies of marine and estuarine systems. The primary study types were spiked sediment bioassays and co-occurrence analysis. These studies evaluated benthic community structure and a wide variety of species (e.g., sandworms, polychaetes, oligochaetes, sea urchins, bivalves, shrimp, flounder, amphipods, etc.). Endpoints included taxa richness, diversity, density, mortality, growth, respiration, behavior (e.g., avoidance, emergence, reburial, etc.) and suborganismal effects (e.g., Mixed-Function Oxidase, abnormal chromosomes, etc.). Hence, the ER-Ls and ER-Ms include many sources of variance as a result of the disparate sources of data and the variability inherent to the toxicity tests. Factors that differ between studies may include the physical characteristics of the sediment (i.e., percent organic matter, texture, pH, pore water hardness, acid-volatile sulfide content, redox conditions, etc.), behavior and exposure of the test organisms (i.e., filter feeders, burrowers, epibenthic organisms, ingestion of sediment, respiration of pore water, etc.), sensitivity of the test organisms, and the chemical species present. Factors inherent to the test type may include effects of other contaminants in the co-occurrence studies and the bioavailability of contaminants in spiked bioassay tests. Spiked sediment tests may over estimate bioavailablity because the chemical forms tested may dissociate more readily than the forms occurring at the site. Also, sorption to solids may bind less of the tested form, or bind it less securely.

The two effects distributions also were derived from the BEDS (MacDonald 1994). Freshwater sediment data from Long and Morgan (1991) were included also and only concentrations associated with effects were used. Measures of community effects included taxa richness and abundance of benthic invertebrates. The lethal effects distributions potentially included mortality data from all study types and tested species. Thus, exceeding the lowest sediment effects concentration or the ER-L is not necessarily indicative of toxicity. The rationale and approach for interpreting the relationship of the exposure and effects distributions are presented in Sect. 6.1.6. In this assessment, risks to benthic invertebrates from COPECs are characterized as significant, marginal, or negligible based on the likelihood of effects and the evaluation of modifying factors. Significant risks are generally indicated if there is a greater than 50% likelihood of toxic effects (i.e., the observed concentration exceeds the 50th percentile of the effects distribution). Marginal risks are generally indicated if there is a greater than 20%, but less than 50%, likelihood of toxic effects. Negligible risks are generally indicated if the likelihood of toxic effects is less than 20%. This interpretation is consistent with the approach developed in Long and Morgan (1991), Long et al. (1995), and McDonald et al. (1994). The final characterization of risks based on single chemical concentrations will be determined by evaluating the risks suggested by the comparisons to the ER-L and ER-M, the risks suggested by the comparison to the two effects distributions, and the factors that modify toxicity. Factors that may modify the characterization of risk include concordance of effects and exposure concentrations and the relative sensitivities of freshwater and marine species. The spatial extent of the potential risk is also characterized, as discussed in Sect. 6.1.6.

Table 6.8 summarizes, for each COPEC, which benchmarks were exceeded in each medium (e.g., sediment and pore water) and subreach. Tables F3.1 and F3.2 detail the maximum observed concentration for each reach, benchmark values, and the corresponding HQs. Therefore, this section addresses only that information which aids in characterizing the risks associated with these COPECs.

The metal COPECs are discussed separately and then summarized as a group. PAHs are addressed as a group with additional discussion of the three PAHs with Sediment Quality Criteria. Organic COPECs are addressed in one of the following groups: pesticides, phthalate esters, and total PCBs.

Aluminum. Aluminum in pore water presents a negligible risk at most sites in the OU. However, pore water concentrations may be a marginal risk at localized sites in Poplar Creek below the ash disposal area (Reach 3.04), in several areas of the lower Clinch River (Reach 4), in Lower McCoy Branch (7.02), and in the negative reference reach (Reach 0). Maximum pore water concentrations exceeded the chronic NAWQC in Reaches 0, 3.04, 4.01, 4.02, 4.04, and 7.02. Only Reach 4.01 exceeded a CV for an invertebrate species. Pore water concentrations are from filtered samples. Therefore, they represent exposure to dissolved aluminum and indicate a possibility of actual toxic effects. Al was detected in most samples from these reaches, but the median concentration was less than all chronic effects values in all reaches. Sediment concentrations of Al have not been shown to be toxic. That is, effects observed in co-occurrence analyses of contaminated sediments have not been attributed to Al and spiked sediment toxicity tests were not found.

Arsenic. Arsenic concentrations are highest in areas highly contaminated with coal ash (Reaches 7.01, 7.02, and 3.04), intermediate in areas where ash and ash-associated arsenic are diluted (Reaches 1, 4.03, and 4.04), and lower in other areas, but still within the range of concentrations associated with toxicity in sediments. These lower concentrations may reflect regional arsenic levels.

The distributions of arsenic concentrations in subreaches 3.04 and 7.02 and the single arsenic concentration from Reach 7.01 lie in the range in which community level effects and lethality occur at most other sites (Fig. F3.6b and d). Hence, the coal ash disposal areas in McCoy Branch and the gooseneck bend in Poplar Creek appear to present a significant risk to benthic invertebrates in Reaches 7 and 3.04. The intermediate sites (Reaches 1, 4.03 and 4.04) fall above the community level effects distribution and at approximately the middle of the lethality distribution (Fig. F3.6a and c). These distributions suggest that risks to benthic invertebrates in these reaches may be increased by arsenic from the coal ash disposal areas in McCoy Branch and at the Kingston steamplant. However, only two studies reporting arsenic effects at the community level were found. Also, arsenic was not speciated in the effects data set and it is not clear whether the forms of arsenic at the sites used to generate the effects distribution are sufficiently similar to the forms in the coal ash-contaminated sediments to be relevant. Arsenic appears to present a marginal risk at most other sites in the OU. Except as noted previously, arsenic concentrations in most reaches in the CR/PC system appear to be relatively similar to the negative reference Reaches 0 and 8. Although the data are limited, this may indicate that the reported effects concentrations are too conservative for CR/PC sediments. This is supported by the inconsistent effects reported in the sediment toxicity literature at these concentrations (Appendix F1). Also, only Reach 7.02 has sediment arsenic concentrations that exceeded the ER-M from Long et al. (1995) and arsenic was detected in pore water in all reaches but did not exceed any aquatic benchmarks.

Barium. Barium in sediment and pore water does not appear to present a risk to benthic invertebrates in the OU. The only sediment benchmark is a background value from EPA Region V, which has no toxicological basis. The Region V background level was exceeded at all sites and is apparently not representative of local background. There is some limited toxicity data for aqueous barium concentrations. The Secondary Acute Values (SAVs) and SCVs are calculated to be conservative because there is little toxicity data. The SCV was exceeded at all sites and appears to be too low for local conditions. Although not exceeded at every site, the SAV was exceeded in two negative reference reaches and none of the acute values used in its derivation were exceeded in any reach. Furthermore, the observed pore water concentrations were at least an order of magnitude less than the lowest CV found for any aquatic organism.

Boron. No data are available to evaluate the toxicity of boron in whole sediments, but boron in pore water appears to present a negligible risk to benthic invertebrates in the OU. Concentrations in pore water in all reaches, including references, exceeded the LCV for daphnids. That benchmark is apparently below the local background due to the compounding of effects across all life stages in its derivation. Boron does appear to be elevated in Poplar Creek below the ash disposal area, which is the only reach (3.04) in which the maximum concentration exceeds any other benchmarks (SCV). The maximum concentration does not exceed the LCV for daphnids or the SAV and the median concentration is less than the SCV. Also, the maximum concentration is less than the toxicity values used in its derivation. Given that, boron is unlikely to be toxic to benthic invertebrates in the Reach 3.04.

Cadmium. Cadmium appears to present a marginal risk in Poplar Creek below East Fork and at very localized hot spots in Reach 4.04, and a negligible risk in all other reaches, including negative references. The distributions of ambient Cd concentrations in whole sediment and sediment effects concentrations are shown in Fig. F3.7(a-d). The minimum observed concentration in all reaches approximates or exceeds the lowest lethal effects concentration, but the median observed concentration is never more than the median lethal concentration. That is, the distribution of observed Cd crosses the effects distribution below the 50th percentile. None of the observed Cd concentration distributions cross the community level effects distribution. The plot of median ΣTUs in whole sediment (Fig. 6.14b) indicates that Reach 3 is impacted the most by cadmium. Cd was detected in one of eleven pore water samples from Reach 4.04. This concentration and the aqueous test endpoints for Cd are shown in Fig. F3.1. Though the ER-M from Long et al. (1995) is not exceeded at any site, freshwater species are reported to be more sensitive to Cd than marine species (Appendix F1). However, Cd concentrations exceed the relatively conservative ER-L in Reach 3 and at sites in Reach 4.04 only.

Cd concentrations in Poplar Creek sediment appear to be more toxic below EFPC (Reach 3) than above the confluence (Reach 13). Although the data are limited, toxicity from Cd in sediment appears to increase below the confluence with Mitchell Branch also. A consistent concentration gradient is not evident within Reach 3 (Fig. F3.7b). However, these results suggest that East Fork and Mitchell branch are the primary contributors to risks from Cd in sediment. Contributions to risk from Mitchell Branch and the ash disposal area can not be distinguished from East Fork. The distribution of concentrations in Reach 3 suggest that community level and lethal effects are not probable at any of the sampled sites, but are possible at roughly half of the sampled sites.

The distributions of Cd concentrations in all other reaches were more similar to each other, and indicative of a more homogenous distribution of Cd, than the distributions observed in Reach 3 (Fig. F3.2a-d). The Clinch River and McCoy Branch distributions suggest that Cd toxicity is unlikely in these reaches. These may be local background concentrations, because there does not appear to be any relationship to potential sources.

Cd was observed at the detection limit in one of the eleven pore water samples from Reach 4.04. This value exceeded half the invertebrate CVs, which were the lowest aqueous toxicity values graphed, and was marginally lower than the chronic NAWQC (Fig. F3.1). The maximum sediment concentration in 4.04 was not continuous with the majority of the distribution (Fig. F3.7c). These results suggest that concentrations of Cd in sediment or pore water at localized hot-spots within Reach 4.04 may be toxic.

Chromium. Chromium appears to present marginal to significant risks in localized areas in Poplar Creek below Mitchell Branch, but negligible risks in most of Poplar Creek and the other reaches. The distributions of ambient Cr concentrations in whole sediment and sediment effects concentrations are shown in Fig. F3.8(a-d). The plot of median ΣTUs in whole sediment (Fig. 6.14b) indicates that Reaches 3 and 4 are similarly impacted by Cr and that Cr is one of the least important metal COPECs. The

sediment effects data are relatively inconsistent, especially below the ER-M (Long et al. 1995), which was not exceeded at any site. Cr was detected in pore water in all reaches but does not appear to be toxic.

Cr concentrations in Poplar Creek sediment above Mitchell Branch cover a very narrow range and suggest negligible toxicity in these reaches (3.01 and 13). The 100th percentile for each subreach shows a downstream gradient below Mitchell Branch, but the distributions as a whole are indistinguishable from each other (Fig. F3.8b). These results suggest that lethal effects of Cr are toxicity is possible to likely at localized hot-spots in Poplar Creek below Mitchell Branch. Community level effects are possible, though unlikely, at localized hot-spots in Reaches 3.02 and 3.03, but are unlikely at most sites in Poplar Creek. This also suggests that Mitchell Branch is the primary contributor to risks to benthic invertebrates from exposure to Cr in sediment.

Cr lethality is unlikely in most of the Clinch River and McCoy Branch Embayment (Figs. F3.8a,c, and d). Cr lethality is possible at less than 20% of the sites in lower McCoy Branch Embayment (7.02) and the Clinch River below the Emory River (4.03). Community level effects are unlikely in the Clinch River and McCoy Branch Embayment.

Cobalt. Risks to benthic invertebrates from cobalt are uncertain. Co in pore water appears to be chronically toxic in parts of Poplar Creek and the Clinch River. Although Co concentrations in Poplar Creek increase below East Fork, a concentration gradient is not evident and Co appears to be toxic above the OU (Reach 13) as well. Co concentrations in pore water in the Clinch River below the Emory River (4.03 and 4.04) also exceeded benchmarks. However, very little aqueous toxicity data, and no sediment toxicity data, were found (Appendix F1). All of the aquatic benchmarks were derived from one study using *D. magna* and fathead minnows. Hence, the precision of the toxicity values and influence of water hardness are unknown.

Copper. Copper appears to present a marginal risk at most sites in Poplar Creek below Mitchell Branch; a marginal risk in localized areas of the Clinch River below the Emory River and in Lower McCoy Branch Embayment; and a negligible risk in all other reaches. The distributions of ambient Cu concentrations in whole sediment and sediment effects concentrations are shown in Fig. F3.9(a-d). The minimum observed concentration in all reaches approximates or exceeds the lowest lethal effects concentration. Pore water concentrations for these reaches and the aqueous test endpoints for Cu are shown in Fig. F3.2.

Cu concentrations in Poplar Creek sediment appear to be more toxic below Mitchell Branch than in Reaches 13 and 3.01 (Fig. F3.9b). Although a concentration gradient is not evident, these results suggest that Mitchell Branch is the primary contributor to risks to benthic invertebrates from Cu in sediment. The effects data are only moderately consistent, especially below the ER-M (Long et al. 1995), which was not exceeded at any site. These results suggest that Cu in sediment may be toxic at most sites below Mitchell Branch, but toxicity is not likely in any reach. The distributions of Cu concentrations in pore water are indicative of localized chronic toxicity: about 20% of the samples appear to be chronically toxic. However, there is no evidence that pore water is more toxic below Mitchell Branch.

Cu in sediment appears to be a negligible risk to benthic invertebrates in most of the Clinch River and McCoy Branch Embayment (Figs. F3.9a,c, and d). The distributions in sediment suggest that risks from Cu are higher below the Emory River (Reaches 4.03 and 4.04) and adjacent to the ORR (Reach 1) than in adjoining reaches. Cu toxicity is possible but unlikely in Reaches 1, 4.03, and 4.04. Pore water concentrations also suggest chronic toxicity in the Clinch River below the Emory River.

Iron. Iron in sediment and pore water appears to present a marginal risk to benthic invertebrates in Reaches 3.02 and 4.04, which the plot of maximum ΣTUs in pore water (Fig. 6.12) indicates are impacted the most by Fe. Maximum sediment concentrations in Reaches 3.03, 4.04, and 7 marginally exceeded the Lowest Effect Level for Fe in Ontario sediments (Table 6.8). This indicates a slight risk in these areas. Maximum pore water concentrations of Fe exceeded toxicity benchmarks in several reaches. Most of the toxicity values are based on Fe in acidic effluents, which are not present in this OU. The maximum concentration in 4.04, however, also exceeded the one CV for *D. magna* in circum neutral water (Sect. 6.2.2.1). These are dissolved Fe concentrations and represent the dissolved fraction in the pore water.

Lead. Lead in OU sediments does not appear to contribute to risks to benthic invertebrates. There appears to be a negligible risk of Pb toxicity at most sites in the CR/PC System and a marginal risk in very localized areas of the Clinch River below Poplar Creek, Reach 2.04, and Reach 3.02. The distributions of ambient Pb concentrations in whole sediment and sediment effects concentrations are shown in Fig. F3.10(a-d). The only trend evident from these distributions is that Pb concentrations appear to increase downstream in the Clinch River below Poplar Creek (Fig. F3.10c). Hence, the apparent risks to benthic invertebrates from Pb in Clinch River sediment are not consistent with any known contaminant sources.

Manganese. There is only weak evidence of increased risks from Mn released from the OU, given the uncertainty in the toxicity data and the lack of concordance with known contaminant sources. The plots of median ΣTUs in whole sediment (Fig. 6.14b) and pore water (Fig. 6.13) indicate that Mn is potentially toxic in almost every reach, including negative reference reaches. Hence, there does not appear to be any relationship between known contaminant sources and the potentially toxic levels of Mn. Also, very little aqueous or sediment toxicity data were found (Appendix F1). All of the aquatic benchmarks were derived from one study using *D. magna* and fathead minnows, and the only sediment toxicity information is for sediments in Ontario, Canada. Given the uncertainty in the toxicity data and the lack of concordance with known contaminant sources, there is only weak evidence of increased risks from Mn released from the OU.

Mercury. Mercury in sediment appears to be a significant risk to benthic invertebrates in Poplar Creek, the lower Clinch River, and Walker Branch Embayment; a negligible risk in Reaches 2.02 and 2.03 and most of Reach 0; and a marginal risk in all other reaches. The distributions of ambient Hg concentrations in whole sediment and sediment effects concentrations are shown in Fig. F3.11(a-d). The plots of maximum ΣTUs in whole sediment (Fig. 6.14a) and pore water (Fig. 6.13) indicate that Reaches 3 and 4 are impacted the most by Hg. Pore water concentrations and the aqueous test endpoints for Hg are shown in Fig. F3.3. The sediment effects distribution may be overly conservative for Clinch River sediment, since toxicity appears to be possible and/or probable at upstream and negative reference sites (Reaches 0, 8, and 13) as well. This is supported by the lack of consistency in the toxicity data: biological effects were observed in only 42% of the documented studies with concentrations greater than the ER-M (Appendix F1). However, effects were nearly always observed in freshwater studies at concentrations prevalent in Reaches 3 and 4 (i.e.; 1–100 mg/kg).

There are two general classes of mercury: organic mercury, including methyl mercury, and inorganic mercury, including metallic mercury, mercuric chloride, and mercuric sulfide (EPRI 1987). Methyl mercury concentrations were measured in sediment and pore water samples from the CR/PC OU. Speciation of inorganic mercury was not performed as part of this investigation. However, speciation and bioavailability studies of mercury in EFPC floodplain soils were performed as part of the Lower EFPC RI (DOE 1994 and Barnett and Turner 1995). In general, these studies indicated that the dominant form was mercuric sulfide, that mercuric chloride constituted less than 1 % of the total mercury, and that

mercuric chloride was the most soluble, and hence most bioavailable, form of inorganic mercury. It is likely that the composition of inorganic mercury in sediments downstream of EFPC is comparable to that in the Lower EFPC floodplain soils because they both have EFPC surface water and sediment as the primary sources of mercury.

Methyl mercury is the most toxic of the mercury species (Eisler 1987 and EPRI 1987). However, pore water concentrations of methyl mercury in the CR/PC did not exceed aqueous toxicity benchmarks. Mercury was not speciated in the sediment effects data. The proportion of inorganic mercury represented by mercuric chloride increases with increasing chloride ion concentrations, but the proportion of mercuric sulfide changes little over the range of naturally occurring sulfide ion concentrations (EPRI 1987). Nearly all of the sediment effects data are from marine and estuarine systems. Hence, it is likely that the sediment benchmarks and effects distributions represent exposures to more soluble, and thus more toxic, mixtures of inorganic mercury species than the exposures received by benthos in this OU.

Hg concentrations in Poplar Creek sediment appear to be more toxic below Mitchell Branch than in Reaches 13 and 3.01 (Fig. F3.11b). However, there is only limited data from Reach 3.01, the distribution spans two orders of magnitude, and it overlaps the other distributions for Poplar Creek. The upper end of the distribution in Reach 3.04 (above the 60th percentile) is not continuous with the rest of the distribution. This indicates a more heterogenous distribution of Hg than is observed in Reaches 3.02 and 3.03 and suggests that the ash disposal area may contribute to risks from exposure to Hg in some sediments of Reach 3.04. These results suggest significant risks to benthic invertebrates from Hg in sediment at nearly every site below East Fork and Mitchell Branch.

Hg concentrations are likely to be toxic at nearly every site in the Clinch River below the Emory River (Reaches 4.03 and 4.04) and at most sites in Reaches 4.01 and 4.02 (Fig. F3.11c). The distributions of ambient Hg in sediment appear to be marginally toxic in all other reaches (Figs. F3.11a and d).

Nickel. In general, sediment concentrations of nickel appear to present a significant risk at most sites in Poplar Creek below Mitchell Branch, and a marginal risk at most sites in the Clinch River below the Emory River and in Lower McCoy Branch Embayment. Ni in sediment appears to present a significant risk of community level effects in Poplar Creek below Mitchell Branch, in the Clinch River below the Emory River, and in Lower McCoy Branch Embayment. Negligible to marginal risks of community level effects are indicated for all other reaches. Risks of lethal effects are significant for localized areas of Poplar Creek below Mitchell Branch; marginal for most site in Polar Creek below Mitchell branch and the Clinch River below the Emory River, and localized areas of Lower McCoy Branch Embayment; and negligible for all other reaches, including Reach 0. The distributions of ambient Ni concentrations in whole sediment and sediment effects concentrations are shown in Fig. F3.12(a-d). The plots of median ΣTUs in whole sediment (Fig. 6.14b) and pore water (Fig. 6.13) indicate that Poplar Creek is impacted the most by Ni. Pore water concentrations and the aqueous test endpoints for Ni are shown in Fig. F3.4. Interpretation of the community level effects distribution is uncertain because of the limited data and extreme slope of the distribution. That is, a marginal effects range can not be easily discerned.

Ni concentrations in Poplar Creek sediment appear to be more toxic below Mitchell Branch than in Reaches 13 and 3.01 (Fig. F3.12b). Ni concentrations exceeded the 50th percentile of the community level effects distribution at most of the sites in Reaches 3.02, 3.03, and 3.04, whereas concentrations in Reaches 13 and 3.01 do not appear to be as toxic. The maxima below Mitchell Branch also exceeded the ER-M from Long et al (1995). However, only 17% of the studies used to derive that value indicated biological effects at concentrations greater than the ER-M, which indicates that the threshold for toxicity is highly uncertain.

Ni in sediment appears to be a marginal risk to benthic invertebrates in most of the Clinch River and McCoy Branch Embayment (Figs. F3.12a,c, and d). The distributions suggest that risks from Ni are higher below the Emory River (Reaches 4.03 and 4.04) than in Reaches 4.01 and 4.02. With the noted exceptions, the Clinch River and McCoy Branch Embayment distributions are comparable to the negative reference sites (Reaches 0 and 8). Pore water concentrations also suggest chronic toxicity in the Clinch River below the Emory River (Fig. F3.4).

Silver. Silver appears to be a significant risk in most of Poplar Creek below Mitchell Branch and in very localized areas of Reach 4.04; a marginal risk in most of Reaches 1, 4.03, and 4.04; and a negligible risk in other reaches. The distributions of ambient Ag concentrations in whole sediment and sediment effects concentrations are shown in Fig. F3.13(a-d). A high percentage (92.8%) of studies indicated an incidence of effects at concentrations greater than the ER-M, which was exceeded in Reaches 3.02 and 3.03 only.

The Ag concentrations in Poplar Creek appear to be lethal to benthic invertebrates at most sites below Mitchell Branch (Fig. F3.13b). Community level effects are indicated for localized areas of Reaches 3.02 and 3.03 only. Reference sediments (Reach 13) do not appear to be as toxic. These distributions suggest that Mitchell Branch is the primary contributor of risks from Ag in sediment. However, the limited data preclude excluding East Fork as a source of Ag toxicity.

Ag appears to be a negligible risk at most sites in the Clinch River and McCoy Branch Embayment (Figs. F3.13a,c, and d). The exceptions to this are Reaches 1, 4.03, and 4.04 (Fig. F3.12c), where most sites appeared to be marginally toxic. The Emory River may contribute to the risks in the Clinch River, but there are no obvious relationships between known contaminant sources and increased risks from Ag in sediment.

Uranium. Uranium appears to be a negligible risk to benthic invertebrates in the CR/PC System. Although U in Poplar Creek pore water increases below Mitchell Branch and a concentration gradient is evident, the only benchmark exceeded was the SCV. This toxicity value is highly conservative because of the small data set used to derive it. The maximum pore water concentrations were 1 to 3 orders of magnitude less than the lowest reported toxic concentration (a fathead minnow LC50 of 2.8 mg/l).

Zinc. Zinc in sediment presents a marginal risk at a few sites in Poplar Creek below Mitchell Branch and most of Reach 4.04 and a negligible risk in all other reaches in the OU. The distributions of ambient Zn concentrations in whole sediment and sediment effects concentrations are shown in Fig. F3.14(a-d). Pore water concentrations and the aqueous test endpoints for Zn are shown in Fig. F3.15.

Approximately 30% of the sediment samples from Reach 3.02 have concentrations higher than the ER-L and the 20th percentile of the lethal effects distribution (Fig. F3.14b). This may indicate that Zn from Mitchell Branch increased toxicity in sediments at some locations. However, a concentration gradient is not evident in Poplar Creek, all other Poplar Creek sites were less than the 20th percentile of the lethal effects distribution, and none of the sites in Reaches 3 or 13 exceeded the ER-M reported by Long et al. (1995).

Summary of Metals. Four metals (As, Hg, Ni, and Ag) present a significant risk to benthic invertebrates at most sites in at least one reach. All four are a significant risk in Poplar Creek. East Fork and/or Mitchell Branch appear to be the primary contributors of these COPECs, though the ash disposal area may increase risks as well. Hg presents a wide spread significant risk in the Clinch River below Poplar Creek. McCoy Branch Embayment is the only other reach in which a metal COPEC, As, is a significant risk at most sites.

Two metals, As and Cr, in whole sediment are a significant risk to benthic invertebrates at localized hot-spots in at least one reach: arsenic in Poplar Creek below East Fork, but above the ash disposal area and Cr below Mitchell Branch. Pore water COPECs were not a localized significant risk.

Six metals (As, Cu, Hg, Fe, Ni, and Zn) in whole sediment are a marginal risk to benthic invertebrates at most sites in at least one reach. Every reach; including negative reference reaches, had concentrations of at least one metal COPEC at which toxicity is possible. Also, Al in pore water presents a marginal risk at localized areas in several reaches.

Five metal COPECs (Ba, B, Pb, Mn, and U) are a negligible risk to benthic invertebrates in the CR/PC System.

Phthalate Esters. Bis(2-ethylhexyl)phthalate was the phthalate ester detected at concentrations exceeding benchmarks. Risks to benthic invertebrates from bis(2-ethylhexyl)phthalate appear to be a negligible. Bis(2-ethylhexyl)phthalate was detected in sediment in all reaches, both above and below the OU. Whole sediment toxicity data were not found for bis(2-ethylhexyl)phthalate. Pore water concentrations were estimated using the equilibrium partitioning approach and were less than all aqueous toxicity benchmarks. However, bis(2-ethylhexyl)phthalate was detected in pore water samples from the Clinch River (Reaches 2.04 and 4.01) and Poplar Creek (Reaches 3.02 and 3.03). Maximum concentrations in Reaches 3.03 and 4.01 marginally exceeded (e.g., HQs of 1.6 or 3.3) the lowest chronic and lowest test values for daphnids. These toxicity values are lower than the secondary acute and CVs, which were not exceeded. A subsequent test with daphnids observed no significant effects at concentrations higher than those found in the OU. Furthermore, the frequency of detection was relatively low, there are no known sources of plasticizers in the OU, and this is a common laboratory contaminant.

Total PAHs. PAHs as a group appear to be major contributors to risk in Poplar Creek above (Reach 13) and below (Reach 3) East Fork Poplar Creek, as indicated by the median ΣTU plot for the general categories of COPECs in whole sediment (Fig. 6.14a). Total PAHs appear to be a significant risk to benthic invertebrates in localized areas of Poplar Creek, above and below East Fork, and in Reach 4.04 of the Cinch River. PAHs present a negligible to marginal risk in all other reaches, including reference reaches.

PAHs were detected in whole sediment samples from all reaches except 1, 2.01, 2.02 and 2.03. PAHs were not detected in pore water in any reach. All 12 detected PAHs were COPECs. The median ΣTU plot for PAHs in whole sediment (Fig. 6.14c) suggests that PAHs as a group present, at a minimum, a marginal risk to benthic invertebrates at most sites in each reach in which they were detected. That is, the effects concentration used to calculate the TUs was the ER-L, which is the 10th percentile of Long et al.'s (1995) effects distribution. However, the risks from each individual PAH in Reaches 3.01 or 7.01 are negligible (i.e., the maximum observed concentration was less than the ER-L). At least one PAH exceeded the ER-L in the remaining reaches. The median ΣTU plot for PAHs in whole sediment (Fig. 6.14c) indicates that the 3 PAHs that contribute the most risk in the CR/PC System are 2-methylnaphthalene, acenaphthene, and fluorene.

The distributions of measured Total PAH concentrations were similar among all reaches in the OU, except Reach 4.04, which was generally an order of magnitude higher than the other distributions. The highest Total PAH concentration was in Reach 13. The distributions for Poplar Creek (Reaches 3 and 13) suggest a more heterogeneous distribution of PAHs than the distributions for the other reaches. The maximum concentration in all reaches, Except Reaches 3.01 and 4.02, exceeds the Total PAH ER-L. None of Total PAH concentrations exceed the ER-M. The distribution of observed concentrations in Reach 13 suggests that localized areas of that reach are likely to contain lethal concentration of PAHs.

Localized concentrations in Reach 4.04 may be lethal also. However, the distributions of total PAH concentrations suggest that lethality is unlikely at all other reaches. Total PAH concentrations should produce significant community level effects at all sites, based on these distributions. That is observed total PAH concentrations are approximately an order of magnitude higher than the community level effects distribution. However, the effects distribution is based on very little data. Hence, local total PAH concentrations, including concentrations at reference reaches, are significantly toxic and/or the community level effects distribution overestimates the likelihood of effects.

Sediment Quality Criteria (EPA_SQC01) are available for three of the detected PAHs: acenaphthalene, fluoranthene, and phenanthrene. Although these were all detected in Poplar Creek, none occurred at concentrations exceeding the SQC. Three PAHs occurred at concentrations that exceed their respective ER-Ms: 2-methylnaphthalene in Reaches 0 and 13, napthalene in Reach 13, and phenanthrene in Reach 13. Concentrations of all individual PAHs at all sites potentially affected by known sources were less than the individual ER-Ms.

PCBs. Total PCBs appear to be a wide spread significant risk to benthic macroinvertebrates in Poplar Creek below Mitchell Branch, and a localized significant risk in Reaches 2.02, 4.01, 4.04. The median ΣTU plot for the general categories of COPECs in whole sediment (Fig. 6.14b) indicates that PCBs contribute to risk in Reach 2.02, Poplar Creek (Reaches 3 and 13), and Lower Clinch River (Reach 4). The distributions of ambient total PCB concentrations in whole sediment and the sediment effects concentrations are shown in Fig. F3.16a and b. Three congeners were detected: PCB-1248, PCB-1254, and PCB-1260. PCB-1248 was detected in two reaches (3.02 and 3.04) of Poplar Creek only, whereas PCB-1254 was present in each reach where PCBs were detected, except Reach 3.01. PCBs were not detected in pore water samples in these reaches and the concentrations estimated using the equilibrium partitioning model were less than the highly conservative SCV. This suggests that PCB toxicity is likely to be associated with the solid phase. Given that, ingestion of sediments would be a more important exposure pathway than respiration of interstitial water. PCBs appear to be significantly toxic in most reaches where they were detected: maxima exceeded the ER-M from Long et al. (1995) and/or the 50th percentile of either effects distribution (Figs. F3.16a-b). However, the toxicity data are highly uncertain. Freshwater data indicate little or no concordance between toxicity and PCB concentrations and there is a low (51%) incidence of biological effects at concentrations greater than the ER-M ("probable-effects range") reported by Long et al. (1995). Also, MacDonald (1994) expressed a low degree of confidence in the Florida Sediment Quality Assessment Guidelines (SQAG). Florida SQAGs were not used in this assessment. However, the data used to derive the effects distributions presented in Appendix F3 were from the same database used to derive the Florida SQAGs. Given these uncertainties, the evidence for PCB toxicity in sediments in the OU is moderate.

PCB concentrations in Poplar Creek sediment appear to be more toxic below Mitchell Branch than in Reaches 13 and 3.01 (Fig. F3.1a). Although a concentration gradient is not evident below Mitchell Branch, toxicity appears to be more likely than not at most sampling sites in these reaches. However, as noted above, low confidence in the toxicity data suggests that toxicity is possible, but not probable. Even so, Mitchell Branch appears to increase the risks to benthic invertebrates from PCBs in sediment.

A gradient in PCB toxicity in sediments is not evident in the Clinch River (Figs. F3.16a-b). Toxicity appears to be more likely than not at most sampling sites in these reaches. However, as noted above, confidence in the toxicity data is only moderate.

Pesticides. 4,4'-DDT and 4,4'-DDD appear to present a marginal risk to benthic invertebrates in the Clinch River adjacent to the ORR (Reach 1). These pesticides were detected in only one sample, but that concentration exceeded the ER-M from Long et al. (1995). Toxicity appears to be associated with the

DDT, which were the only pesticides included in that report. Given these uncertainties, it appears that toxicity is possible at isolated locations in Reach 1 only.

6.3.3.2 Ambient sediment toxicity

There was very little indication of sediment toxicity in any of the tests and no clear spatial trends. Two expressions of the results of sediment toxicity tests are used, the average magnitude of the effects and the frequency of effects that are significant. Test results are deemed significant if (1) there is at least a 20% difference between the response of the organisms exposed to sediment or pore water from the OU and the organisms exposed to control water or reference sediment/pore water, or (2) the likelihood that the difference is due to chance is less than 5%. Test results are related to two expressions of exposure, the location of the sample relative to sources and the relationship between the test responses and the concentrations of sediment COPECs from the same location. Mean proportional reductions in survival best represent the likely impacts in a reach because of the inherent spatial heterogeneity of sediments and sediment-associated contaminants. The methods and results of the sediment tests are discussed in Sect. 3.4.2. This section analyzes their implications for risks to benthic macroinvertebrates in the OU.

Survival of the sediment-associated organism *H. azteca* was the most responsive and reliable test, but the magnitude and frequency of significant effects was very low. Less than 25% of the tests from all reaches and dates had significant reductions in survival and the mean reduction was less than 20% for every reach. The least responsive tests were those using pore water as the exposure medium.

Mortality of *H. azteca* in sediments from all four subreaches of Poplar Creek was statistically significantly elevated relative to the reference site (PCM 6.0, Reach 13) in at least one test (Fig. 6.15). However, the sediment toxicity laboratory notes that the first test of *H. azteca* was used for method performance evaluation and technician training and advises caution when interpreting these results. Only Reaches 3.01 and 3.03 had significant mortality in subsequent tests. Furthermore, even with the first test included, the mean proportional reductions in survival were not biologically significant (i.e., reduced less than 20% relative to the reference) at any of the Poplar Creek locations.

Mortality of *H. azteca* in sediments from both of the tested Clinch River subreaches (CRM 19.0; Reach 2.03 and CRM 9.0; Reach 4.01) were significantly elevated relative to the reference site (CRM 22.0; 2.01) in three of the seven tests (Fig. 6.15). One of the significant responses for Reach 2.03 was from the first *H. azteca* test, which is caveated as noted above. Though the proportion of significant tests was higher in the Clinch River than in Poplar Creek, the mean proportional reductions in survival were still not biologically significant (i.e., reduced less than 20%).

Mortality of *H. azteca* in sediments from McCoy Branch Embayment (MBM 0.2; Reach 7.02 and MBM 0.4; Reach 7.01) was not significantly elevated relative to the reference site (WBM 0.4–0.6; Reach 8) in either of the two tests (Fig. 6.15).

Concentrations of COPECs in whole sediment were not statistically significantly positively correlated with *H. azteca* survival ($\alpha = 0.05$). However, significant correlations may be masked by the spatial heterogeneity of sediment-associated contaminants. Sediment samples for toxicity testing and

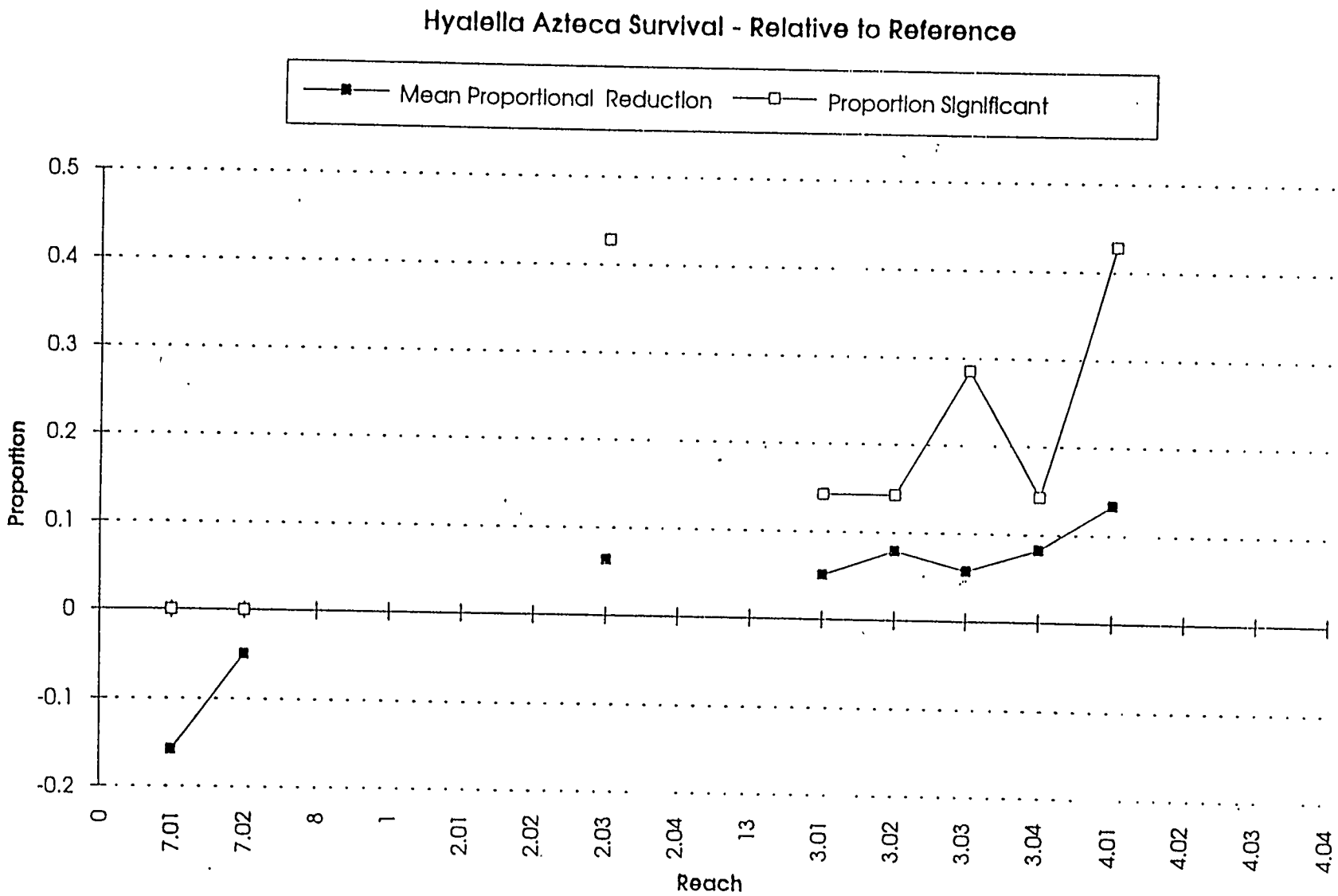


Fig. 6.15. Proportional reduction in *Hyalella azteca* survival relative to references and proportion of tests in which survival was statistically significantly decreased relative to controls or was decreased by at least 20% relative to controls (i.e., significantly decreased).

chemical analysis were collected at different times and, although the whole sediment concentrations are unlikely to vary appreciably in time, they are likely to vary in space. That is, although an effort was made to collect samples from the same location, the observed chemical concentrations may not reflect the exposures received during any given toxicity test.

In summary, these tests indicate that some of the sediments at these locations are toxic, but when evaluated as a whole, the impacts do not appear to be biologically significant. Significant impacts may, however, be obscured by impacts at the reference sites. The fact that sediment test results were more sensitive than pore water test results may indicate that sediment-associated contaminants contribute more to risks in the sediments or that the sample processing procedure significantly altered the toxicity of the pore water.

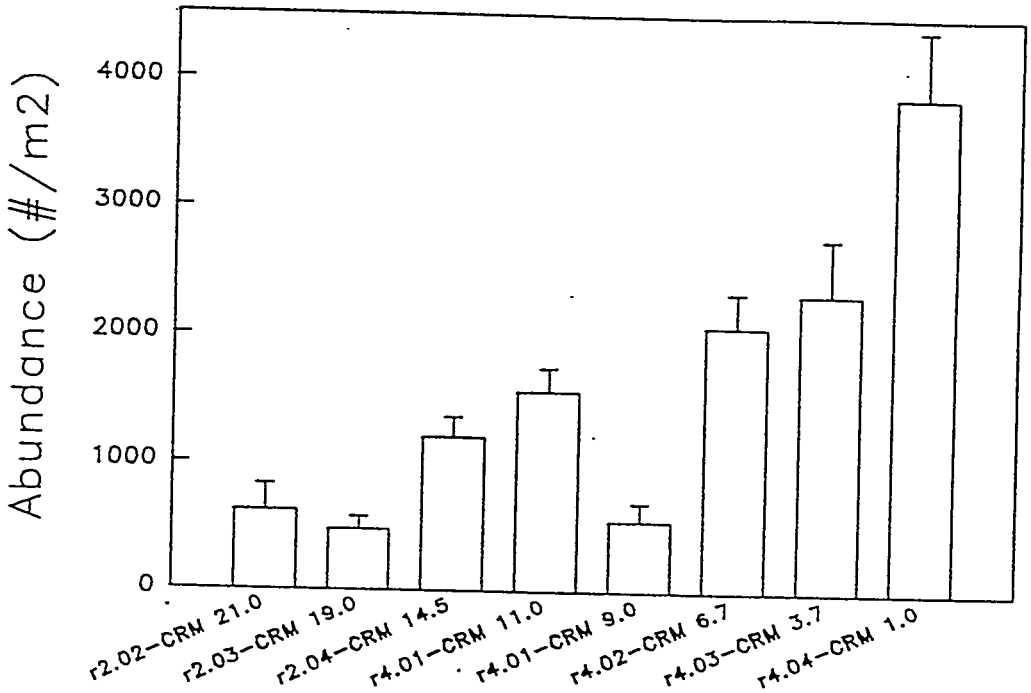
6.3.3.3 Biological surveys

Discriminant analysis as described in Appendix F8 shows no clear distinction between Poplar Creek embayment and the mainstem Clinch River. Clinch River Reach 2 (above Poplar Creek) is as different from Reach 4 (below Poplar Creek) as either is from Poplar Creek itself (Reaches 3 and 13). The analysis of total abundance and species richness (Figs. 6.16–6.19) does, however, demonstrate some fine-scale spatial patterns within the reaches.

Figure 6.16 shows a distinct gradient in total benthic invertebrate abundance (# of individuals/m^2), within the Clinch River. Abundance is highest at the mouth of the Clinch (Reach 4.04) and declines with increasing distance from Watts Bar Reservoir. The only exception to this pattern is Reach 4.01; invertebrate abundance within this subreach is significantly lower than in either of the adjoining subreaches. The pattern of taxonomic richness (# of taxa/m^2) shows that richness is in general positively correlated with abundance. Richness is high in the lowermost subreaches (4.02–4.04), low in the uppermost subreaches (2.02 and 2.03), and low in Reach 4.01. Taxonomic richness of invertebrates is higher in Reach 2.04 than would be expected based on the abundance data. Chironomids and tubificids are frequently associated with soft substrates and are sometimes used as indicators of poor environmental quality. Figure 6.17 shows that both families are abundant in the Clinch, comprising more than 80% of the total benthic invertebrates in most subreaches. Tubficids predominate in Reaches 4.01 and above; chironomids predominate in Reaches 4.02–4.04.

Figure 6.18 shows that there is no evident spatial trend in invertebrate abundance or species richness within Poplar Creek embayment. The two uppermost stations within Reach 13 (Poplar Creek mile 8.0 and mile 7.0) are low in both abundance and richness, however, the next two stations (Reach 13, mile 6.0 and Reach 3.01, mile 5.1) are high in both abundance and richness. Reaches 3.02, 3.03, and 3.04 are low in abundance and richness compared to adjoining subreaches. The differences in abundance exceed 20% and are statistically significant. Comparison of Figs. 6.16 and 6.18 shows that invertebrates are on average much more abundant in the Clinch River than in Poplar Creek, but taxonomic richness is similar. As in the Clinch, tubificides and chironomids are the dominant invertebrate taxa at all Poplar Creek stations except mile 1.0 (Reach 3.04).

These trends do not in and of themselves demonstrate a contaminant impact. Measured in terms of abundance and richness, Clinch River Reach 4.01, immediately below Poplar Creek is significantly different from Reach 4.02 downstream. However, given the obvious upstream-downstream spatial gradient present in the Clinch, this difference may be due to ecological conditions rather than to a contaminant effect. There is no such gradient observable in the Poplar Creek data. Low abundance and richness present in Reaches 13, 3.02, 3.03, and 3.04 may be attributed to local conditions, including the presence of contaminants.



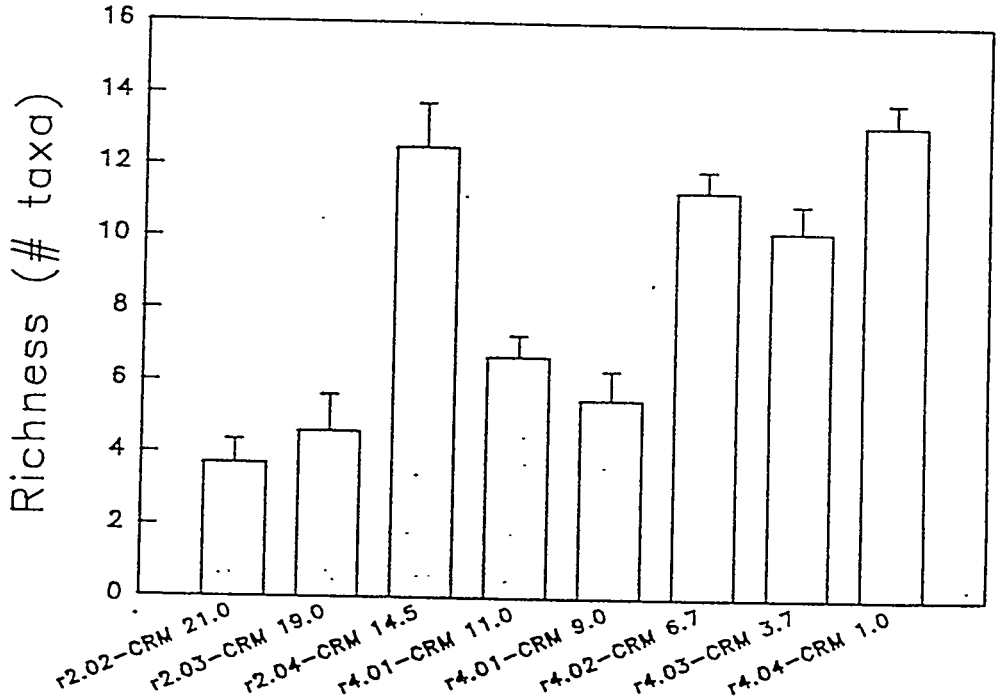


Fig. 6.16. Taxonomic richness and abundance (Mean ± SE) of benthic macroinvertebrates in reaches of the Clinch River in 1994.

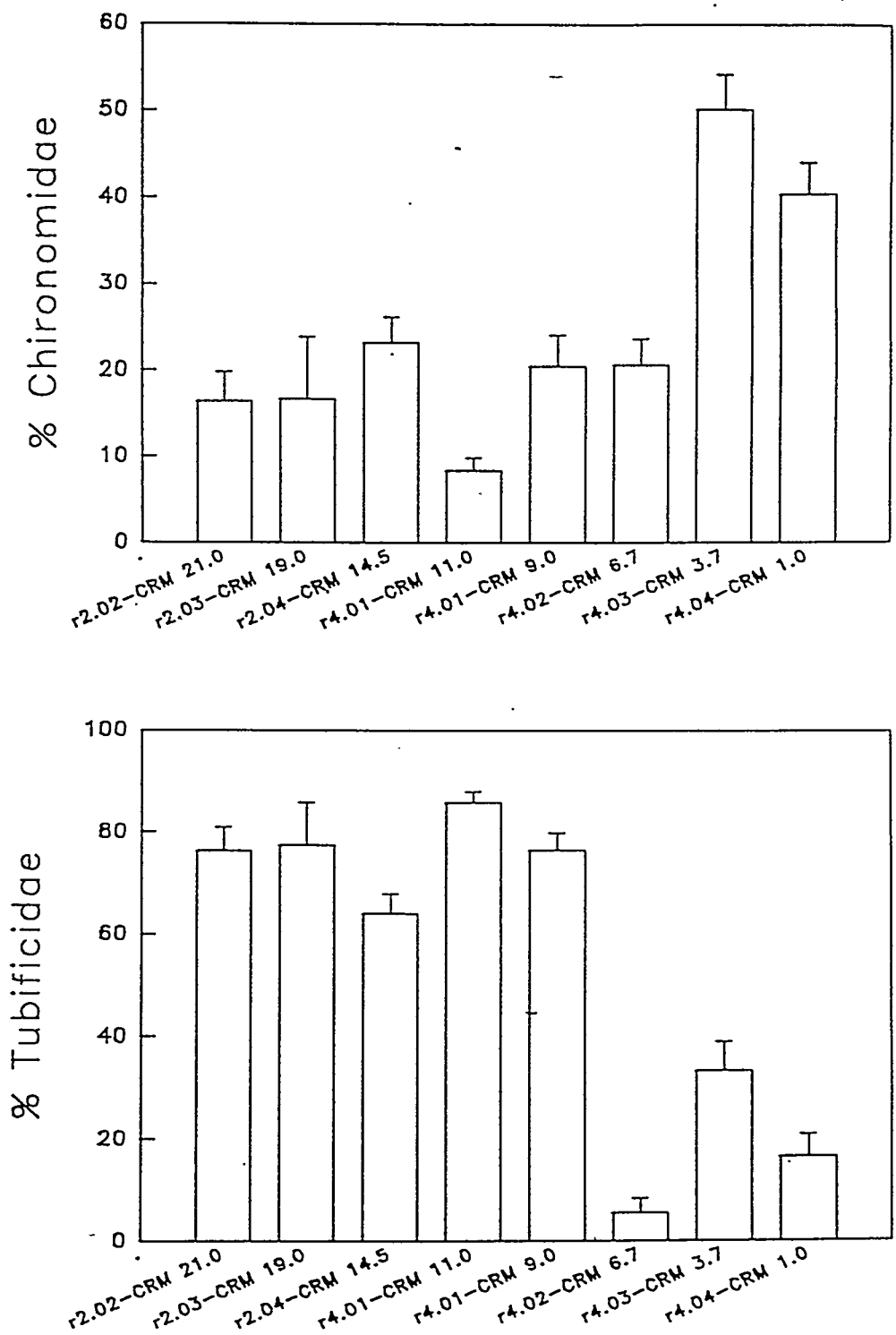


Fig. 6.17. Percentage of benthic macroinvertebrate community (Mean ± SE) represented by *Chironomidae* and *Tubificidae* in reaches of the Clinch River in 1994.

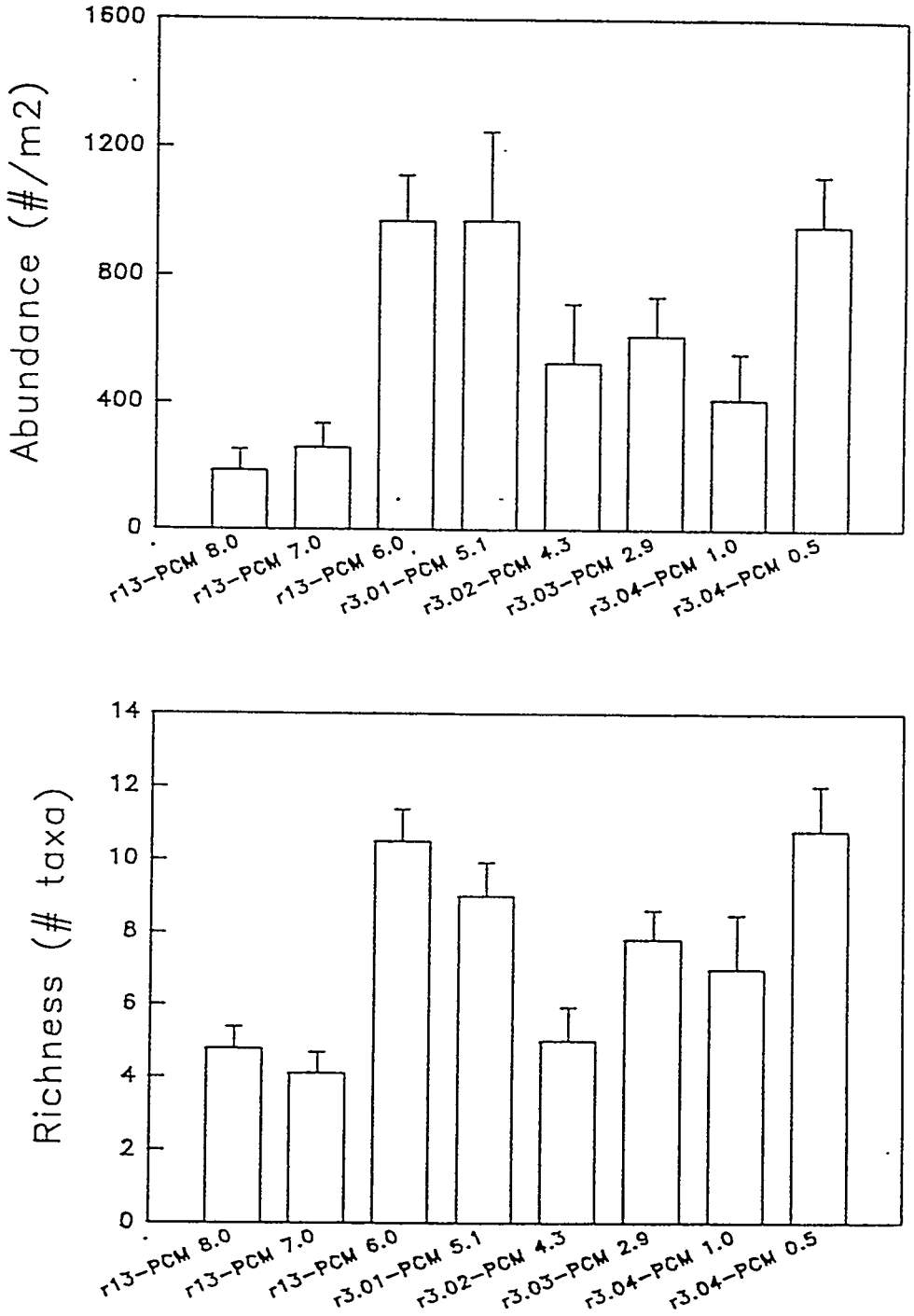


Fig. 6.18. Taxonomic richness and abundance (Mean ± SE) of benthic macroinvertebrates in reaches of Poplar Creek in 1994.

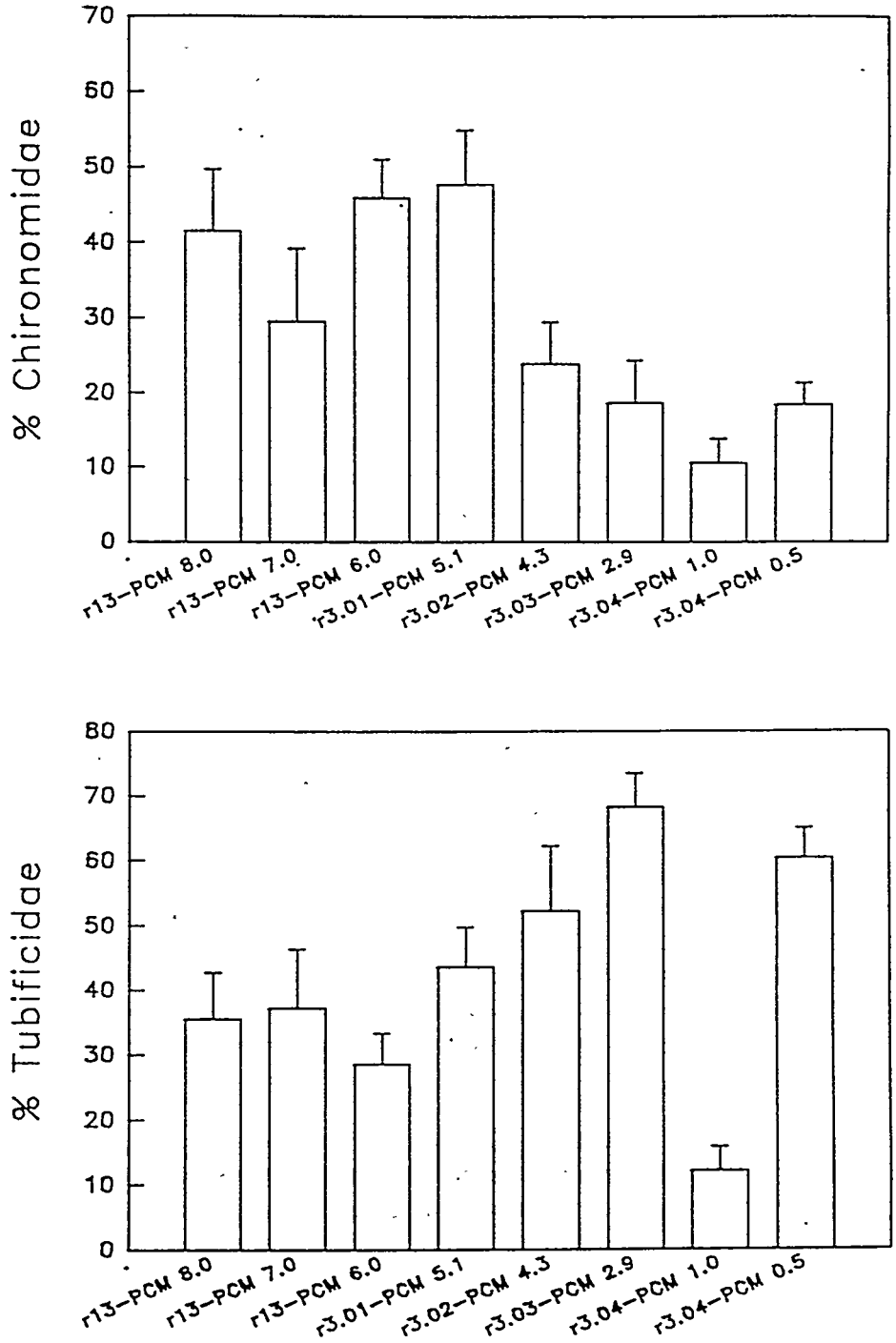


Fig. 6.19. Percentage of benthic macroinvertebrate community (Mean ± SE. represented by *Chironomidae* and *Tubificidae* in reaches of Poplar Creek in 1994.

The TVA (TVA 1994) qualitatively characterized the sediment in the CR/PC benthic invertebrates survey samples. The sites in Reaches 4.02, 4.03 and 4.04 were more lacustrine in nature than the other Clinch River sites. Silt and detritus, primarily in the form of decaying leaves, were the predominant substrates in samples from Reaches 4.03 and 4.04. The amount of detritus was much lower, and the amount of sandy substrates was generally higher, in samples from sites above Reach 4.02. This is consistent with the spatial pattern of particle size distribution observed in the samples for chemical analysis. Sediment from survey samples in Reach 3.04 was almost entirely composed of fine silt (TVA 1994). Poplar Creek sediments above Reach 3.04 were a mixture of fine and coarse sediments with varying amounts of silt present in nearly every survey sample (TVA 1994).

Multiple linear regression analysis as described in Appendix F8 indicates that differences in habitat are more important than differences in contaminant concentrations, with regard to the amount of variation explained in taxa richness, dominance, and the abundance of five taxa (*Chironomidae*, other *Diptera*, *Tubificidae*, *Hexagenia limbata*, and *Veneroida*). Contaminants cannot, however, be excluded from consideration based on these results.

Table 6.9 shows the amount of variance in each of these seven response variables explained by including physical and chemical parameters (full model R^2) or only physical parameters (reduced model R^2). The additional variance explained by including contaminants is the difference between the full model R^2 and reduced model R . Including contaminants significantly ($P<0.05$) increased the amount of explained variance in all benthic community measures for the Clinch River and in four benthic community measures for Poplar Creek.

The variance explained by contaminants given the habitat variables are in the model, however, was small relative to the variance explained by physical parameters alone. Habitat differences in the Clinch River explained more than half of the observed variance in five of the seven response variables, including taxa richness and dominance. In fact, 83% of the variance in *Hexegenia limbata* abundance was explained by the habitat variables alone. Contaminants in the Clinch River explained less than 20% of the variance above that explained by the habitat variables in all response variable except non-*Chironomidae Diptera* (23%). In general, statistical analysis of the Poplar Creek data did not explain as much of the variance in the community measures. However, habitat characteristics were still more important than contaminants. Nearly half of the variance in taxa richness (49%) was explained by physical parameters alone, but only an additional 11% was explained by including contaminant concentrations. The greater importance of habitat relative to contaminants may be partly due to the number of observations at each site. The physical parameters, except for percent TOC, were reported for each benthic invertebrate sample, whereas contaminant concentrations were reported once for each benthic sampling site.

Table 6.10 shows the number of benthic community measures significantly ($P<0.10$) correlated with each of the contaminant variables and the consistency of the signs of these correlations with the hypothesis that contaminants negatively impact the benthic invertebrate community. The fact that chemical variables explain a significant amount of variance in a variety of community measures for the Clinch River and Poplar Creek provides some (admittedly weak) evidence that contaminants may be adversely affecting the benthic community in some locations. Of the contaminants included in the analysis, PAH would appear to be among the ones most likely to be important and toxic metals in Poplar Creek would appear to be among the ones least likely to be important. However, this is weak evidence given the high collinearity of many of the explanatory variables, especially correlations between PAH, PCB, and TOC.

Table 6.9. Amount of variance in benthic community measures explained by the physical, physical plus chemical, and chemical variables and the significance of the chemical variables

Community Measures	Amount of Variance Explained			P-value for Chemicals
	Physical Variables[1]	Physical & Chemical Variables[2]	Chemical Variables Given Physicl Variables[3]	
		Clinch River		
Taxa Richness	52%	69%	17%	<0.0001
Dominance	57%	67%	10%	0.0018
Chironomidae[4]	64%	78%	14%	0.0001
Diptera (other)[4]	21%	44%	23%	0.0002
Hexagenia limbata[4]	83%	90%	7%	<0.0001
Tubificidae[4]	39%	53%	14%	0.0032
Veneroida[4]	55%	64%	9%	0.0140
		Poplar Creek		
Taxa Richness	49%	60%	11%	0.0157
Dominance	23%	28%	5%	0.5014
Chironomidae[4]	25%	44%	19%	0.0057
Diptera (other)[4]	33%	39%	5%	0.4412
Hexagenia limbata[4]	61%	70%	9%	0.0122
Tubificidae[4]	47%	53%	6%	0.2481
Veneroida[4]	45%	55%	11%	0.0336

[1] Physical variables included depth, substrate characteristics (% sand, % silt, % clay, % gravel), and total organic carbon.
[2] Chemical Variables included total PCBs, total PAH, and toxic metals in whole sediment samples and ammonia nitrogen and aluminum in sediment pore water. Toxic metals (arsenic, cadmium, chromium, lead, mercury, nickel, silver, and zinc) were combined into toxic units prior to analysis.
[3] Variance explained by chemicals was derived by subtracting the R^2 for physical variables only from the R^2 for physical plus chemical variables.
[4] Abundance

Table 6.10. Signs of significant correlations between chemical variables and benthic invertebrate variables and the concsistency[1] of signs with negative impacts on benthic communities

Chemical Variables	Clinch River			Poplar Creek		
	Inconsistent	Consistent	Not Significant at $\alpha = 0.05$	Inconsistent	Consistent	Not Significant at $\alpha = 0.05$
Toxic Metals[2]	2	2	3	3	0	4
PCBs (total)	3	2	2	3	1	3
PAHs (total)	2	3	2	1	3	3
Ammonia[2]	1	1	5	1	2	4
Aluminum[2]	2	2	3	1	3	3

[1] High dominance, *Tubificidae* abundance, and *Chironomidae* abundance are generally accepted as indicators of poor water quality. For these variables, a positive coefficient was interpreted as being consistent with contaminant effects. A negative coefficient for taxa richness and abundance of non-*Chironomidae Diptera*, *Hexagenia limbata*, and *Veneroida* was interpreted as being consistent with contaminant effects.

[2] Toxic metals in whole sediment included arsenic, cadmium, chromium, lead, mercury, nickel, silver, and zinc. Because all of these were found to be highly intercorrelated in initial exploratory analyses, the concentrations of the individual metals were combined into toxic units prior to analysis.

[3] Concentrations in sediment pore water.

6.3.3.4 Weight of evidence for benthic invertebrates

The weighing of evidence is performed by asking the following questions concerning each reach in the OU:

1. Is the benthic invertebrate community less species-rich or abundant than would be expected?
2. Is the sediment toxic to aquatic organisms?
3. Does that sediment contain chemicals in toxic amounts?
4. What factors account for apparent discrepancies in the results?

Poplar Creek Embayment (Reach 3). The weight of evidence suggests that the benthic invertebrate community is significantly impacted by contaminants. This conclusion is based on the results indicating that sediment-associated organisms at most sites are exposed to levels of several contaminants that have been observed to be toxic; the biosurvey results show a greater than 20% reduction in taxa richness and abundance; the statistical analysis of the physical, contaminant, and biosurvey data did not exclude contaminants as a causal factor; and the sediment toxicity tests are too ambiguous to definitively exclude impacts in this reach. The lines of evidence concerning risks to benthic invertebrates in Poplar Creek Embayment are summarized in Table 6.11, and are discussed below.

If significant toxic effects were occurring, then the community would have fewer species and individuals than other sites, and they do. That is, reaches 3.02, 3.03, and 3.04 are low in abundance and richness compared to adjoining subreaches. The differences in abundance exceed 20% and are statistically significant. Although this is the most ecologically relevant line of evidence, interpretation of these results is complicated by the highly variable responses, the presence of contaminants and apparent impacts in the reference reach, the importance of habitat characteristics wit h regard to community measures, and the high collinearity of the physical and contaminant variables.

If significant toxic effects were occurring, then the sediment should be toxic, and some samples were. However, the interpretation of these results is uncertain because of the frequency and magnitude of effects. At least one, but less than half, of the sediment samples from each site were significantly toxic to *H. azteca*. The mean reduction in survival, which includes tests with higher than reference survival rates, did not meet the endpoint criterion for biological significance. The inconsistent responses in samples from the same sites is suggestive of a highly heterogeneous system. Hence, some, but not most, of the sediment appears to be acutely lethal to at least one test species. Some impacts at sites below East Fork may be obscured by toxic effects in the reference sediments from Reach 13. That is, a control sediment was not available and reductions in survival are relative to the reference.

Table 6.11. A summary of risk characterization for the benthic invertebrate community in Poplar Creek (Reach 3)

Evidence	Result[a]	Explanation
Biological Surveys	+	Reaches 3.02, 3.03, and 3.04 are low in abundance and richness compared to adjoining subreaches. The differences in abundance exceed 20% and are statistically significant. Habitat is a principle factor, but contaminants may also contribute to the observed differences.
Toxicity Tests	±	At least 1 significant test in each reach, but mean response was not biologically significant.
Media Analyses	+	Risks from 4 metals (As, Hg, Ni, and Ag) and PCBs are significant at most sites in several reaches, especially below Mitchell Branch and East Fork. Arsenic and Cr are significant at localized hot-spots below Mitchell Branch and East Fork. PAHs may also contribute to toxicity.
Weight-of-Evidence	+	Contaminant mediated impacts to the community are likely, though habitat characteristics are critical also.

a + indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the benthic invertebrate community.
- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the benthic invertebrate community.
± indicates that the evidence is too ambiguous to interpret.

If significant toxic effects were occurring, then chemicals should be found in sediment at concentrations that have been reported in the literature to be toxic, and they were. Several COPECs were a significant risk at most sites in at least one reach. Although the primary sources of metals and PCBs appear to be within the OU, PAHs appear to be sourced above the OU and may be a natural constituent of the system. That is, a seam of coal fines was consistently observed in Poplar Creek sediments, especially upstream of the OU.

Upper Clinch River arm (Reach 2). Although there is some indication of toxicity in sediments from the Clinch River above Poplar Creek but below the Melton Hill dam (Reach 2), the invertebrate community does not appear to be significantly affected. This conclusion is based on the results indicating that the benthic community in Watts Bar is similar to other regional mainstem reservoirs, that contaminant concentrations are not a significant risk, and that the sediment toxicity tests neither support, nor refute, this conclusion. The lines of evidence concerning risks to benthic invertebrates are summarized in Table 6.12, and are discussed below.

If significant toxic effects were occurring, then the community would have fewer species and individuals than other sites. This does not appear to be the case. The relatively low richness and abundance observed in Watts Bar is typical of other mainstem reservoirs in the upper Tennessee Valley. Although these metrics are low relative to other sites in Watts Bar, habitat quality appears to be a causal factor (e.g., the amount of organic matter was also low in these reaches). Although the statistical analyses did not exclude contaminants as a source of the variability in the community measures, they did indicate that habitat characteristics are considerably more important for many of the community measures (e.g., physical variables alone explain 83% of the variability in the abundance of the mayfly *Hexagenia limbata*).

If significant toxic effects were occurring, then the sediment should be toxic. Although some samples were toxic, the biological significance of these results is uncertain because of the frequency and magnitude of effects. Less than half of the sediment samples were significantly toxic to *H. azteca* and the mean reduction in survival did not meet the endpoint criterion for biological significance. The inconsistent responses in samples from the same site is suggestive of a highly heterogeneous system. Also, the other sediment toxicity tests were not suggestive of significant toxicity.

If significant toxic effects were occurring, then chemicals should be found in the sediment at concentrations that have been reported in the literature to be toxic. Although some COPECs may be toxic, none are likely to be toxic. That is, several contaminants present a marginal risk at one or more sites in Reach 2, but no contaminant was observed at concentrations suggesting a significant risk to benthic invertebrates and a relationship to known sources was not evident. Given the high degree of uncertainty associated with the sediment effects data, this is, at best, weak evidence of contaminant mediated impacts in this reach.

Lower Clinch River arm (Reach 4). Although there is some indication of toxicity in sediments from the Clinch River below Poplar Creek, the invertebrate community does not appear to be significantly affected. This conclusion is based on the results indicating that the benthic community in Watts Bar is similar to other regional mainstem reservoirs, that Reach 4 has the highest richness and abundance observed in the OU, and that contaminant concentrations which are likely to be toxic were observed only at sites where the community metrics were highest. The sediment toxicity tests neither support, nor refute, this conclusion. The lines of evidence concerning risks to benthic invertebrates are summarized in Table 6.13, and are discussed below.

Table 6.12. A summary of risk characterization for the benthic invertebrate community in the upper Clinch River arm of Watts Bar Reservoir (Reach 2)

Evidence	Result[a]	Explanation
Biological Surveys	-	Density and abundance are low, but habitat appears to be the principle causal factor and Watts Bar is similar to other Upper Valley Reservoirs.
Toxicity Tests	±	At least 1 significant test, but mean response was not biologically significant due to high variability between tests.
Media Analyses	±	Risks are marginal from metals and PAHs, but no COPEC was a significant risk.
Weight-of-Evidence	-	Community does not appear to be significantly impacted by contaminants.

a + indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the benthic invertebrate community.
- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the benthic invertebrate community.
± indicates that the evidence is too ambiguous to interpret.

Table 6.13. A summary of risk characterization for the benthic invertebrate community in the lower Clinch River arm of Watts Bar Reservoir (Reach 4)

Evidence	Result[a]	Explanation
Biological Surveys	-	Density and abundance highest in these reaches, probably due in part to habitat quality.
Toxicity Tests	±	At least 1 significant test. Mean response was not biologically significant, but Reach 4.01 was the only site tested.
Media Analyses	+	Risks from PAHs and Hg are significant at most sites in at least one reach, including 4.04.
Weight-of-Evidence	-	Community does not appear to be significantly impacted by contaminants.

a + indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the benthic invertebrate community.
- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the benthic invertebrate community.
± indicates that the evidence is too ambiguous to interpret.

If significant toxic effects were occurring, then the community would have fewer species and individuals than other sites. This is clearly not the case. The benthic invertebrate community in this reach has the highest density and species richness observed in the CR/PC system. Reach 4.01 had reduced richness and abundance relative to Reach 4.02, but this is probably due primarily to habitat differences. That is, although the statistical analyses did not exclude contaminants as a source of the variability in the community measures, they did indicate that habitat characteristics are considerably more important for many of the community measures.

If significant toxic effects were occurring, then the sediment should be toxic. Although some samples were toxic, the biological significance of these results is uncertain because of the frequency and magnitude of effects. Less than half of the sediment samples were significantly toxic to *H. azteca* and the mean reduction in survival did not meet the endpoint criterion for biological significance. The inconsistent responses in samples from the same site is suggestive of a highly heterogeneous system. Also, the other sediment toxicity tests were not suggestive of significant toxicity.

If significant toxic effects were occurring, then chemicals should be found in sediment at concentrations that have been reported in the literature to be toxic. Several COPECs were observed at concentrations that are likely to be toxic. However, these samples are from areas supporting the most diverse and abundant benthic communities. Given the high degree of uncertainty associated with the sediment effects data, this is, at best, weak evidence of contaminant mediated impacts in this reach.

McCoy Branch embayment (Reach 7). The benthic invertebrate community in McCoy Branch Embayment is unlikely to be significantly impacted by contaminated sediments. Only arsenic is present at concentrations which are likely to be toxic. Community survey data were not available for McCoy Branch. However, these sediments were tested in the laboratory and there was no indication of toxicity, either acute or sub-chronic. Given the significant uncertainties associated with the sediment effects data, it appears unlikely that impacts to the community are actually occurring. The lines of evidence concerning risks to benthic invertebrates in the McCoy Branch Embayment are summarized in Table 6.14.

Table 6.14. A summary of risk characterization for the benthic invertebrate community in McCoy Branch Embayment (Reach 7)

Evidence	Result[a]	Explanation
Biological Surveys		Community surveys not performed
Toxicity Tests	-	Sediments were not toxic.
Media Analyses	+	Risks from As are significant.
Weight-of-Evidence	-	It is unlikely that the community is significantly impacted by contaminants.

a + indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the benthic invertebrate community.
- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the benthic invertebrate community.
± indicates that the evidence is too ambiguous to interpret.

6.3.4 Uncertainties Concerning Risks to Benthic Invertebrates

The following issues constitute the major sources of uncertainty in the risk assessment for the benthic invertebrate community. The primary source of most of these uncertainties is the inherent heterogeneity of the sediment system.

There is a high degree of uncertainty associated with the sediment effects data because sediments are highly heterogeneous and complex. There are few standardized sediment toxicity tests and most of the available data are from marine and estuarine systems. The endpoints used to define the ER-L and ER-M range from community level responses to sub-organismal effects. These sources of variance are discussed in more detail in Sect. 6.3.1.2.

The relationship between observed sediment toxicity and the chemical and physical data are uncertain. Samples for sediment toxicity testing were collected at approximately the same locations as the samples for chemical analysis. Because sediment contamination may be very heterogeneous, the exposures received by the test organisms may be different from those estimated using the chemical analyses data.

There is uncertainty associated with the biosurvey data because benthic invertebrate ecology is complex and influenced by the heterogeneity of the sediment system. The characteristics of the benthic invertebrate community at a site is a function of non-contaminant and contaminant parameters, both of which may vary considerably within and between sites. The contribution of each of these factors to the variance in observed community metrics cannot be clearly delineated with the available data. That is, statistical analyses were confounded by the high collinearity of the physical characteristics of the sediments and the contaminant concentrations.

The sediment characterization section (Sect. 3.4) identified ammonia in pore water as a non-contaminant parameter which may be ecologically important. A major source of ammonia is the decomposition of organic matter. Thus, ammonia is a natural constituent of aquatic systems and is likely to be elevated in sediments with high organic matter content. Sewage treatment plants are also a potential source. However, release of ammonia from treatment plants is controlled under the National Pollution Discharge Elimination System (NPDES). Pore water concentrations of ammonia in all reaches, except 2.01, were higher than the chronic NAWQC. Several reaches, including reference reaches 0 and 13, had pore water concentrations that exceeded the acute NAWQC. These reaches were also generally high in sediment or pore water total organic carbon. Given the measured concentrations, ammonia may be a contributing factor to the degraded benthic invertebrate communities in Poplar Creek. This is highly uncertain, however, because ammonia toxicity is dependent on pH and temperature (EPA 1985-NH4). Field measures of these parameters in pore water were not available and laboratory measures are not representative: both pH and temperature can change rapidly. Surface water measures of pH are unlikely to be representative of pore water pH, because the slower exchange rate of pore water may result in the accumulation of ammonia and other natural products which elevate pH.

The lack of clean reference sites contributed to the uncertainties in all three lines of evidence. Some of the chemicals in the OU may be at naturally occurring levels. This determination was complicated by the lack of acceptable reference concentrations. The sediment toxicity tests and community survey results may be due to local sediment and habitat characteristics. Estimation of the importance of these factors also was complicated by the lack of acceptable reference sites and laboratory control sediments.

Furthermore, there is a general need for reliable and standard sublethal whole sediment tests. That is, the only standard test that uses whole sediment is an acute lethality test.

6.4 RISKS TO PISCIVOROUS WILDLIFE

6.4.1 Exposure Assessment for Piscivorous Wildlife

Exposure of piscivorous wildlife to contaminants may be expressed as the rate of ingestion of contaminated media (fish and water) or as the concentration of contaminants accumulated in the tissues of the piscivore itself. Contaminant exposure through ingestion was estimated for osprey (*Pandion haliaetus*), the great blue heron (*Ardea herodias*), mink (*Mustela vison*), and river otter (*Lutra canadensis*). Exposure estimates were calculated for all contaminants in CR/PC subreaches 0, 1, 2.01, 2.02, 2.04, 13, 3.01, 3.02, 3.03, 3.04, 4.01, 6, 4.04, 18, 5, and 15. Exposure through contaminants accumulated in tissues was measured for nestling great blue herons.

An iterative approach was employed to assess the exposure of piscivores to contaminants. First, conservative exposure estimates were generated using point-estimates of exposure parameters and conservative assumptions. These conservative estimates were compared to NOAELs to identify COPECs. More realistic estimates of exposure at each subreach were then generated for the COPECs using the Monte Carlo simulation. The Monte Carlo simulations incorporate the variability in the contaminant concentrations and use more realistic foraging and life history data. Exposure distributions generated by these distributions were compared to NOAELs and LOAELs to identify subreaches where exposure is sufficiently high to present a risk. Finally, as part of the Risk Characterization (Sect 6.4.3.), the Monte Carlo simulation of exposure from adjacent subreaches was performed to address how foraging behavior and movements of piscivores influences contaminant exposure.

6.4.1.1 Exposure Through Oral Ingestion of Fish and Water

Oral exposure to contaminants experienced by wildlife may come from multiple sources. They may consume contaminated food (either plant or animal), drink contaminated water, or ingest soil or sediment. Soil or sediment ingestion may be incidental while foraging or grooming or purposeful to meet nutrient needs. The total oral exposure experienced by an individual is the sum of the exposures attributable to each source and may be described as:

$$E_{total} = E_{food} + E_{water} + E_{soil}$$

Where:

E_{total} = total exposure from all pathways
E_{food} = exposure from food consumption
E_{water} = exposure from water consumption
E_{soil} = exposure from soil consumption

Because osprey dive and catch fish in open water and great blue herons forage by stalk and strike techniques while wading (Ehrlich et al. 1988), incidental ingestion of sediment by these endpoints is unlikely. While Hamilton (1940) observed sand in 1.3% of mink scats examined, this amount did not account for any measurable scat volume. Because river otter are more piscivorous than mink, soil ingestion be otter is likely to less than that of mink. Therefore, ingestion of soil or sediment by osprey, heron, mink, or otter was assumed to be negligible. Exposure of piscivorous wildlife may then be described as:

$$E_{total} = E_{food} + E_{water}$$

For exposure estimates to be useful in the assessment of risk to wildlife, they must be expressed in terms of a body weight-normalized daily dose or mg contaminant per kg body weight per day (mg/kg/d). Exposure estimates expressed in this manner may then be compared to toxicological benchmarks for wildlife, such as those derived by Opresko et al. (1994), or to doses reported in the toxicological literature. Estimation of the daily contaminant dose an individual may receive from a particular medium for a particular contaminant may be calculated using the following equation:

$$E_j = \sum_{i=1}^{m} \left(\frac{IR_i \times C_{ij}}{BW} \right) \qquad (1)$$

where:

E_j = total exposure to contaminant (j) (mg/kg/d)
m = total number of ingested media (e.g., food, water, or soil)
IR_i = consumption rate for medium (I) (kg/d or L/d)
C_{ij} = concentration of contaminant (j) in medium (I) (mg/kg or mg/L)
BW = body weight of endpoint species (kg)

For the purposes of this assessment, the generalized model was modified to reflect the foraging characteristics of the endpoint species and the idiosyncracies of the available data. First, because the literature suggests that osprey, heron, mink, and otter do not consume fish of the same size, fish size was added to the model. It was assumed that all four species would forage and take fish opportunistically based upon the size of the fish. Fish species was assumed to be an unimportant factor in prey selection.

Second, while piscivorous wildlife consume whole fish, only part of the contaminant data for fish from the Clinch River was for whole fish. While all shad (both threadfin and gizzard) were analyzed as whole fish, all non-shad fish were analyzed as fillets. Both fillet and carcass (whole-body minus fillet) analyses were performed for 25 non-shad fish (15 largemouth bass and 10 channel catfish). These data were used to produce a fillet to whole-body ratio (see below) so that whole body concentrations in non-shad fish could be estimated. Non-shad fish were then combined with shad to produce summary statistics (i.e., mean, standard error, etc.) for all fish within each size class. With these additional considerations taken into account, the exposure model for Clinch River piscivorous wildlife is as follows:

$$E_j = \left(\frac{IR_w \times C_{w-j}}{BW} \right) + \left(P_a \times \sum_{i=1}^{n} \frac{(P_{f-i} \times IR_f) \times C_{ij}}{BW} \right)$$

where:

E_j = exposure to contaminant (j) (mg/kg/d)
IR_w = ingestion rate of water (L/d)
C_{w-j} = concentration of contaminant (j) in water (mg/L)
BW = body weight (kg)
P_a = proportion of aquatic prey in diet
n = number of size categories of fish consumed
P_{fI} = proportion of fish in diet in size class (I)
IR_f = ingestion rate of fish (kg/d)
C_{ij} = concentration of contaminant (j) in fish in size class (I) (mg/kg)

Exposure estimates were calculated for all contaminants in all Clinch River subreaches for which data were available. Because wildlife are mobile, their exposure is best represented by the mean contaminant

concentration in media. To be conservative, the 95% UCL is used in exposure estimates. To prevent bias that may result from calculating 95% UCLs using data that contains values below the detection limit, product limit estimator was used to calculate the 95% UCLs for contaminants observed in fish and water. These data were used in the initial exposure estimates. Exposure estimates for contaminants that may potentially present a risk to piscivorous wildlife (based upon comparisons to NOAELs) were recalculated using Monte Carlo simulations. ***(Note: because the purpose of the initial exposure estimate is to be conservative and to identify COPECs, the 95% UCL was used regardless of whether or not the value exceeded the maximum observed value. Overestimates of exposure that may occur at the screening level are addressed through the use of Monte Carlo simulation).***

Life History Parameters for Endpoint Species. Species-specific parameters necessary to estimate exposure using the equation described above are listed in Tables F4.1, F4.2, F4.3, and F4.4.

Fillet-to-Whole Fish Ratios. Contaminant-specific fillet-to-whole fish ratios were calculated to estimate the whole-body contaminant concentration for fish for which only fillet analyses were performed. For organic chemicals, the ratios were developed using data from 15 largemouth bass and 10 channel catfish for which both fillet and carcass (whole-body minus fillet) analyses were performed. Whole fish contaminant concentrations were determined by calculating the weighted average of the fillet and carcass contaminant concentrations (weighted by the proportion of the total fish weight represented by the carcass and fillet weights, respectively). The contaminant concentration in the whole fish was then divided by the fillet concentration to produce the fillet-to-whole fish ratio (Table F4.5). Bass and catfish were pooled to produce one ratio for each contaminant. Ratios were not available for all contaminants detected in the larger pool of Clinch River fish. Ratios for these contaminants were approximated using ratios for related contaminants. The ratios for arsenic, copper, mercury, selenium, and zinc were obtained from spotted bass collected in the vicinity of the Portsmouth Gaseous Diffusion Plant (Southworth 1994). Mean ratio values were used to generate all whole-fish contaminant concentration estimates.

Contaminant Concentrations in Abiotic and Biotic Media. Contaminant concentrations in water, and fish are needed to estimate exposure. The 95% UCLs [calculated using the product limit estimator (PLE)] for contaminants detected in water and fish from the Clinch River are presented in Table F4.6. Note that data were not available for all size classes of fish in all subreaches. Contaminant concentrations in the missing size classes were assumed to be equivalent to that in the next higher size class for which contaminants were detected. If contaminants were detected in fish in size classes above and below that in which data were missing, concentrations were estimated to be the mean of the concentrations in the higher and lower size classes.

Exposure Modeling using Point-Estimates. To estimate contaminant exposure experienced by osprey, the following assumptions were made:

1) body weight = 1.5 kg
2) food consumption = 0.3 kg/d (fresh weight)
3) water consumption = 0.077 L/d
4) soil consumption = 0 kg/d
5) diet consists 100% of fish
6) fish sizes consumed:

0-10 cm	3.3%
11-20 cm	42.1 %
21-30 cm	46.7 %
31-40 cm	6.6 %
>41 cm	1.3 %

7) all prey selected based upon size and not by species

8) individuals forage exclusively within each given subreach

To estimate contaminant exposure experienced by great blue heron, the following assumptions were made:

1) body weight = 2.39 kg
2) food consumption = 0.42 kg/d (fresh weight)
3) water consumption = 0.1058 L/d
4) soil consumption = 0 kg/d
5) diet consists 100% of fish or other aquatic prey.
6) contaminant concentration in fish is representative of that in other aquatic prey.
7) fish sizes consumed:

0-10 cm	39.2%
11-20 cm	47.1 %
21-30 cm	13.7 %

8) all prey selected based upon size and not by species
9) individuals forage exclusively within each given subreach

To estimate contaminant exposure experienced by mink, the following assumptions were made:

1) body weight = 1 kg
2) food consumption = 0.137 kg/d (fresh weight)
3) water consumption = 0.099 L/d
4) soil consumption = 0 kg/d
5) diet consists 54.6% of fish or other aquatic prey.
6) contaminant concentration in fish is representative of that in other aquatic prey.
7) fish sizes consumed:

0-10 cm	72%
11-20 cm	28 %

8) all prey selected based upon size and not by species
9) individuals forage exclusively within each given subreach
10) all non-aquatic prey consumed are uncontaminated.

To estimate contaminant exposure experienced by river otter, the following assumptions were made:

1) body weight = 8 kg
2) food consumption = 0.9 kg/d (fresh weight)
3) water consumption = 0.64 L/d
4) soil consumption = 0 kg/d
5) diet consists 100% of fish or other aquatic prey.
6) contaminant concentration in fish is representative of that in other aquatic prey.
7) fish sizes consumed:

0-10 cm	16.7%
11-20 cm	16.7%
21-30 cm	16.7 %
31-40 cm	25 %
>41 cm	25 %
(50%<30 cm, 50%>30 cm)	

8) all prey selected based upon size and not by species
9) individuals forage exclusively within each given subreach

Using the Clinch River piscivore exposure model and the assumptions and data described above, exposure to contaminants was estimated for osprey, great blue heron, mink, and river otter using the

CR/PC system. Exposure estimates for all analytes detected in fish samples are presented in Tables F4.7, F4.8, F4.9, and F4.10. Some contaminants were detected in water but not in fish tissues. Exposure to these contaminants is considered as part of the benchmark screening process and are presented in Sect. 6.4.3.1.

Exposure modeling using Monte Carlo simulations. Employing point estimates for the input parameters in the Clinch River Piscivore exposure model does not take into account the variation and uncertainty associated with the parameters and therefore may over or under estimate the contaminant exposure that endpoints may receive in any given reach. In addition, calculating the model using point estimates produces a point estimate of exposure. This estimate provides no information concerning the distribution of exposures or the likelihood that individuals within a reach will actually experience potentially hazardous exposures. To incorporate the variation in exposure parameters and to provide a better estimate of the potential exposure experienced by piscivores in each reach, the exposure model was re-calculated using Monte Carlo simulations. A detailed discussion of the theory and application of Monte Carlo simulation is presented in Sect. 5.5.

Monte Carlo simulations of exposure estimates were performed for all endpoint-subreach-contaminant combinations where comparison of point exposure estimates to NOAELs produced HQs≥ 1 (NOAELs are presented in Sect 6.4.2.1.; Screening of exposure estimates against NOAELs is presented in Sect. 6.4.3.1.). Endpoint-subreach-contaminant combinations for which Monte Carlo simulations were performed are presented in Table F4.11.

Distributions were used for the following parameters in the Clinch River piscivore exposure model: endpoint body weight, average contaminant concentrations in fish and in water, and the proportion of aquatic prey in mink diet. All distributions were assumed to be normal, except osprey body weight which was assigned a triangular distribution (while a standard deviation was not available, a range was). Because these wildlife are mobile, the contaminant concentration they are exposed to on a daily basis is best represented by the average concentration instead of the entire distribution. The standard error of the mean was used to describe variation in the average contaminant concentration. All other distributions employed the calculated standard deviation of the observed data. Piscivore body weight distributions and values are listed in Table 6.15.

Table 6.15. Piscivore body weight distributions and values

Endpoint	Distribution	Mean (kg)	Standard Deviation	Range	Source
Osprey (♀)	triangular	1.568		1.25-1.9	Dunning 1984
Great Blue Heron (♀)	normal	2.204	0.337		Dunning 1984
Mink (♀)	normal	0.974	0.202		EPA 1993
River Otter	triangular	8		5.84-10.4	EPA 1993

Exposure of female individuals was modeled because females were determined to be the most sensitive subgroup. Toxicity data used to evaluate the significance of estimated contaminant exposures generally consider effects on reproduction. Because reproductive effects are most likely to be evident among female individuals, females were chosen as the best models for contaminant exposure. In addition, adverse impacts to females are most likely to result in population-level effects.

The proportion of aquatic prey in the diets of osprey, heron, and otter were assumed to be 100%. No data suggest that non-aquatic prey constitute a significant portion of their diet (see endpoint discussion, above). In contrast, mink have a very variable diet. Aquatic prey (fish, amphibians, crayfish, etc.) may make up from 16% to 92%. Nine observations from five studies indicate the proportion of aquatic prey to be 0.546±0.21 (mean±standard deviation; Table F4.3). Mean and standard errors for contaminants in fish are presented in Table F4.12.

Monte Carlo simulations were performed using the @Risk software. Samples from each distribution were selected using latin hypercube sampling. The number of iterations, or recalculations, of each exposure simulation was determined by the convergence criteria set in the software. Under these criteria, iterations are performed until the between-iteration percent change in the percentiles, mean, and standard deviation are below 1.5% (i.e., the percentile, mean, and standard deviation for the latest iteration is less than 1.5% different than the those from the previous iteration). Using this convergence criteria, from 600 to 1000 model iterations were performed for each exposure estimate. Monte Carlo estimates of contaminant exposures are presented in Table F4.13.

6.4.1.2 Internal exposure of great blue herons to contaminants

To determine if contaminants from the ORR are being bioaccumulated by piscivorous wildlife, great blue heron eggs and chicks were collected from two colonies located within 3 km of the ORR and two colonies located >10 km from the site. Analyses were performed to determine the concentrations of arsenic, chromium, mercury, and PCBs in eggs, and feathers, liver, fat, and muscle of chicks. Elevated levels of Cr, Hg, and PCBs were observed in eggs from the ORR colonies (Tables C13 and C15). Hg concentrations in feathers and liver (Table C14) and PCB concentrations in fat (Table C16), liver (Table C17), and muscle (Table C18) were significantly elevated in samples from the ORR as compared to data from the offsite locations. A detailed discussion of these data are presented in Sect. 3.5.

6.4.2 Effects Assessment for Piscivorous Wildlife

6.4.2.1 Single chemical toxicity data

Toxicological benchmarks for piscivorous wildlife. To determine if the contaminant exposure experienced by piscivorous wildlife that use the Clinch River could produce adverse effects, exposure estimates from Sect. 6.4.1.1. were compared to NOAELs and LOAELs derived according to the methods outlined by Opresko et al. (1994) and EPA (1993d). NOAELs represent the highest exposure at which no adverse effects were observed among the animals tested. LOAELs represent the lowest exposure at which significant adverse effects are observed.

Toxicological studies of the effects of contaminants observed in the Clinch River were obtained from the open literature. Due to differences in physiology between birds and mammals, separate studies were located (if available) for each wildlife class. Only studies of the effects of chronic oral exposures, whether in food, water, or by oral intubation, were used. To make the NOAELs and LOAELs relevant to possible population effects, preference was given to studies that evaluated effects on reproductive parameters. In the absence of a reproduction endpoint, studies that considered effects on growth, survival, and longevity were used.

In cases where a NOAEL for a specific chemical was not available, but a LOAEL had been determined experimentally or where the NOAEL was from a subchronic study, the chronic NOAEL was estimated. EPA (1993d) suggests the use of uncertainty factors of 1 to 10 for subchronic to chronic

NOAEL and LOAEL to NOAEL estimation. Because no data were available to suggest the use of lower values, uncertainty factors of 10 were used in all instances in which they were required.

Smaller animals have higher metabolic rates and are usually more resistant to toxic chemicals because of more rapid rates of detoxification. It has been shown that metabolism is proportional to body surface area which, for lack of direct measurements, can be expressed in terms of body weight (bw) raised to the 2/3 power ($bw^{2/3}$) (EPA 1980a). If the dose (d) itself has been calculated in terms of unit body weight (i.e., mg/kg), then the dose per unit body surface area (D) equates to:

$$D = \frac{d \ x \ bw}{bw^{2/3}} = d \ x \ bw^{1/3}$$

The assumption is that the effective dose per body surface area for species "a" and "b" would be equivalent. Therefore, knowing the body weights of two species and the dose (d_b) producing a given effect in species "b," the dose (d_a) producing the same effect in species "a" can be determined:. Using this approach, if a NOAEL was available for the test species ($NOAEL_t$), the equivalent NOAEL for a wildlife species ($NOAEL_w$) was calculated by using the adjustment factor for differences in body size:

$$NOAEL_w = NOAEL_t \left(\frac{bw_t}{bw_w} \right)^{1/3}$$

This methodology is equivalent to that the EPA uses in their carcinogenicity assessments and Reportable Quantity documents for adjusting from animal data to an equivalent human dose.

NOAELs and LOAELs were derived for osprey, great blue heron, and mink. Mammalian and avian NOAELs and experimental information used to estimate wildlife NOAELs and LOAELs (e.g. test species, test endpoints, citation, etc.) are listed in Tables F4.14 and F4.15.

More contaminants were detected in surface water than were observed in fish tissue. To simplify exposure estimation and contaminant screening, a water benchmark was used for these contaminants. The water benchmark is the concentration of the contaminant in the drinking water of an animal (C_w, in mg/L) resulting in a dose equivalent to a $NOAEL_w$. It can be calculated from the daily water consumption rate (W, in L/day) and the average body weight (bw_w) for the species:

$$C_w = \frac{NOAEL_w \ x \ bw_w}{W} \qquad (19)$$

Water benchmarks for osprey, great blue heron, mink, and river otter are presented in Table F4.16.

Ecotoxicological profiles. Ecotoxicological profiles of the effects of As, Cu, Hg, Se, DDT, and PCBs to wildlife are presented in Appendix F1.

6.4.2.2 Effects of contaminants on the reproductive performance of mink

Studies, conducted at Michigan State University Experimental Fur Farm, evaluated bioaccumulation of contaminants and reproductive effects in mink fed fish collected from Poplar Creek, the Clinch River (upstream of Melton Hill Dam) and the ocean. Mink were fed five diets consisting of 75% fish and 25% commercial mink diet (Table 6.16).

Table 6.16. Diet composition and contaminant concentrations for each diet

DIET	FISH COMPOSITION	CONTAMINANT CONCENTRATION	
		Mercury	Aroclor 1260
A	75% ocean	0.02 ± 0.00	0.169 ± 0.002
B	75% Clinch River	0.05 ± 0.00	11.44 ± 0.327
C	25% Poplar Creek 50% ocean	0.09 ± 0.00	4.69 ± 0.174
D	50% Poplar Creek 25% ocean	0.15 ± 0.01	10.41 ± 0.250
E	75% Poplar Creek	0.22 ± 0.01	20.67 ± 0.458

Twenty- three PCB congeners were also present in varying amounts. Concentrations of most congeners increased progressively from diets A through E (Table C24).

Ten mink (8 females and 2 males) were fed each diet for approximately 7 months (3 months prior to breeding - 6 weeks postpartum). Reproductive indices measured included: number of females mated; number of females whelping; length of gestation; number of kits whelped (alive, dead); kit sex ratio; average kit body weight at birth, 3, and 6 weeks of age; and kit survival to 3 to 6 weeks of age. At 6 weeks of age, 3 kits from dietary groups A, B, C, and E were euthanized, organs (liver, spleen, and kidneys) were weighed, and tissue samples (liver, kidney, and remaining carcass) were analyzed for contaminant accumulation. (note: kits from diet D were not sampled). At the termination of the study, all adult mink were necropsied. Organs (brain, liver, kidneys, heart, lungs, gonads, and adrenal glands) were weighed and examined for histopathologies. Adipose tissue, liver, kidney, and hair were analyzed for contaminant accumulation. Liver tissue also was analyzed for ethoxyresorufin-o-deethylase (EROD) activity.

The bioaccumulation of mercury in liver, kidney, and hair (Table C22), and Aroclor 1260 (and other PCB congeners) in liver and fat (Tables C25 and C26) substantially increased in adult female mink from groups fed diet A up to diet E. Mink offspring also bioaccumulated mercury in kidney tissue and carcasses and many other PCB congeners in the liver and carcasses (Tables C27 and C28), increasing progressively from mink fed diets A through E. The lowest levels were observed for mink fed diet A and increased to a maximum observed among mink fed diet E.

Significant effects were observed only among mink fed diet E; no adverse effects were observed for any other diet. Adverse effects from diet E included: weight reduction in adult mink and their offspring, reduction in litter size, and increase in liver EROD activity in adult females. Weight reduction was observed at the end of the experimental period, increasing magnitude from diet groups A to E. At

the end of the experiment, the mean whole body weights of female mink in diet group E were significantly less (p=0.03) than mean weights of females in diet group A (percent reduction =20%). Mean female relative organ weights (organ weights/body weight) were not significantly different among diet groups. At 6 weeks of age, mean whole body weights were also significantly lower (p=0.004) in male kits from diet group E compared to those from diet group A (percent reduction =17%). Similar trends were observed for female kits, although differences were not statistically significant. No histological lesions were attributed to any diet. Mean litter size was significantly reduced (p=0.01) in diet group E compared to diet groups A, B, and C (percent reduction relative to diet A=38%); but not diet group D. Liver EROD activity was significantly increased in adult female mink from diet groups D and E compared to those from diet group A.

6.4.2.3 Great blue heron reproduction survey

To determine if contaminants from the ORR are adversely affecting piscivorous wildlife, reproductive success of great blue herons at two colonies located within 3 km of the ORR and two colonies located >10 km from the site was monitored. Data were collected from each nest colony between 1992 and 1994. The mean number of eggs/nest, number of chicks/nest, egg weight, and eggshell thickness did not differ between colonies within 3 km of the ORR and those >10 km away (Table C19) A detailed discussion of these data are presented in Sect. 3.5.

6.4.3 Risk Characterization for Piscivorous Wildlife

While three lines of evidence are available to assess risks to piscivorous wildlife along the Clinch River, not all are available for every endpoint. Single chemical toxicity data are available for all four endpoints. However, toxicity tests and field surveys are available only for mink and great blue heron respectively.

6.4.3.1 Single chemical toxicity data

Exposure estimates generated by the exposure model (see Sect. 6.4.1.1.) produced by both point estimates of parameter values and Monte Carlo simulation represent exposure at the individual level. The exposure estimates using point estimates of parameter values at each individual sampling point are used to identify COPECs and locations that contribute significantly to risk. In contrast, the watershed-level exposure distributions generated by Monte Carlo simulation represent the likelihood that an individual within the area for which exposure is modeled will experience a particular exposure.

Two types of single chemical toxicity data are available with which to evaluate piscivore contaminant exposure: NOAELs and LOAELs. NOAELs are used to screen exposure estimates generated from point-estimates of exposure parameters; if the estimate is greater than the NOAEL, adverse effects are possible and additional evaluation is necessary (i.e., exposure modeling using Monte Carlo simulation). LOAELs are compared to the exposure distribution generated by the Monte Carlo simulation. If the LOAEL is lower than the 80th percentile of the exposure distribution, there is a >20% likelihood that individuals within the modeled location are experiencing contaminant exposures that are estimated to produce adverse effects. By combining literature-derived population density data with the likelihood or probability of exceeding the LOAEL, population-level impacts may be estimated.

Screening point estimates of exposure. To determine if the contaminant exposures experienced by osprey, great blue heron, mink, and river otter along the CR/PC are potentially hazardous, the total contaminant exposure estimates (generated using point estimates of parameter values; Tables F4.7, F4.8, F4.9, and F4.10) were compared to estimated NOAELs for these species (Tables F4.14 and F4.15). To

quantify the magnitude of hazard, a HQ was calculated where: HQ = exposure/NOAEL. HQs greater than 1 indicate that individuals may be experiencing exposures that are in excess of NOAELs and suggest that adverse effects may be occurring. HQs for osprey, great blue heron, mink, and river otter along the Clinch River are presented along with the point estimates of exposure in Tables F4.7, F4.8, F4.9, and F4.10. It should be noted that because few data are available for specific PCB congeners, all PCBs were compared to Aroclor-1254 toxicity data.

The spatial distribution of contamination and potential risks to osprey, great blue heron, mink and river otter in the CR/PC system are illustrated in Figs. 6.20, 6.21, 6.22 and 6.23, respectively. These figures display the sum of the NOAEL-based HQs (e.g., ΣTUs) for the six most important contaminants: arsenic, copper, DDT, mercury, selenium, and total PCBs. (Total PCBs were determined by summing the exposure of all Aroclors within a given reach. This value was then compared to the Aroclor-1254 NOAEL). Importance of contaminants was determined based upon the magnitude of the HQ. River subreaches were arranged from the northern-most to the southern-most.

While the ΣTUs scale differed among endpoints (lowest for mink, Fig. 6.22; highest for osprey, great blue heron and river otter, Figs. 6.20, 6.21, and 6.23), the pattern of ΣTUs was similar among all four endpoints; with the exception of a PCB spike at subreach 2.04, the maximum ΣTUs were observed at the Poplar Creek subreaches (13, 3.01, 3.02, 3.03, and 3.04). For osprey and great blue heron, the contaminants contributing the most to total risk are mercury followed by total PCBs (Figs. 6.20 and 6.21). PCBs, mercury, and selenium account for the majority of risk to mink and river otter (Figs. 6.22 and 6.23). A summary of the subreaches where NOAEL-based HQs>1 were observed is listed in Table F4.11 by endpoint and contaminant.

Screening of water data. More chemicals were detected in Clinch River water than in fish flesh. To evaluate the risk that these contaminants may present, HQs were calculated for these contaminants using the 95% UCL water concentration and the water benchmarks from Table F4.16. HQs for these contaminants are presented in Table F4.17. With the exception of thallium in subreach 1, no contaminant produced an HQ>1 for any endpoint in any Clinch River reach. In subreach 1, thallium in water exceeded the benchmark for both mink and river otter (Table F4.17). This observation must be viewed with caution, because thallium was detected in only one of 48 samples from this subreach.

Screening Monte Carlo Simulation Estimates of Exposure. To incorporate the variation present in the parameters employed in the exposure model, Monte Carlo simulations were performed for exposure of each species to contaminants where NOAEL-based HQs>1 were observed (see Table F4.11). The mean, standard deviation, and 80th percentile of the simulated exposures are presented in Table F4.13. By superimposing NOAEL and LOAEL values on these distributions, the likelihood of an individual experiencing potentially hazardous exposures can be estimated and the magnitude of risk to individuals may be determined. These comparisons are presented in Table F4.18. Interpretation of the comparison of exposure distributions to NOAELs and LOAELs is described in Table 6.17.

To evaluate the likelihood and magnitude of population-level effects on piscivores, literature-derived population density data (expressed as number of individuals/km of stream or pond shoreline) were combined with lengths of streams or pond shorelines for which risks were assessed to estimate the number of individuals of each endpoint species expected to be present in each watershed.

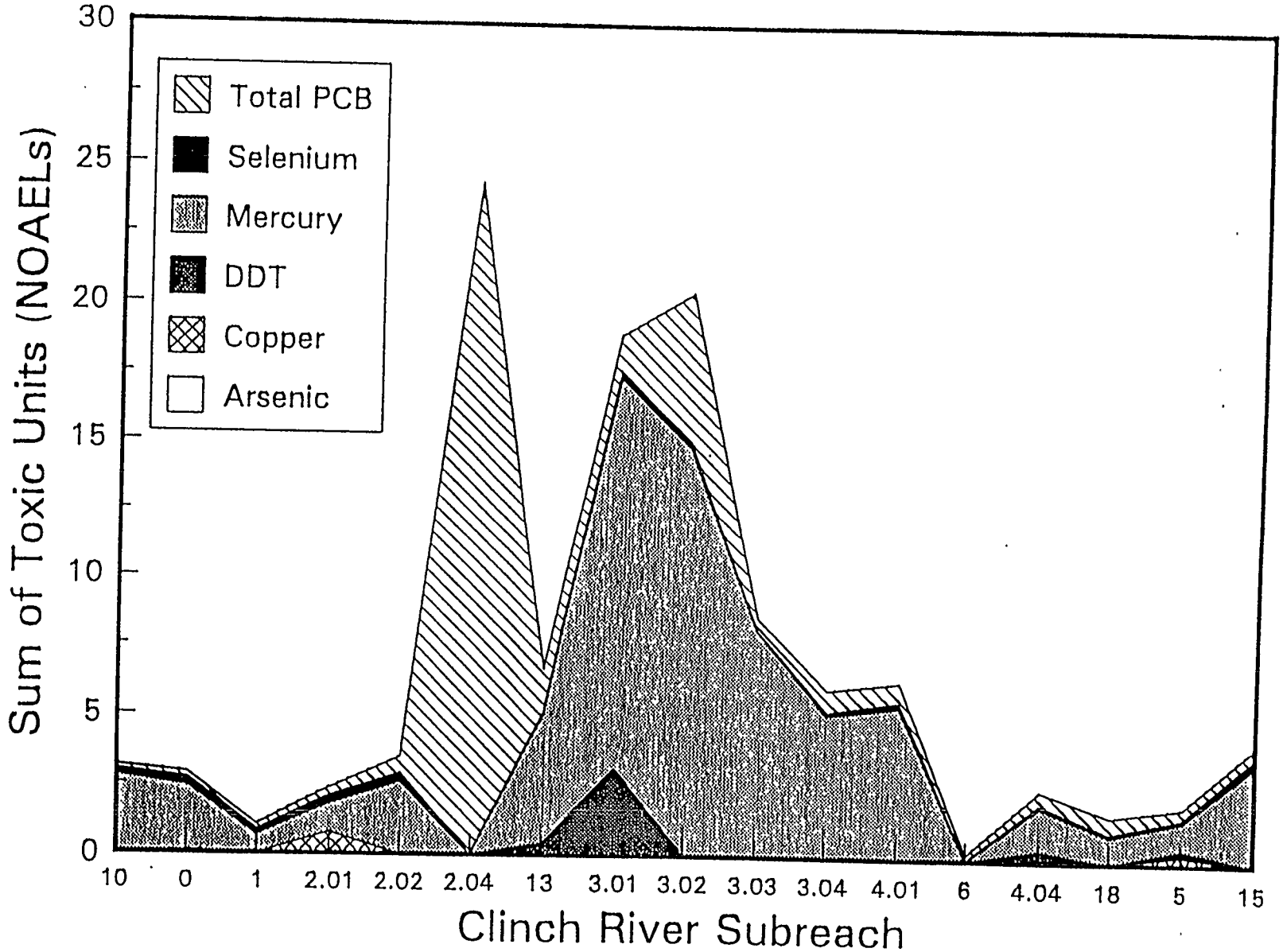


Fig. 6.20. Sum of NOAEL-based toxic units for osprey in the Clinch River/Poplar Creek system.

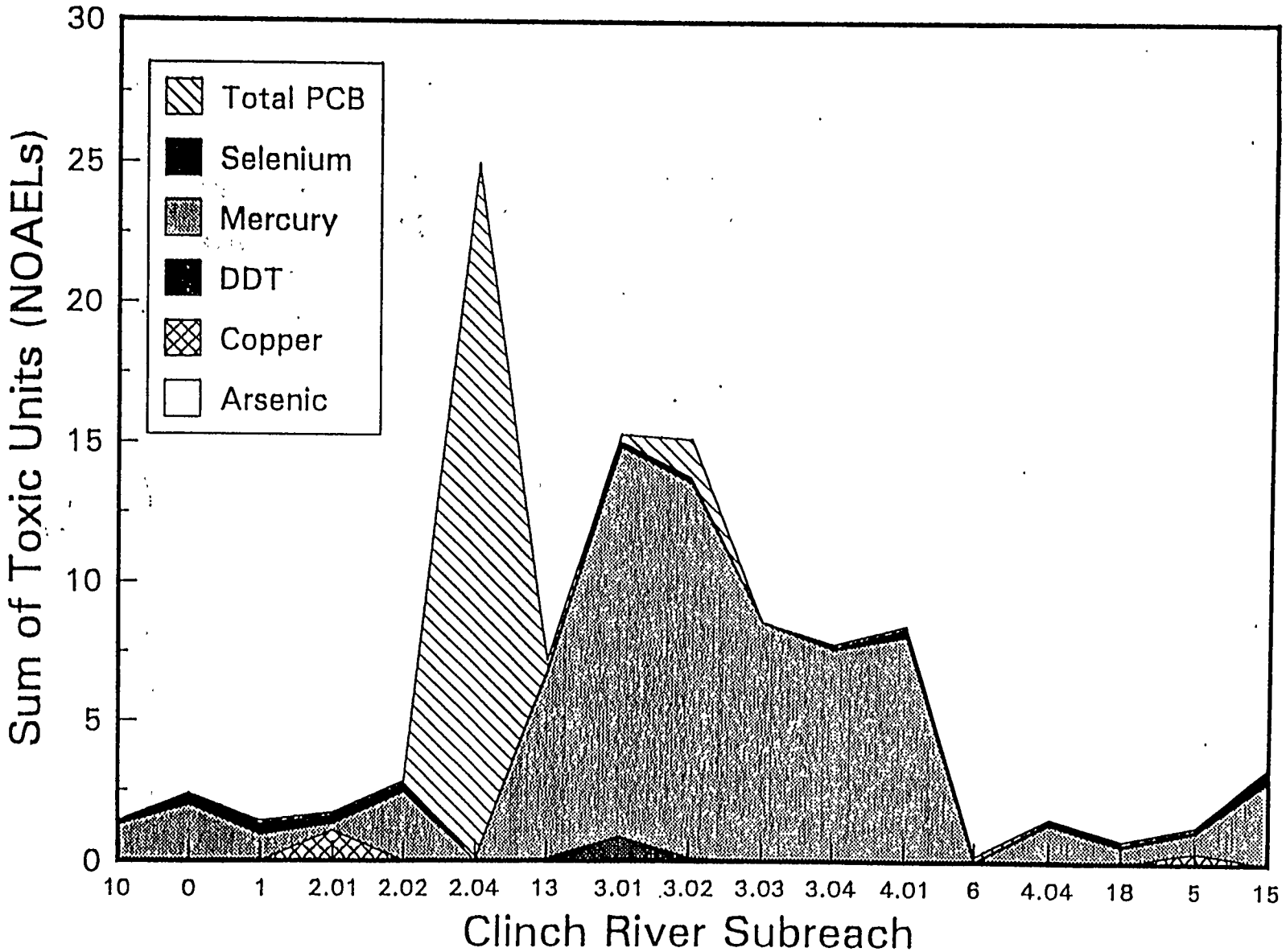


Fig. 6.21. Sum of NOAEL-based toxic units for great blue heron in the Clinch River/Poplar Creek system.

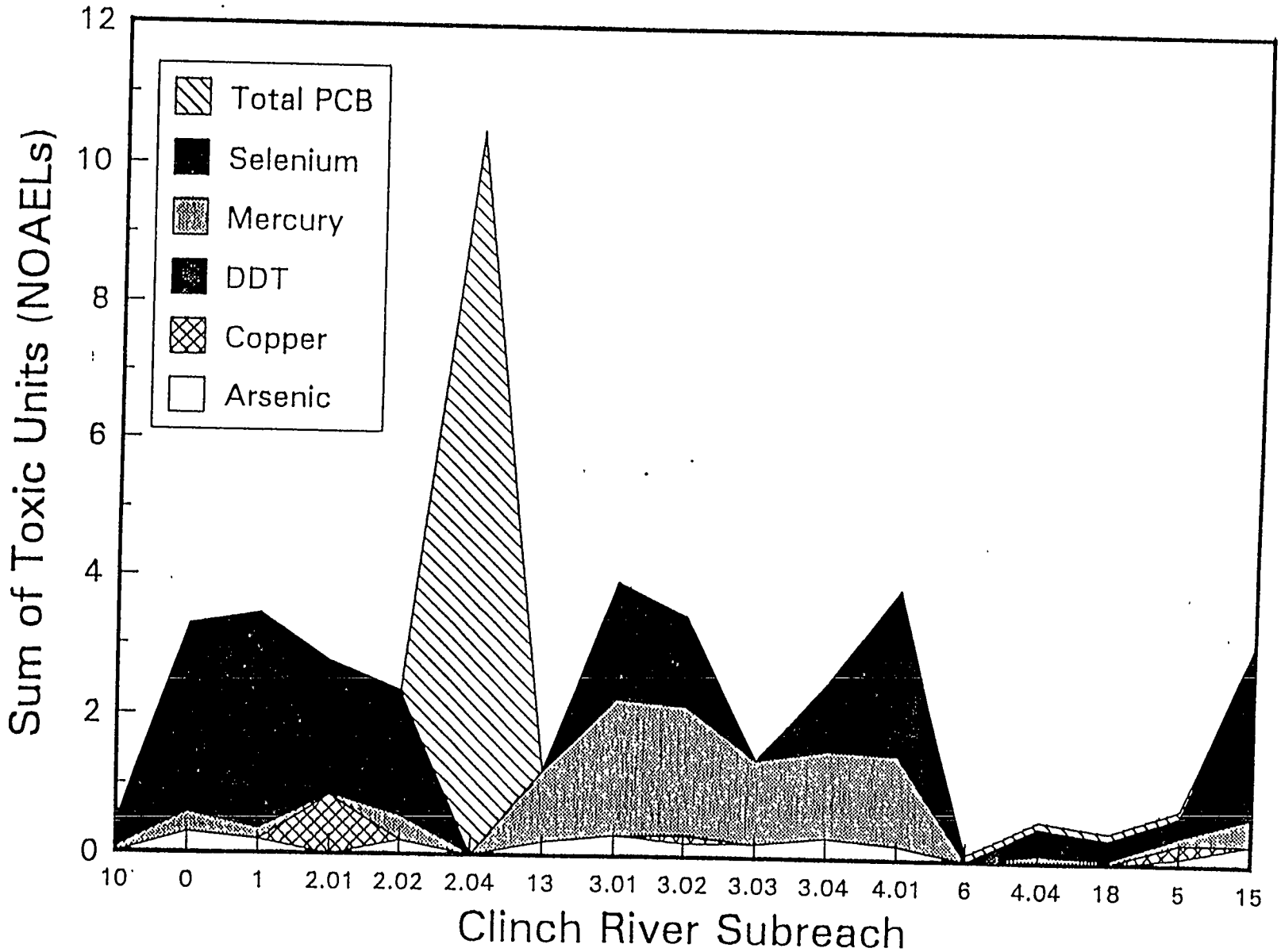


Fig. 6.22. Sum of NOAEL-based toxic units for mink in the Clinch River/Poplar Creek system.

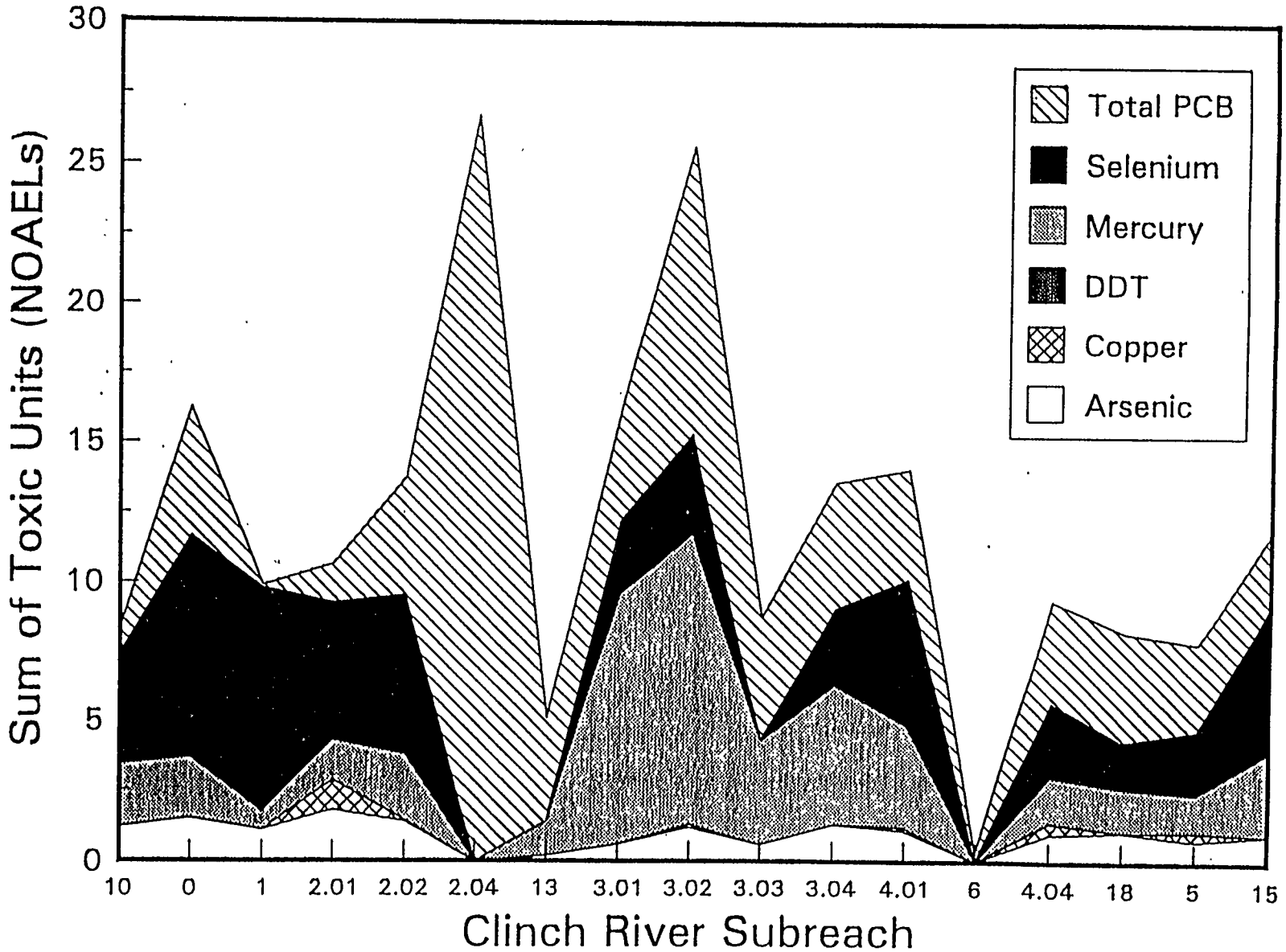


Fig. 6.23. Sum of NOAEL-based toxic units for river otter in the Clinch River/Poplar Creek system.

Table 6.17. Comparison of exposure distributions to NOAELs and LOAELs

Comparison	Meaning	Risk-based Interpretation
NOAEL>80th percentile of exposure distribution	less than 20% of exposures> NOAEL	Individual- and population-level adverse effects are highly unlikely
NOAEL<80th percentile<LOAEL	More than 20% of exposures > NOAEL, but less than 20% of exposures> LOAEL	Individuals experiencing exposures at the high end of the distribution may experience adverse effects, but those effects are unlikely to significantly contribute to effects on the ORR population.
LOAEL<80th percentile of exposure distribution	More than 20% of exposures> LOAEL	Effects on some individuals are likely and they may contribute significantly to effects on the ORR population.

Literature-derived population densities used for each endpoint species were: mink: 0.6/km; river otter 0.37/km; and great blue heron; 2.3/km. Linear population density data were not available for osprey (osprey are addressed separately). It should be noted that density values for all endpoint species but the great blue heron represent the maximum values obtained from the literature (Tables F4.2, F4.3, and F4.4). The literature values for herons (Table F4.2) appear inflated and are not believed to accurately represent densities in the CR/PC system. Therefore, the minimum value, which is consistent with local densitities, was used. Population estimates based upon these densities are listed in Table 6.18 for the primary CR/PC subreaches.

The number of individuals within a given subreach likely to experience exposures greater than LOAELs can be estimated using cumulative binomial probability functions (Dowdy and Warden 1983). Binomial probability functions are estimated using the following equation:

$$b(y;n;p) = \binom{n}{y} p^{y} \ (1-p)^{n-y}$$

where:

y	= the number of individuals experiencing exposures > LOAEL
n	= total number of individuals within the subreach
p	= probability of experiencing an exposure in excess of the LOAEL
b (y; n; p)	= probability of y individuals out of a total of n, experiencing an exposure > LOAEL, given the probability of exceeding the LOAEL=p.

By solving this equation for y=0 to y=n, a cumulative binomial probability distribution may be generated that can be used to estimate the number of individuals within a subreach that are likely to experience adverse effects. Summing the number within each subreach across all subreaches and dividing by the total estimated CR/PC population, the proportion of the population potentially at risk may be estimated.

Table 6.18. Estimated number of individuals by watershed

Subreach	Length (km)	Mink	River Otter	Great Blue Heron
2.01	7.7	5	3	18
2.02	10.6	6	4	24
2.03	28.7	17	11	66
2.04	23.0	14	9	53
3.01	3.1	2	1	7
3.02	5.6	3	2	13
3.03	9.7	6	4	22
3.04	4.2	3	2	10
4.01	19.2	12	7	44
4.02	19.5	12	7	45
4.03	18.0	11	7	41
4.04	7.6	5	3	17
Total	156.9	96	60	360

It should be noted that population estimates focused on those reaches that are within the OU and immediately downstream of the ORR (reaches 2, 3, and 4). These reaches were selected because (1) they represent the greatest exposures, (2) using all reaches would greatly over-estimate the population immediately adjacent to the ORR and reduce the likelihood of detecting a potential population-level effect.

Because the area of this population range is small relative to the mobility of these species and because it is limited to contaminated areas, it is a conservative definition of the exposed populations of mink, otter, and herons.

Binomial probability distributions were generated only for contaminant-endpoint-subreach combinations where the percent of the exposure distribution exceeding the LOAEL was 20% to 80% (these values are reported in Table F4.18). If the percent of the exposure distribution exceeding the LOAEL was less than 20%, it was assumed that no individuals within that subreach were experiencing adverse effects. Conversely, if the percent of the exposure distribution exceeding the LOAEL was greater than 80%, it was assumed that all individuals within that subreach were experiencing adverse effects. The total numbers of individuals of each endpoint species estimated to be experiencing adverse effects within each subreach are summarized in Table F4.19. Because all exposure estimates were either >80% or <20%, calculation of cumulative binomial probability distributions was not necessary.

While all great blue heron that forage within subreaches 3.01 and 3.02 are likely to experience mercury exposures that exceed the LOAEL (Figs 6.24 and 6.25), these birds represent only 6% of the

total birds expected to use the CR/PC reaches downstream of the ORR (Reaches 2, 3, and 4; Table F4.19). Because the number estimated to be adversely affected is les than 20%, population-level effects to from mercury great blue herons downstream of the ORR are unlikely. PCBs and copper are also unlikely to have adverse effects on the great blue heron population.

Among mink, while estimated exposures to mercury, selenium and PCBs exceeded NOAELs in subreaches downstream of the ORR (Table F4.18), estimated exposures to these contaminants did not exceed LOAELs within any subreach (Tables F4.18 and F4.19). Therefore population-level effects of contaminants to mink are unlikely.

Among river otter, while adverse effects from arsenic, selenium, and copper are unlikely, individual otter within subreaches 3.01 and 2.04 may be adversely affected by exposure to mercury or PCBs, respectively (Figs 6.26 and 6.27; Tables F4.18 and F4.19). Because the river otter is a threatened species in Tennessee, adverse effects to individuals are a concern. Therefore, mercury in subreach 3.01 and PCBs in subreach 2.04 present a risk to river otter.

Osprey at subreaches 3.01 and 3.02, are estimated to receive exposures to mercury in excess of the LOAEL >99% and 70% of the time (Figs 6.28 and 6.29; Table F4.18). No other contaminants in any other subreach are estimated to present a risk to osprey. To evaluate the significance of mercury exposure among osprey within subreaches 3.01 and 3.02, the foraging range of osprey must be considered. Osprey are wide-ranging species, with individuals ranging 10 to 15 km from their nest sites in search of food (Van Daele and Van Daele 1982). EPA (1993) reports the mean foraging radius for osprey to be 1.7 km with a range of 0.7 km to 2.7 km. Of the three active osprey nests in the vicinity of the ORR (B. Anderson, Pers. Comm.), two are located along Melton Hill Reservoir (Subreach 1) and one on Poplar Creek approximately at the border between subreaches 3.03 and 3.04 (Fig. 6.30). While the Subreach 1 nest sites are within 15 km of subreaches 3.01 and 3.02, due to the availability of suitable habitat nearer to their nests and that the mean foraging radius is 1.7 km, birds from these nest sites are unlikely to forage within subreaches 3.01 and 3.02. Therefore potentially deleterious mercury exposure to these birds is unlikely. In contrast, the 3.03/3.04 nest site is within 3 km of subreaches 3.01 and 3.02. Birds from this nest may therefore forage and be exposed to elevated mercury in fish from subreaches 3.01 and 3.02.

To estimate and model the potential mercury exposure for osprey at the 3.03/3.04 nest location, it was assumed that the birds would travel up to 5 km from the nest to forage. Most foraging was assumed to occur near to the nest, with approximately 50% of diet obtained from within 1 km of nest, 25% obtained from 1 to 2 km, 15% from 2 to 3 km, and 5% each from 3 to 4 km and 4 to 5 km from the nest, respectively. Subreaches that fell within these ranges were identified. Subreaches, approximate distance from nest and estimated contribution to total diet for the nest are listed in Table 6.19.

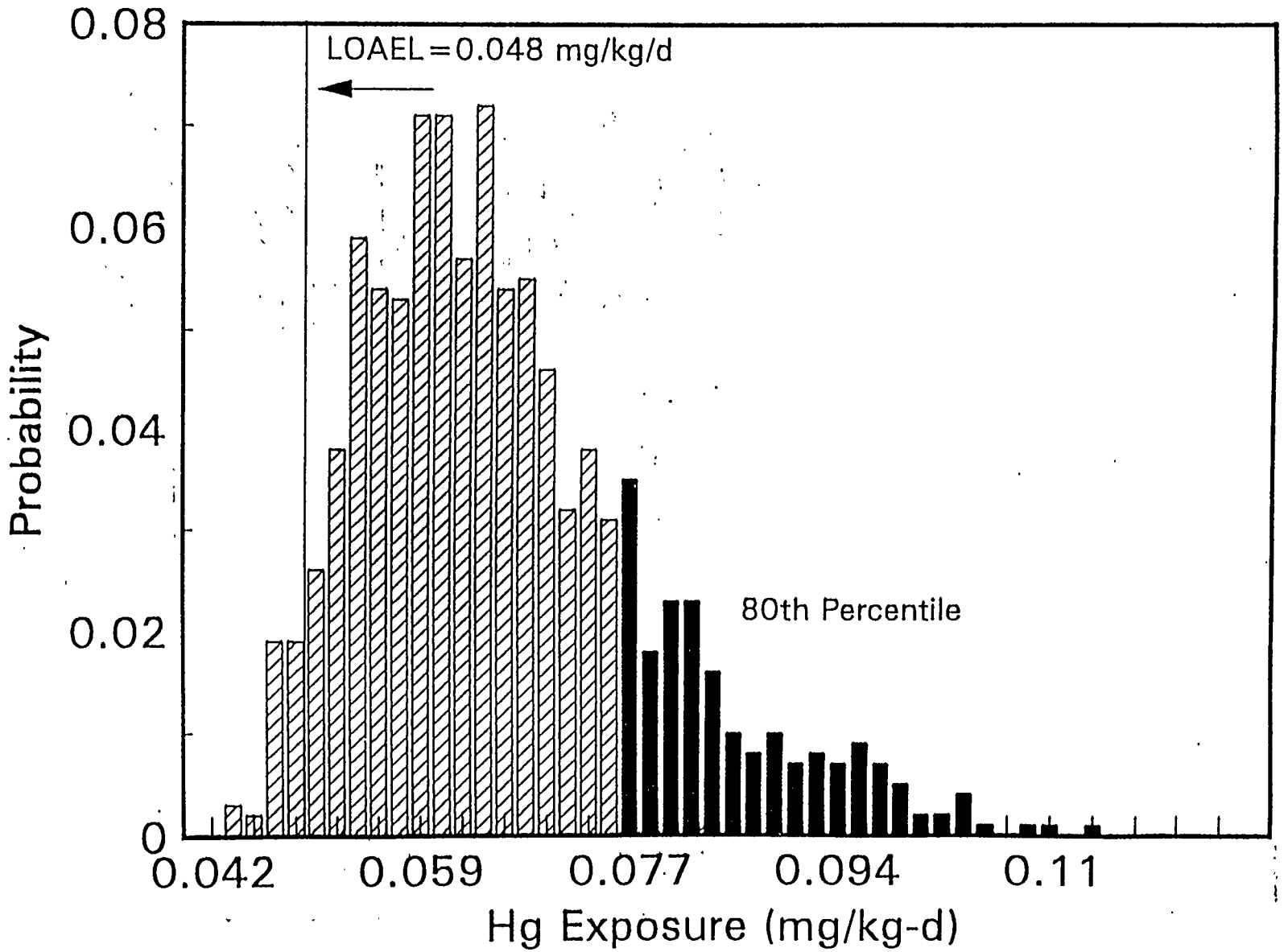


Fig. 6.24. Estimated distribution of mercury exposure for great blue heron in subreach 3.01. Distribution generated from Monte Carlo simulation of exposure model. If 80th percentile of distribution > LOAEL, adverse effects to individuals resulting from contaminant exposure are likely.

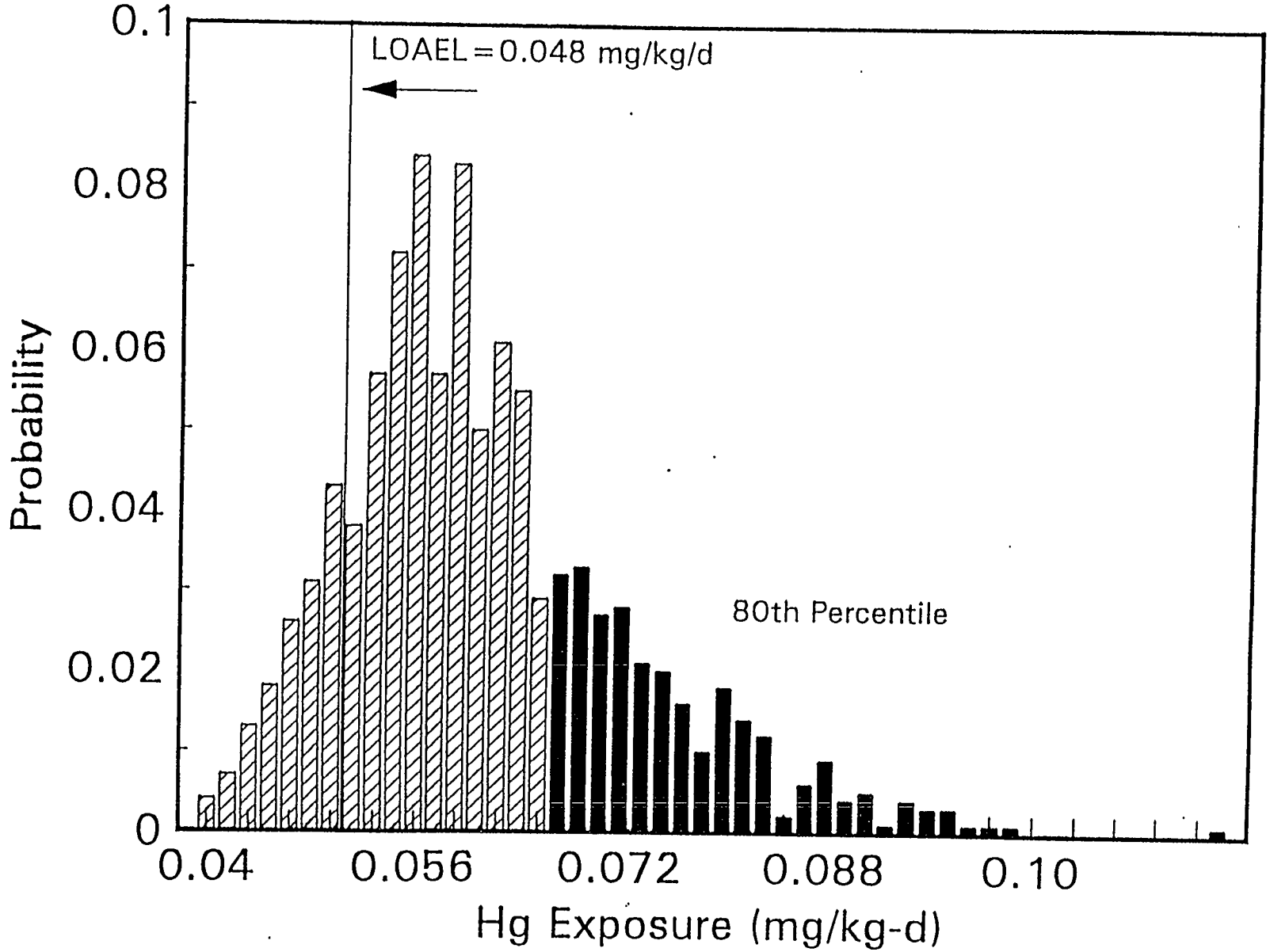


Fig. 6.25. Estimated distribution of mercury exposure for great blue heron in subreach 3.02. Distribution generated from Monte Carlo simulation of exposure model. If 80th percentile of distribution > LOAEL, adverse effects to individuals resulting from contaminant exposure are likely.

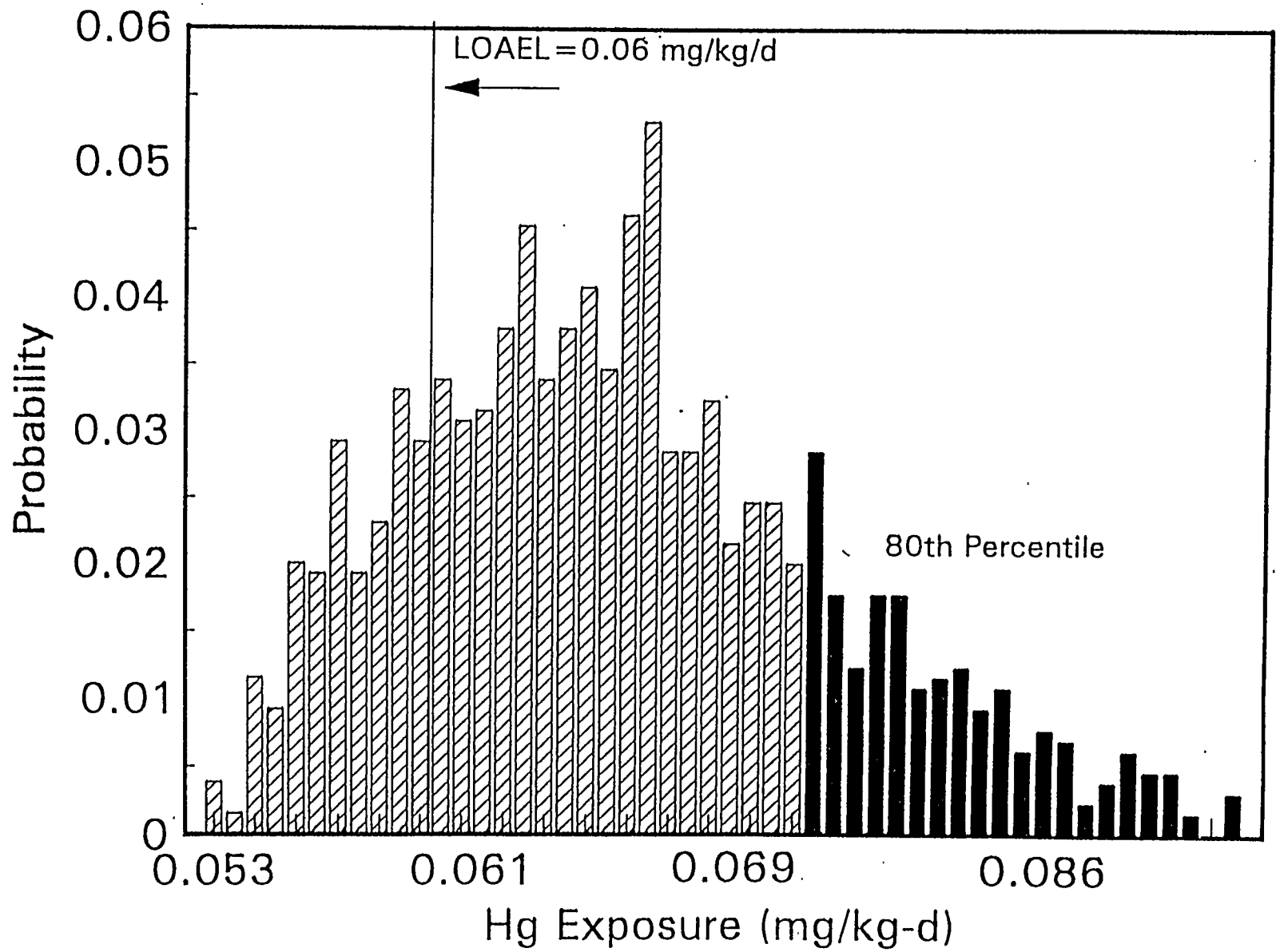


Fig. 6.26. Estimated distribution of mercury exposure for river otter in subreach 3.01. Distribution generated from Monte Carlo simulation of exposure model. If 80th percentile of distribution > LOAEL, adverse effects to individuals resulting from contaminant exposure are likely.

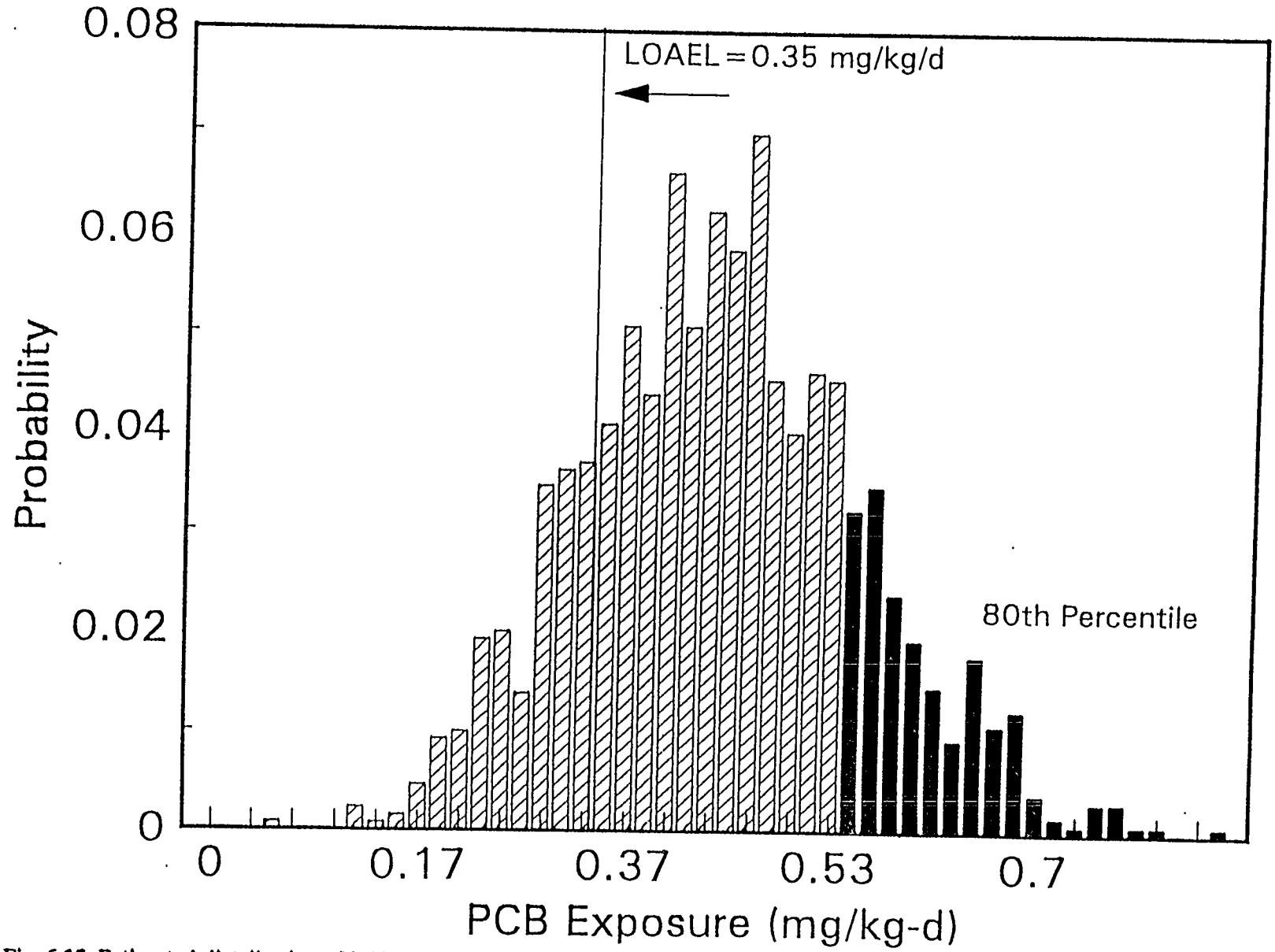


Fig. 6.27. Estimated distribution of PCB exposure for river otter in subreach 2.04. Distribution generated from Monte Carlo simulation of exposure model. If 80th percentile of distribution > LOAEL, adverse effects to individuals resulting from contaminant exposure are likely.

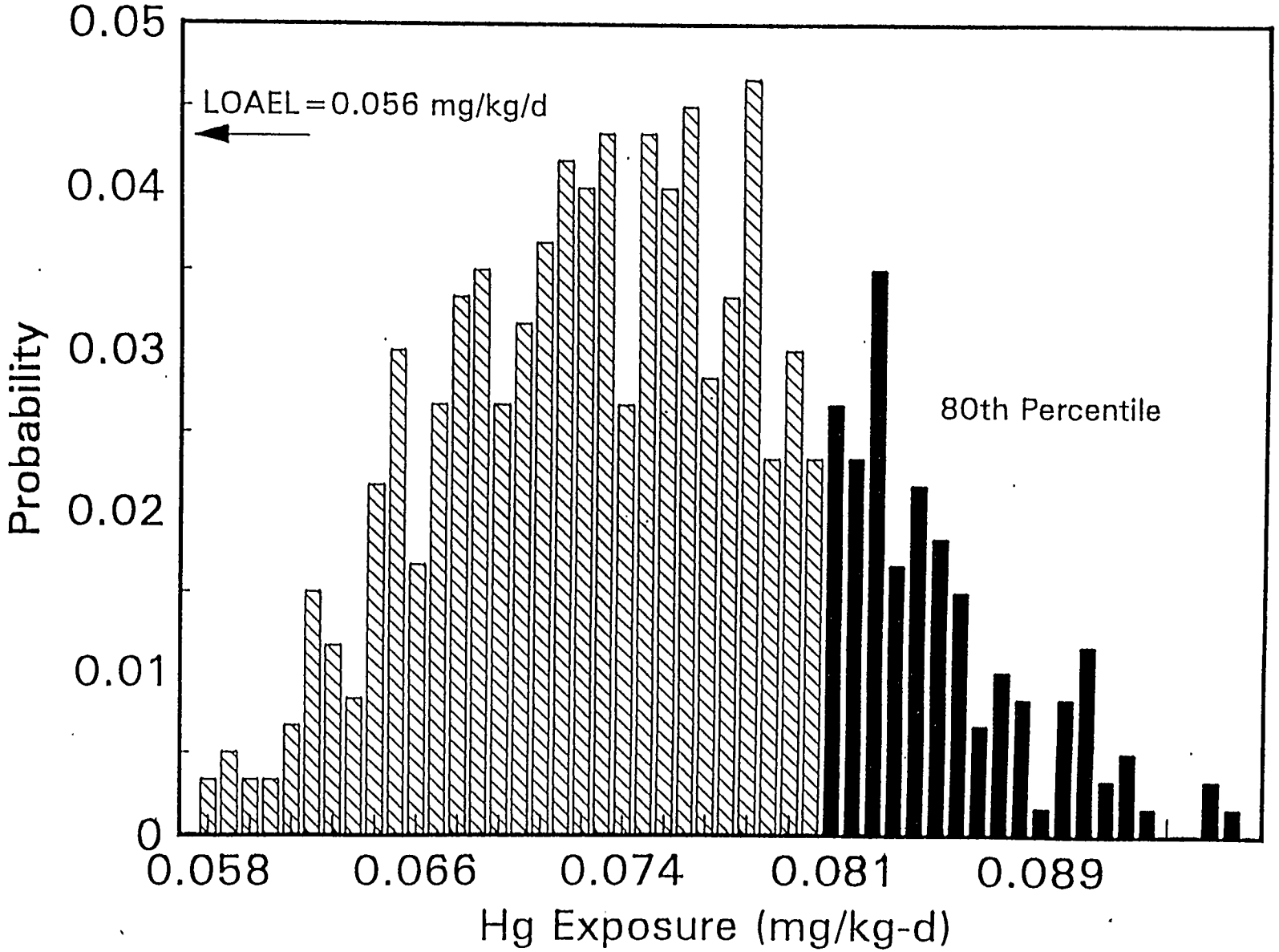


Fig. 6.28. Estimated distribution of mercury exposure for osprey in subreach 3.01. Distribution generated from Monte Carlo simulation of exposure model. If 80th percentile of distribution > LOAEL, adverse effects to individuals resulting from contaminant exposure are likely.

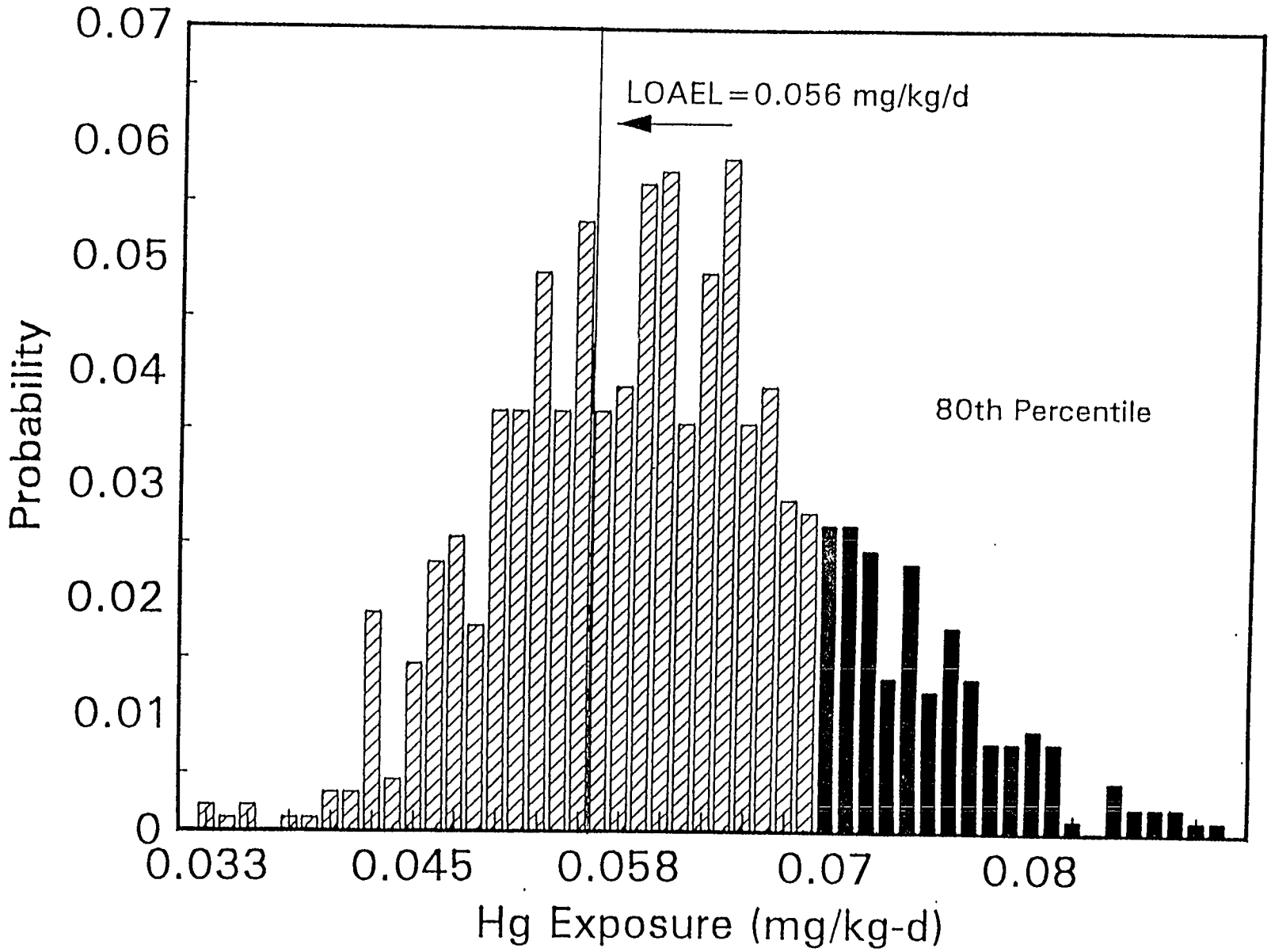


Fig. 6.29. Estimated distribution of mercury exposure for osprey in subreach 3.02. Distribution generated from Monte Carlo simulation of exposure model. If 80th percentile of distribution > LOAEL, adverse effects to individuals resulting from contaminant exposure are likely.

Both the NOAEL and LOAEL for river otter are based on a study in which mink were fed copper sulfate for 357 days (including a critical lifestage) (Aulerich et al. 1982). While consumption of 15.14 mg/kg/d copper increased the percentage of mortality in mink kits, no adverse effects were observed at a 11.71 mg/kg/d exposure level. Based on the results of Aulerich et al. (1982), otter experiencing exposures ≥ LOAEL may display a reduction in offspring survival.

DDE. The 80th percentile for exposure of osprey to DDE at subreach 3.01 exceeded the NOAEL but not the LOAEL. The osprey NOAEL and LOAEL for DDE were derived from a study of brown pelicans exposed to DDT for 5 yrs. (Anderson et al. 1975). Because DDE is a metabolite of DDT, effects from DDE were assumed to be comparable to those observed for DDT. Chronic exposure to 0.028 mg/kg/d DDT reduced reproductive success. This dose level was considered to be a LOAEL. Because an experimental NOAEL was not established, the NOAEL was estimated using LOAEL-NOAEL correction factor of 0.1. Because an experimental NOAEL was not established, the nature and exposure level at which adverse effects to individual birds may become evident cannot be defined.

Mercury. For the purposes of this assessment, it is assumed that 100% of the Hg to which piscivores are exposed consists of methyl mercury.

The 80th percentile for mercury exposure experienced by osprey and great blue heron exceeded both the NOAEL and LOAEL at subreaches 3.01 and 3.02; exposure at all other modeled subreaches exceeded the NOAEL but not the LOAEL. Both the avian NOAEL and the LOAEL are based upon a study of mallard ducks fed methyl mercury for three generations (Heinz 1979). The study was considered to represent a chronic exposure and a subchronic-chronic correction factor was not employed. The only dose level administered, 0.064 mg/kg/d, caused hens to lay fewer eggs, lay more eggs outside of the nest box, and produce fewer ducklings. This dose level was considered to be a LOAEL. Because an experimental NOAEL was not established, the NOAEL was estimated using LOAEL-NOAEL correction factor of 0.1. Based on the results of Heinz (1979), birds experiencing exposure ≥ LOAEL are likely to display impaired reproduction.

The 80th percentile for mercury exposure experienced by mink exceeded the NOAEL at subreaches 13, 3.01, 3.02, 3.03, 3.04, and 4.01; the LOAEL was not exceeded at any modeled subreach. For river otter, while the 80th percentile for mercury exposure exceeded the NOAEL at 14 subreaches, the LOAEL was exceeded only at subreach 3.01 (Table F4.18). The mink and otter NOAELs for mercury was derived from a study of mink fed methyl mercury for 93 d (Wobeser et al. 1976). While consumption of 0.247 mg/kg/d methyl mercury resulted in significant mortality, weight loss, and behavioral impairment, no effects were observed at the 0.15 mg/kg/d exposure level. The 0.15 mg/kg/d exposure was considered to be a NOAEL. Because the study was subchronic in duration (<1 yr), a subchronic-chronic correction factor was applied (NOAEL=0.015). The mink LOAEL for mercury was derived from a study of rats fed methyl mercury for 3 generations (Verschuuren et al. 1976). While consumption of 0.16 mg/kg/d methyl mercury resulted in reduced pup viability, no effects were observed among rats consuming 0.032 mg/kg/d. Because the data were derived from a multigeneration study, the 0.16 mg/kg/d exposure was considered to be a chronic LOAEL. Based on the results of Verschuuren et al. (1976), mink experiencing exposure ≥ LOAEL are likely to display impaired reproduction. Because the NOAEL for mink was derived using a subchronic-chronic correction factor, it is not reasonable to assume that mink experiencing exposure greater than the NOAEL but less than the LOAEL will experience increased mortality. It is more likely that mink whose exposures are at the high end of the distribution will display impaired reproduction (effects based on Verschuuren et al. 1976). The effects are likely to be less pronounced than that displayed among individuals where exposure is greater than the LOAEL.

PCBs. The 80th percentile for PCB exposure experienced by osprey exceeded the NOAEL but not the LOAEL at subreaches 2.04, 13, 3.01, and 3.02; a similar relationship (exposure exceeding the NOAEL but not the LOAEL) was observed for great blue heron at subreaches 2.04 and 3.02. Both the avian NOAEL and LOAEL are based upon a study in which reduced egg hatchability was observed among ring-necked pheasants fed two dose levels, 1.8 and 3.6 mg/kg/d Aroclor 1254 for 17 weeks (Dahlgren et al. 1972). The study was considered to represent a chronic exposure, therefore a subchronic-chronic correction factor was not employed. Effects were observed at both dose levels, therefore the 1.8 mg/kg/d dose level was considered to be a LOAEL. Because an experimental NOAEL was not established, the NOAEL was estimated using LOAEL-NOAEL correction factor of 0.1. Because an experimental NOAEL was not established, the nature and exposure level at which adverse effects to individual birds may become evident cannot be defined.

The 80th percentile for PCB exposure experienced by mink exceeded the NOAEL but not the LOAEL at subreach 2.04. For river otter, while the 80th percentile for PCB exposure exceeded the NOAEL at 14 subreaches, the LOAEL was exceeded only at subreach 2.04 (Table F4.18). The mink and otter NOAELs and LOAELs for PCBs was derived from a study of mink fed Aroclor 1254 for 4.5 mo. (Aulerich and Ringer 1977). While consumption of 0.69 mg/kg/d Aroclor 1254 reduced kit survivorship, no effects were observed at the 0.14 mg/kg/d exposure level. The study was considered to represent a chronic exposure, therefore a subchronic-chronic correction factor was not employed. The 0.14 mg/kg/d exposure was considered to be a chronic NOAEL; the 0.69 mg/kg/d exposure was considered to be a chronic LOAEL Based on the results of Aulerich and Ringer (1977), mink experiencing exposure ≥ LOAEL are likely to display reduced kit survivorship.

Selenium. The 80th percentile for selenium exposure experienced by mink and river otter exceeded the NOAEL but not the LOAEL at 9 (mink) and 13 (otter) subreaches. Both the NOAEL and the LOAEL are based upon a study in which reduced reproductive success and offspring survival was observed among mice fed one dose level, 0.75 mg/kg/d Se in drinking water, for three generations (Schroeder and Mitchner 1971). The study was considered to represent chronic exposure, therefore a subchronic-chronic correction factor was not employed. This dose level was considered to be a LOAEL. Because an experimental NOAEL was not established, the NOAEL was estimated using LOAEL-NOAEL correction factor of 0.1. Because an experimental NOAEL was not established, the nature and exposure level at which adverse effects to individual mink may become evident cannot be defined. Based on the results of Schroeder and Mitchner (1971), mink experiencing exposure ≥ LOAEL are likely to display reduced reproductive success and offspring survival.

6.4.3.2 Mink toxicity tests

To evaluate the nature and magnitude of toxicity of contaminants in fish from the Clinch River to mink, fish were collected from the Poplar Creek embayment, formulated into mink diets, and fed to mink. Mink were fed five different diets:

Diet A: 75% ocean fish, 25% mink chow
Diet B: 75% fish from upstream of ORR, 25% mink chow
Diet C: 25% Poplar Creek fish, 50% ocean fish, 25% mink chow
Diet D: 50% Poplar Creek fish, 25% ocean fish, 25% mink chow
Diet E: 75% Poplar Creek fish, 25% mink chow

Ten mink (2 males, 8 females) were fed each diet for 7 months; starting approximately 3 months prior to breeding, extending to 6 weeks post-partum. Bioaccumulation, growth, histopathology, and reproduction were recorded. Significant effects were observed only among mink fed diet E. These effects

included statistically significant reductions in body weights of adult females and male kits and in litter size. Percent reductions were 20% and 17% for adult female and male kit weights, respectively, and 37.7% for litter size. A detailed discussion of the methods and results of the mink toxicity test is presented in Sect. 3.5.

To evaluate how the exposures experienced by mink in the toxicity test compare to those modeled for mink along the Clinch River, Monte Carlo simulations of mink exposure were performed using the concentrations of mercury and Aroclor 1260 measured in the five diets (Tables C20 and C24). Parameter values in the exposure model were those used in estimates using Clinch River data (body weight=0.974±0.202 kg; food ingestion rate = 0.137 kg/d). Results of the exposure simulation are presented in Table F4.20. Estimated exposures to mercury and Aroclor 1260 in diet A were below both the NOAEL and LOAEL. For diets B, C, D. and E, mercury exposures exceeded the NOAEL (only marginally for diet B) but not the LOAEL, suggesting that it is unlikely that toxicity observed in diet E is attributable to mercury. In contrast, exposures to Aroclor 1260 in diets B, C, D, and E were greater than both the NOAEL and LOAEL (Table F4.20). These data suggest that impaired reproduction should have been evident in all four diets, not just diet E.

Estimating that toxicity should be observed in four diets but actually observing it only in the highest concentration suggests that the LOAEL for PCBs used in this assessment is too low and is not representative of the toxicity of the PCBs present on the ORR. ORR-specific NOAEL and LOAEL for PCBs (represented by PCB 1260) of 1.7 mg/kg/d and 3 mg/kg/d can be derived from the toxicity test exposure estimate for diets B and E (Table F4.20). While an ORR-specific LOAEL for mercury cannot be derived from these toxicity test results, a site-specific NOAEL may be estimated. The ORR-specific NOAEL for mercury would be 0.022 mg/kg/d (diet D) or 0.033 mg/kg/d (diet E, assuming that mercury is not contributing significantly to toxicity observed from this diet).

The mercury exposure estimate for mink at the Clinch River subreach where the highest exposure estimate was obtained (subreach 3.01; mean = 0.027±0.013 mg/kg/d) is higher than that estimated for test diets A, B, C, and D, but less than that in diet E (Table F4.16). The estimated total PCB exposure at subreach 2.04 (mean = 0.311±0.222 mg/kg/d) is less than that in all test diets except the control diet (diet A; Table F4.20).

Several conclusions may be drawn from these toxicity test data.

1) Comparisons of exposure estimates to NOAELS and LOAELs suggest that effects observed in diet E are attributable to PCBs. It is unlikely that mercury is significantly contributing to adverse effects observed in the toxicity test. A significant contribution of mercury to the toxic effects would have resulted in a LOAEL that was lower than literature values, not higher.

2) Given the difference between predicted and observed toxicity from the test diets, the PCB LOAEL used in this assessment is too low and does not reflect toxicity observed among mink exposed to Poplar Creek fish.

3) Consumption of a diet consisting of 75% fish from the Poplar Creek produces reproductive impairment in mink.

4) Assuming that toxicity in the test is entirely due to PCBs, a LOAEL for mink on the ORR fish of 3 mg/kg/d can be derived. Using the ORR-specific value rather than the literature value, PCBs would not be expected to cause toxic effects on survival, growth, or reproduction of mink in any ORR watershed.

Differences between the results of the toxicity tests and modeled exposures for mink on the ORR may result for several reasons.

1) Differences in fish size. Exposure estimates for mink on the ORR were based solely on contaminant concentrations in fish most likely to be consumed by mink (i.e., ≤30 cm in length). Due to the large volume of fish needed to formulate the test diets and to feed mink for 7 months, the majority of fish used in the toxicity test were large (mean=39 cm, STD=17 cm). Because body burdens of bioaccumulative contaminants like mercury and PCBs are generally greater in older, larger individuals, concentrations in the toxicity test diets were higher than that in fish expected to be consumed by mink on the ORR.

2) Differences in fish species. Over 50% of the fish used in the test diets were sucker, carp, or buffalo (Table C20). In contrast, only 0.1% of fish used to estimate exposure for Clinch River piscivores were carp; no data from sucker and buffalo were used in the exposure assessment. Because fish species accumulate contaminants differently, variation in species included in test diets and modeled diets may have contributed to the differences in results.

3) Differences in the PCB congener composition on the ORR vs. that used in the literature toxicity test. PCBs measured in environmental samples are not Aroclors. Aroclors are specific mixtures of PCB congeners as manufactured. The environmental measurements of PCBs used in the Poplar Creek toxicity test are called PCB 1254 or PCB 1260 because they have ~54% or 60% Cl. The congener makeup of PCB 1254 or 1260 from the Poplar Creek fish is likely to be very different from the congener makeup of Aroclor 1254 or 1260. More importantly, PCB toxicity is generally correlated with individual congeners, not with Aroclors.

6.4.3.3 Biomonitoring data

Great bue heron reproduction study. To determine if contaminants from the ORR are adversely affecting piscivorous wildlife, bioaccumulation of contaminants and reproductive success of great blue herons at two colonies located within 3 km of the ORR and two colonies located >10 km from the site was monitored. Data were collected from each nest colony between 1992 and 1994. A discussion of these data are presented in Sect. 3.5.

Analyses indicated significantly elevated levels of Cr, Hg, and PCBs in eggs (Tables C13 and C15), Hg in feathers and liver of chicks (Table C14) and PCBs in fat (Table C16), liver (Table C17), and muscle (Table C18) of chicks from samples from the ORR as compared to data from the offsite locations. King et al. (1991) report that 0.5 to 1.5 mg/kg mercury concentrations in bird eggs may are associated with reproductive failure; Harris et al. (1993) report a NOAEL for hatching success of Forster's Tern eggs to be 7 mg/kg. Mean concentrations of mercury (0.17 mg/kg) and PCBs (1.68 mg/kg) in great blue heron eggs from within 3 km of the ORR are substantially below both levels, suggesting that reproductive effects from mercury or PCBs in eggs are unlikely.

Despite elevated contaminant burdens, the mean number of eggs/nest, number of chicks/nest, egg weight, and eggshell thickness did not differ between colonies within 3 km of the ORR and those >10 km away (Table C19). In addition, the number of eggs/nest observed at the colonies within 3 km of the ORR (3.5 eggs/nest) and at the colonies >10 km away (3.2 eggs/nest) are comparable to those reported in EPA (1993) (3.16 to 4.37 eggs/nest)

The results of the great blue heron reproduction survey indicate that herons are experiencing higher contaminant exposures at the colonies adjacent to the ORR. However, this exposure is not sufficiently high to result in adverse effects to the populations at the colonies within 3 km of the reservation.

Osprey reproduction. While an osprey monitoring study was not performed as part of the CRRI, an ongoing osprey reintroduction program is being conducted by the TWRA in the Clinch/Tennessee River system. Osprey are currently nesting at three locations adjacent to the reservation: Gallaher and Solway bends (both located in subreach 1) and in Poplar Creek approximately at the boundary of subreaches 3.03 and 3.04. Mean reproductive success at these three osprey nests was 3 young/nest (B. Anderson, pers. comm). For comparison, mean reproductive success of osprey in N. America ranges from 1.7 to 2.14 young/nest (EPA 1993a).

6.4.3.4 Weight of evidence

Osprey. Two lines of evidence, literature toxicity data and biomonitoring data, were available to evaluate ecological risk to osprey. Comparison of exposure estimates to LOAELs indicates that within only two subreaches (Poplar Creek 3.01 and 3.02) are significant risks present. These risks are attributable solely to mercury. Risk from mercury is not retained when exposure is recalculated taking into account the spatial component of osprey foraging behavior. Reproductive success of osprey adjacent to the ORR is high relative to that observed among other osprey populations in N. America. The weight of evidence suggests that contaminants from the ORR do not present a risk to osprey.

Great blue heron. Two lines of evidence, literature toxicity data and biomonitoring data, were available to evaluate ecological risk to great blue heron. Comparison of exposure estimates to LOAELs indicates that exposure to Hg within the subreaches 3.01 and 3.02 may be sufficiently high to result in impaired reproduction of individual herons that forage exclusively within these areas. However, because these subreaches account for only 6% of the heron population downstream of the ORR, adverse population-level effects are unlikely. Biomonitoring data indicate that PCBs and mercury are being accumulated in heron eggs and chicks, but levels are below those reported to adversely affect other bird species. Because heron reproduction adjacent to the ORR does not appear to be impaired, the weight of evidence suggests that contaminants from the ORR do not present a risk to great blue heron.

Mink. Two lines of evidence, literature toxicity data and toxicity test data, were available to evaluate ecological risk to mink. Comparison of exposure estimates to LOAELs indicates no significant risk in any subreach. Toxicity test results indicate that consumption of a diet consisting primarily of fish from the Poplar Creek embayment adversely affects reproduction. The maximum exposure estimated for mink along the Clinch River however is significantly lower than the toxicity test exposure level that produce effects. The weight of evidence suggests that contaminants from the ORR do not present a risk to mink.

River Otter. Two lines of evidence, literature toxicity data and the PCB NOAEL and LOAEL and mercury NOAEL derived from the Poplar Creek mink toxicity test, were available to evaluate potential risk to river otter. Comparison of exposure estimates to literature-derived LOAELs indicates a significant risk from mercury in subreach 3.01 and from PCBs in subreach 2.04.

Using approach outlined in Sect.6.4.2.1. and the ORR-specific PCB NOAEL and LOAEL and mercury NOAEL for mink (Sect. 6.4.3.2), ORR-specific values for otter were estimated (Table 6.20).

Table 6.20. ORR-specific values for otter

Analyte	Estimated NOAEL (mg/kg/d)	Estimated LOAEL (mg/kg/d)
PCBs	0.85	1.5
Mercury	0.011[a]	no data

[a] To be conservative, based on the lower of two possible NOAELs.

Comparison of the ORR-specific PCB LOAEL to the exposure distributions presented in Table F4.13 indicate that there is a less than 1% likelihood of individual otter in subreach 2.04 experiencing PCB exposure greater than the ORR-specific LOAEL. Therefore, based upon the results of the Poplar Creek mink toxicity test, PCBs are unlikely to present a significant risk to otter in the CR/PC system.

The ORR-specific mercury NOAEL, while greater than the literature-derived NOAEL (0.008 mg/kg/d; Table F4.15) is still less than the literature-derived LOAEL (0.06 mg/kg/d; Table F4.15). Therefore, the results of the Poplar Creek mink toxicity test do not significantly alter the conclusions derived from evaluation of the literature-based toxicity data. The weight-of-evidence indicates that individual otter using subreach 3.01 may be adversely affected by mercury exposure. Because the river otter is a state threatened species, effects to any individual is significant.

6.4.4 Uncertainties Concerning Risks to Piscivorous Wildlife

Estimation of contaminant concentrations for missing fish size classes. Contaminant concentrations in fish size classes for which no data were available were assumed to be comparable to that observed larger fish. Because larger fish generally have higher contaminant concentrations than smaller fish, concentrations in smaller fish are likely to be overestimated. Consequently, exposure estimates that use these estimated fish values are likely to overestimate the actual contaminant exposure experienced.

Bioavailability of contaminants. It was assumed that 100% if the contaminant concentration reported in fish and water was bioavailable. Much of the biotic media are bioavailable; however, the uptake efficiencies for wildlife may not be 100%. Therefore, exposure estimates based upon the contaminant concentrations in media are conservative and are likely to overestimate the actual contaminant exposure experienced.

Extrapolation from published toxicity data. While published toxicity studies are available for mink, there are no published data for osprey or great blue heron. To estimate toxicity of contaminants at the site, it was necessary to extrapolate from studies performed on test species (i.e., mallard ducks, ring-necked pheasant, and rats). While it was assumed that toxicity could be estimated as a function of body size, the accuracy of the estimate is not known. For example, osprey or herons may be more or less sensitive to contaminants than ducks or pheasants.

Additional extrapolation uncertainty exists for those contaminants for which data consisted of either LOAELs or was subchronic in duration. For either case, an uncertainty factor of 10 was employed to estimate NOAELs or chronic data. The uncertainty factor of 10 may either over- or underestimate the actual LOAEL-NOAEL or subchronic-chronic relationship.

Toxicity of PCBs to piscivorous wildlife was evaluated using toxicity data from studies on Aroclor 1254. Because toxicity of PCB congeners can vary dramatically, the applicability of data for Aroclor 1254 is unknown. Comparison of the results of the mink toxicity test results and the estimated LOAELs for mink, suggests the Aroclor 1254 data do not accurately reflect (i.e., overestimate) the toxicity of the PCB mixture present in Clinch River fish.

Variable food and water consumption. While food consumption by piscivorous wildlife was assumed to be similar to that reported for the same or related species in other locations, the validity of this assumption cannot be determined. Food consumption by wildlife along the Clinch River may be greater or less than that reported in the literature, resulting in either an increase or decrease in contaminant exposure. Similarly, water consumption for all species was estimated according to the allometric equations of Calder and Braun (1983). The accuracy with which the estimated water consumption represents actual water consumption is unknown.

Single contaminant tests vs exposure to multiple contaminants in the field. While piscivores along the Clinch River are exposed to multiple contaminants concurrently, published toxicological values only consider effects experienced by exposures to single contaminants. Because some contaminants to which wildlife are exposed can interact antagonistically, single contaminant studies may overestimate their toxic potential. Similarly, for those contaminants that interact synergistically, single contaminant studies may underestimate their toxic potential.

Inorganic constituents or species present in the environment. Toxicity of metal species varies dramatically depending upon the valence state or form (organic or inorganic) of the metal. For example, Arsenic (III) and methyl mercury are more toxic than arsenic (V) and inorganic mercury, respectively. The available data on the contaminant concentrations in media do not report which species or form of contaminant was observed. Because benchmarks used for comparison represented the more toxic species/forms of the metals (particularly for arsenic and mercury), if the less toxic species/form of the metal was actually present in fish from the Clinch River or Poplar Creek, potential toxicity at the sites may be overestimated.

Contaminant concentrations in aquatic prey. While fish are the primary prey of piscivores, other aquatic prey are also consumed. It was assumed that the contaminant concentration in fish was representative of that in other aquatic prey. Due to the different life histories of other aquatic prey (i.e., amphibians, crayfish, benthic invertebrates), their contaminant burdens are likely to differ from that in fish. Therefore, assuming comparability to fish may either over or underestimate exposure.

Fish size selection. Data concerning the sizes of fish consumed by piscivores were obtained from the literature. Because fish sizes consumed by Clinch River piscivores may differ from that reported in the literature, exposure may be overestimated or underestimated. In addition, while Alexander (1977) report that mink only consume fish ≤20 cm in length, few data from the Clinch River were available in this size range. To provide data with which to assess exposure, the size range of fish consumed by mink was expanded to include fish up to 30 cm in length. Including these larger fish may overestimate the exposure experienced by mink along the Clinch River.

Monte Carlo simulation. To perform Monte Carlo simulations, distributions must be assigned to parameters. Because wildlife are mobile, the mean of the contaminant concentration is likely to best represent their exposure. For this reason the contaminant concentrations in fish were assumed to be normally distributed.

The literature values used for body weights of each endpoint are nationwide values which may overestimate or underestimate the body weight of species found at the site. Similarly the proportion of fish and aquatic prey in mink diet were derived from data from northern locations (i.e., MI, Canada, etc.). The applicability of these data to the percentage of fish and aquatic prey consumed by mink in Tennessee is unknown.

Estimated whole fish concentrations. Contaminant concentrations in whole no-shad fish were estimated using contaminant specific fillet to whole fish ratios. Data to generate ratios were only available for PCBs in largemouth bass and channel catfish from the Clinch River. Ratios for metals were obtained from spotted bass samples from near the PORTS facility in Ohio. Applicability of these ratios to species other than those from which they were developed is unknown. Similarly, applicability of metal ratios from Ohio spotted bass to Clinch River fish is unknown.

6.5 RISKS TO INSECTIVOROUS WILDLIFE

6.5.1 Exposure Assessment for Insectivorous Wildlife

Insectivorous wildlife may be exposed to contaminants through ingestion of contaminated media (aquatic insects and water) associated with the Clinch River. Rough-winged swallows (*Stelgidopteryx serripennis*) and little brown bats (*Myotis lucifugus*) forage regularly within the Clinch River system. During the breeding season, from April to July, the swallows reside in burrows located in the high vertical banks. Although no burrows were located within Poplar Creek, swallows may also reside in crevices in rock cliffs, bridges, and tunnels. The swallows continue to forage in the area until they migrate south in the fall. The little brown bats are nocturnal foragers along the waterways; living in caves, trees, and buildings during the day (Harvey et al. 1992). Little brown bats and gray bats hibernate throughout the winter. Colonies of the federally endangered gray bat (*Myotis grisescens*) have been found within the Tennessee river basin, specifically at Norris and Chickamauga lakes. Although no colonies have been found in Roane or Anderson counties, gray bats have been observed foraging in these areas. The exposure parameters for both little brown bats and the gray bats are similar. Therefore, this assessment will address both species of bats simultaneously. The following sections describe the modes of exposure that occur at the Clinch River system for these endpoints, the ways in which exposure was estimated, and the exposure data available for ecological risk assessment. Exposure estimates were calculated for all contaminants in all CR/PC subreaches for which data were available (Subreaches 0, 1, 2.01, 2.02, 2.04, 3.01, 3.02, 3.03, 3.04, 4.01, 4.04, 5, 6, 10, 13, 15, and 18).

6.5.1.1 Exposure through oral ingestion of aquatic insects and water

Potential routes of exposure for rough-winged swallows, little brown bats, and gray bats include ingestion of contaminated food and surface water associated with the CR/PC. All three of the endpoint species have diets consisting almost exclusively of aerial insects which are abundant on site. The total exposure experienced by insectivorous wildlife is represented by the sum of the exposures from each individual source (e.g., food and water).

The generalized wildlife exposure model, as described in Sect. 6.4.1.1, was used to calculate contaminant exposure to insectivorous wildlife. In general, wildlife may be exposed to contamination via three pathways: oral, dermal, or inhalation. The primary route of exposure for these endpoints is through oral exposure. The feathers and fur of swallows and bats reduce the likelihood of significant dermal exposure by limiting the contact of skin with contaminated media. Therefore, dermal exposure is assumed to be negligible. Inhalation of contaminants is also assumed to be negligible since volatile

organic carbons are present in extremely low amounts in the surface water. Thus, the exposure model for Clinch River insectivorous wildlife is as follows:

$$E_j = \left(\frac{IR_w \times C_{w\text{-}j}}{BW}\right) + \left(\frac{(C_{i\text{-}j})(P_i) \times IR_i}{BW}\right)$$

E_j = exposure to contaminant (j) (mg/kg/d)
IR_w = ingestion rate of water (L/d)
$C_{w\text{-}j}$ = contaminant concentration (j) in water (mg/L)
BW = body weight (kg)
$C_{i\text{-}j}$ = contaminant concentration (j) in aquatic insects (mg/kg)
P_i = proportion of aquatic insects (mayflies) in diet
IR_i = ingestion rate of insects (kg/d)

Exposure estimates were calculated for all contaminants in all Clinch River subreaches for which data were available. Because wildlife are mobile, their exposure is best represented by the mean contaminant concentration in the media. The 95% UCL is a conservative estimate of exposure for wildlife. The PLE was used to calculate the 95% UCLs in order to prevent bias from values below the detection limit. Exposure estimates for contaminants that may potentially present a risk to insectivorous wildlife (based upon comparisons to NOAELs) were recalculated using Monte Carlo techniques.

Life history parameters for endpoint species. Species-specific parameters necessary to estimate exposure using the equation described above are listed in Tables F5.1 and F5.2.

Contaminant concentrations in abiotic and biotic media. Contaminant concentrations in surface water, sediment, and food are needed to estimate exposure for insectivorous wildlife. The PLE 95% UCL surface water concentrations within each subreach were used to estimate exposure from drinking water. The only surface water contaminants that were used in the exposure model were those present in the mayflies. The contaminants in surface water which were not detected in mayflies were compared to the NOAELs for surface water consumption for swallows and bats. If the concentration is below the water consumption benchmark, the contaminant need not be considered further.

Concentrations of contaminants in food (mayflies) were measured at three locations in Clinch River subreaches 3.03, 4.04 and 18 (Table F5.3). Contaminant concentrations in mayflies at other locations were estimated using sediment-mayfly contaminant uptake factors developed for the Clinch River System (Table F5.4). Contaminant uptake factors were calculated for arsenic, lead, mercury, zinc, and PCBs by dividing the contaminant concentration found in mayflies by the concentration found in the sediment closest to the point of mayfly collection. The average uptake factor from the three locations for each contaminant was used to estimate the mayfly contaminant concentrations using the sediment data at all other reaches. However, the mercury uptake factor was calculated using sediment and mayfly concentrations collected within subreaches 3.03 and 3.04 only. Data from subreach 18 was excluded due to potential differences in mercury speciation off the ORR. The estimated and measured mayfly contaminant concentrations, and surface water concentrations for each subreach were used in the insectivorous exposure model to estimate exposure for swallows and bats.

The resultant estimated mayfly concentrations were compared to the measured concentrations (at three locations) by performing a Student's t-test. This comparison was performed to determine the quality of the uptake factors. There were no significant differences between the estimated and the actual

mayfly contaminant concentrations (Table F5.5). Therefore, this model appears to be a valid predictor of mayfly concentrations for each subreach.

Exposure modeling using point-estimates. To estimate contaminant exposure experienced by rough-winged swallows, the following assumptions were made:

1) body weight = 0.0159 kg
2) food consumption = 0.012 kg/d
3) water consumption = 0.0037 L/d
4) soil consumption = 0 kg/d
5) diet consists 37.93% aquatic insects (32.89% dipterans and 5.04% ephemeropterans: represented by mayflies) (Beal 1918)
6) individuals forage exclusively within each given subreach

To estimate contaminant exposure experienced by little brown and gray bats, the following assumptions were made:

1) body weight = 0.0075 kg
2) food consumption = 0.0025 kg/d
3) water consumption = 0.0012 L/d
4) soil consumption = 0 kg/d
5) diet consists 100% aquatic insects (represented by mayflies)
6) individuals forage exclusively within each given subreach

Using the Clinch River insectivorous exposure model and the assumptions and data described above, exposure to contaminants was estimated for rough-winged swallows and little brown and gray bats foraging in the Clinch River. Exposure estimates for analytes detected in mayfly samples (arsenic, mercury, lead, zinc, and PCBs) are presented in Tables F5.6 through F5.15.

Exposure modeling using Monte Carlo simulations. Employing point estimates for the input parameters in the Clinch River insectivore exposure model does not take into account the variation and uncertainty associated with the parameters and may over or under estimate the contaminant exposure that endpoints may receive in any given reach. In addition, calculating the model using point estimates produced a point estimate of exposure. This estimate provides no information concerning the distribution of exposures or the likelihood that individuals within a reach will actually experience potentially hazardous exposures. To incorporate the variation in exposure parameters and to provide a better estimate of the potential exposure experienced by insectivores in each subreach, the exposure distribution was simulated using Monte Carlo techniques. For a detailed discussion of Monte Carlo simulation (Sect. 6.4).

Monte Carlo simulations of exposure estimates were performed for all endpoint-subreach-contaminant combinations where comparison of point exposure estimates to NOAELs produced HQs ≥ 1 (NOAELs are presented in Sect 6.5.2.1; Screening of exposure estimates against NOAELs is presented in Sect. 6.5.3.1). Monte Carlo simulations were performed for the subreach-contaminant combinations presented in Table F5.16.

Distributions were used for the following parameters in the Clinch River insectivore exposure model: 1) endpoint body weight; 2) sediment-mayfly uptake factors (Table F5.4); and 3) contaminant concentrations in sediment and mayflies (Table F5.17) and water (Table F5.18). All distributions were assumed to be normal, except for the body weight distribution of the little brown bat which was assigned

a triangular distribution and the log normal sediment distribution. Because wildlife are mobile and are more likely to be exposed to average concentrations and not to the extreme values, the standard error of the mean was used to describe variation for contaminant concentrations. All other distributions employed the standard deviation. The food and water consumption rates used in the exposure model were average values.

Rough-winged swallows also feed on a variety of other types of insects (i.e., Hymenoptera, Coleoptera, Hemiptera) which do not come in contact with sediments. Therefore, the percentage of aquatic insects (dipterans 32.89% and ephemeropterans 5.04%; Beal, 1918) in the diet of rough-winged swallows was assumed to be 37.93%.

The little brown and gray bat diet was assumed to consist of 100% aquatic insects. Belwood and Fenton (1976) found that only 80.4% of the diet consisted of chironimids (39.5%), tricopterans (31.5%), and miscellaneous insects (9.4%); while the remaining portions of the diet were lepidopterans (11.0%), coleopterans (5.5%), and neuropterans (3.1%). Additionally, Rabinowitz (1978) found that mayflies are the choice food item of gray bats within eastern Tennessee. Since the bat's diet is highly variable and opportunistic (Fenton and Barclay 1980), exposure was conservatively estimated using contaminant concentrations from a 100% aquatic insect diet. This assessment assumed that contaminant concentrations found in mayflies are representative of aquatic insects.

The initial comparison of the exposure distributions with the estimated LOAELs was conducted under the assumption that the population would be feeding exclusively from a single subreach. This assumption is appropriate for rough-winged swallows since their feeding territory does not extend over 1/2 mile from the nesting site (Stoner and Stoner 1941). Therefore, contaminant exposure within a subreach could potentially impact a colony if present within that subreach. In contrast, little brown and gray bats have a larger home range and may forage within multiple subreaches. Laval et al. (1977) documented that gray bats were observed foraging 8.5 km upstream or downstream of their roost. Therefore, if the contaminant exposure from foraging in a single subreach exceeded the LOAEL, the exposure distribution would be reassessed for bats foraging in adjacent subreaches (e.g., 3.01 and 3.02) or within the entire reach.

Table 6.21. Insectivorous body weight distributions

Endpoint	Distribution	Mean (kg)	Standard Deviation	Range	Source
Rough-winged Swallow	normal	0.0159	0.00058		Dunning 1984
Little Brown Bat	triangular	0.0075		0.007-0.009	Gould 1955 Burt and Grossenheider 1976

Monte Carlo Simulation could not be performed for exposure to mercury (both rough-winged swallows and bats) and PCBs (bats only) at subreach 22 (White Oak Creek Embayment). Only one sediment sample was collected from each subreach, therefore, an appropriate contaminant distribution found in mayflies could not be estimated. Consequently, the exposure estimate for each endpoint for Hg and PCBs within each subreach was calculated as a point exposure estimate and compared directly to a LOAEL to obtain a HQ.

6.5.2 Effects Assessment for Insectivorous Wildlife

Effects assessment involves the identification of known effects of contaminants on swallows and bats using ecotoxicological benchmarks. The types, development, and interpretation of appropriate toxicological benchmarks are discussed and available toxicity data relevant to swallows and bats are summarized in toxicity profiles for COPEC. Conventional toxicity data consists of published values for toxicity of contaminants to test species. These data are used in the development of toxicological benchmarks which are used to determine if biological effects are likely. Contaminant exposures are compared to benchmarks to obtain HQs used in the risk characterization.

6.5.2.1 Ecotoxicological benchmarks

To determine if the contaminant exposures experienced by swallows and bats that use the Clinch River or Poplar Creek could produce adverse effects, exposure estimates are compared to NOAELs and LOAELs derived according to the methods outlined by Opresko et al. (1994) and EPA (1993). NOAELs represent the highest exposure at which no adverse effects were observed among the animals tested. LOAELs represent the lowest exposure at which significant adverse effects are observed.

Toxicological studies of the effects of contaminants observed within the Clinch River were obtained from the open literature. Only studies of long-term, chronic oral exposures were used to estimate the NOAEL. To make the NOAELs relevant to possible population effects, preference was given to studies that evaluated effects on reproductive parameters. In the absence of a reproduction endpoint, studies that considered effects on growth, survival, and longevity were used. The NOAELs and LOAELs for rough-winged swallows and little brown bats and the studies which derived them are located in Tables F5.19 and F5.20. Specific details on development of the NOAELs for all wildlife endpoints are discussed in Sect. 6.4.2.1.

6.5.2.2 Ecotoxicological profiles

The mercury and PCB toxicity profiles can be found in Appendix F1.

6.5.3 Risk Characterization for Insectivorous Wildlife

Risk characterization integrates the results of the exposure assessment (Sect. 6.5.1) and effects assessment (Sect. 6.5.2) to estimate risks (the likelihood of effects given the exposure). Procedurally, the risk characterization in this assessment is performed for each assessment endpoint by (1) screening all measured contaminants against toxicological benchmarks, (2) estimating the effects of the contaminants retained by the screening analysis, (3) listing and discussing the uncertainties in the assessment. There is only one line of evidence, single chemical toxicity data, available to evaluate the risks to rough-winged swallows and bats foraging at the Clinch River.

6.5.3.1 Chemical screening for insectivorous wildlife

Two types of single chemical toxicity data are available with which to evaluate insectivore contaminant exposure: NOAELs and LOAELs. The total contaminant exposure estimates (Tables F5.6–F5.15) for rough-winged swallows and little brown/gray bats foraging within each subreach of the Clinch River were compared to estimated NOAELs to determine if adverse effects are possible. The comparison of estimated exposure and the NOAEL acts as a screening tool to identify contaminants of concern which will be further evaluated for possible estimated effects (i.e., exposure modeling using Monte Carlo simulation). LOAELs are compared to the exposure distribution generated by the Monte Carlo

simulation. If the LOAEL is lower than the 80th percentile of the exposure distribution, >20% of the endpoint population is experiencing contaminant exposures that are likely to produce adverse effects. Consequently, population-level effects to swallows and bats are likely.

Screening point estimates of exposure. To determine if the contaminant exposures experienced by rough-winged swallows and little brown/gray bats feeding within the Clinch River are potentially hazardous, the total exposure estimates were compared to estimated NOAELs. HQs were calculated to quantify the magnitude of the hazard where: HQ = estimated exposure/NOAEL. HQs greater than one indicate that individuals may be experiencing exposures that are in excess of NOAELs, and may suggest that adverse effects may be occurring. HQs for rough-winged swallows and bats are presented along with exposure estimates in Tables F5.6–F5.15.

The spatial distribution of contamination and potential risks to rough-winged swallows and little brown/gray bats for each Clinch River subreach are illustrated in Figs. 6.31 and 6.32. These figures display the sum of the NOAEL-based HQs (e.g., sum of toxic units or ΣTUs) for five contaminants: arsenic, mercury, lead, zinc and PCB-1254. The importance of each contaminant, relative to an endpoint, was determined based on the magnitude of the HQs. River reaches were arranged from upstream to downstream locations.

The magnitude of the ΣTUs was much greater (at least 3 times) for rough-winged swallows compared to little brown and gray bats. The maximum ΣTUs for both endpoints was observed at subreach 22 (White Oak Creek Embayment) followed by subreaches 3.01, 3.02, and 3.04 in Poplar Creek (below Mitchell Branch, East Fork Poplar Creek, and Poplar Creek Mouth). However, the magnitude of risk to bats is minimal (HQ<1) at Poplar Creek 3.01 and 3.02. The total risk at subreaches 3.01, 3.02, 3.04, and 22 is attributable primarily to mercury. Additionally, zinc contributes to the total risk to swallows, while PCBs contribute slightly to risk to little brown and gray bats.

A summary of the reaches where HQs > 1 were observed is listed for each contaminant in Table 6.22. HQs > 1 were not observed for any contaminant or insectivorous endpoint in Clinch River subreaches 0, 1, 7.01, 7.02, 8, 2.01, 2.02, 2.03, 2.04, 13, 3.03, 4.01, 4.02, 4.03, 4.04, 18, or 5.

Table 6.22. Reaches where HQs > 1 were observed

		Contaminants Where HQ > 1	
Subreach	**Subreach Name**	**Rough-winged Swallow**	**Little Brown or Gray Bats**
3.01	Poplar Creek: East Fork Poplar Creek	Hg	
3.02	Poplar Creek: Mitchell Branch	Hg	
3.04	Poplar Creek Mouth	Hg	Hg
22	White Oak Creek Embayment	Hg	Hg, PCBs

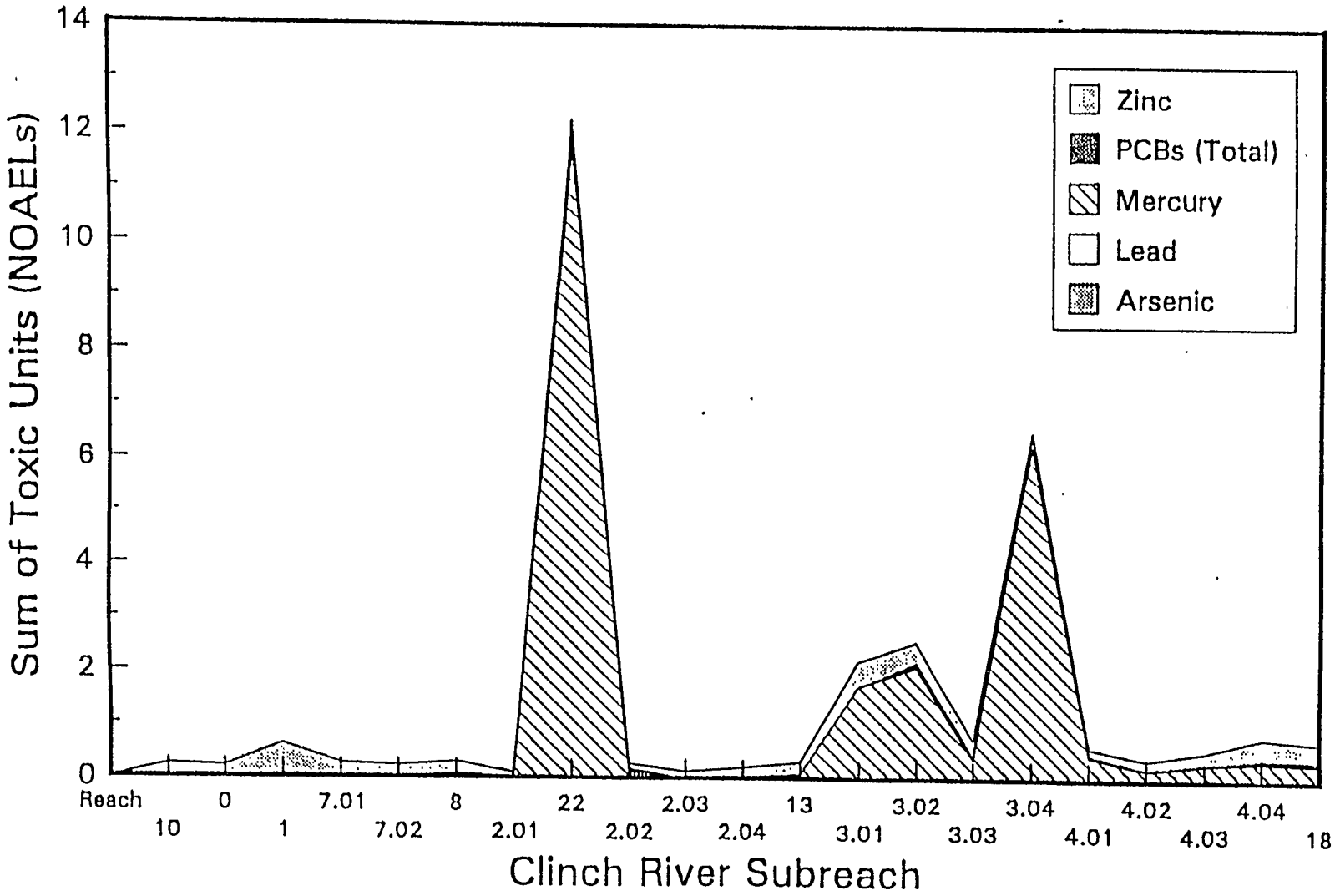


Fig. 6.31. Sum of NOAEL-based toxic units for rough-winged swallows.

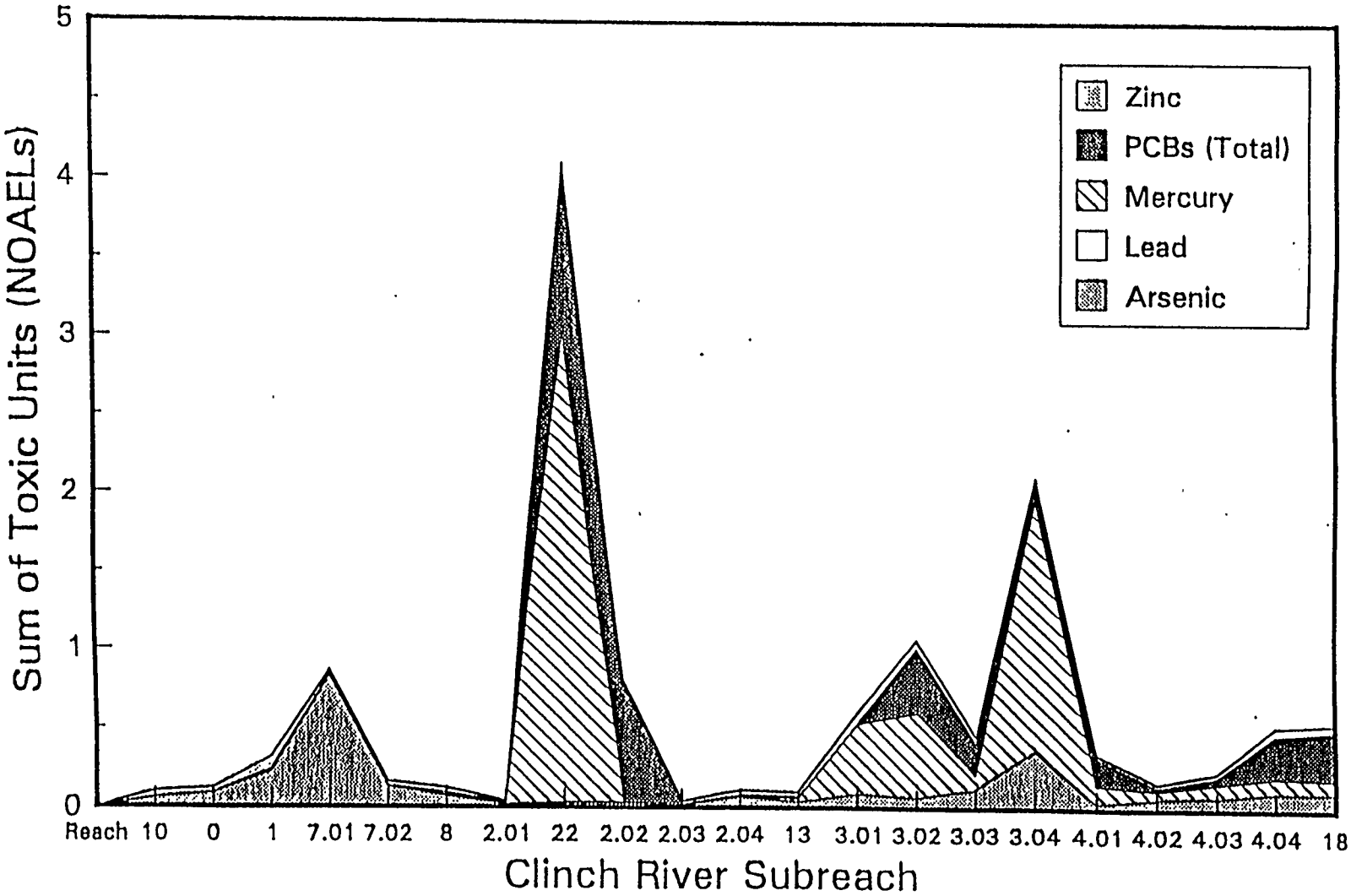


Fig. 6.32. Sum of NOAEL-based toxic units for little brown bats and gray bats.

Screening of water data. More chemicals were detected in Clinch River surface water than in mayflies. To evaluate the risk that these contaminants may present, HQs were calculated for these contaminants using the 95% UCL water concentration and the water consumption benchmarks from Table F5.21. HQs for these contaminants are presented in Table F5.22. No contaminant produced a HQ > 1 for any endpoint in any Clinch River subreach.

Screening Monte Carlo simulation estimates of exposure. To incorporate the variation present in the parameters employed in the Clinch River insectivore exposure model, Monte Carlo simulations were performed for all endpoint-subreach-contaminant combinations where HQs > 1 were observed. The mean, standard deviation, and 80th percentile of the simulated exposures are presented in Table 6.23. Graphical representations of the exposure distributions are presented in Figs 6.33(a-d) and 6.34(a-d). By superimposing NOAEL and LOAEL values on these distributions, the proportion of the population experiencing potentially hazardous exposures, can be identified and the magnitude of risk may be determined. Interpretation of the comparison of exposure distributions to NOAELs and LOAELs is described in Table 6.24.

Table 6.23. Results of Monte Carlo simulation of insectivore contaminant exposure estimates in the Clinch River

			Simulation Results (mg/kg/d)		
Analyte	**Subreach**	**Endpoint**	**Mean**	**Standard Deviation**	**80th Percentile**
Mercury	3.01	Rough-winged Swallow	0.314	2.409	0.418
Mercury	3.02	Rough-winged Swallow	0.048	0.345	0.058
Mercury	3.03	Rough-winged Swallow	0.009	0.064	0.011
Mercury	3.04	Rough-winged Swallow	0.100	0.706	0.121
Mercury	3.01	Little Brown/Gray Bat	0.308	0.073	0.368
Mercury	3.02	Little Brown/Gray Bat	0.045	0.003	0.048
Mercury	3.03	Little Brown/Gray Bat	0.009	0.0006	0.009
Mercury	3.04	Little Brown/Gray Bat	0.094	0.007	0.099

Hg LOAEL for rough-winged swallows = 0.25 mg/kg/d
Hg LOAEL for little brown/gray bats = 0.57 mg/kg/d

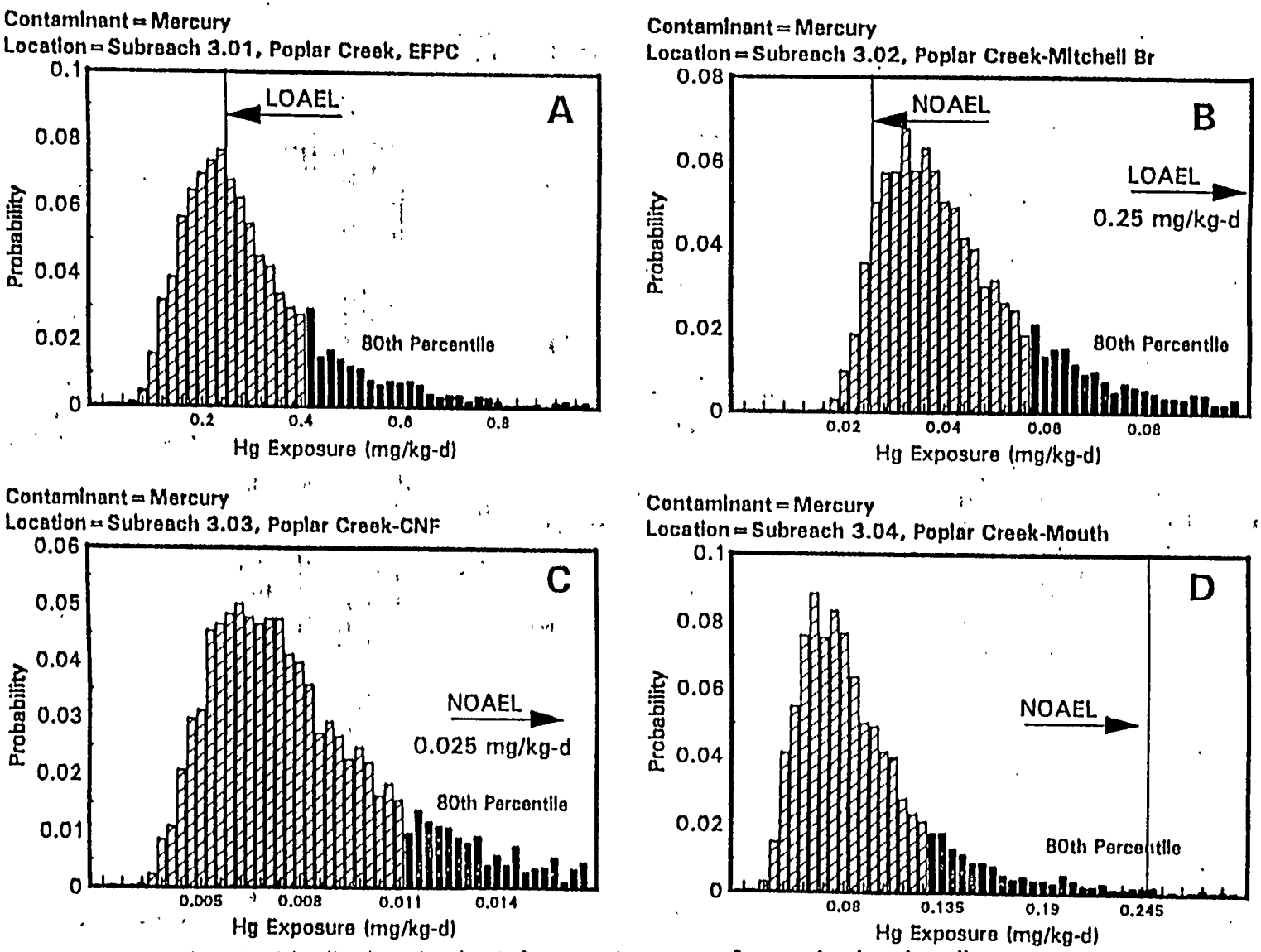


Fig. 6.33. Distribution of estimated mercury exposures for rough-winged swallows.

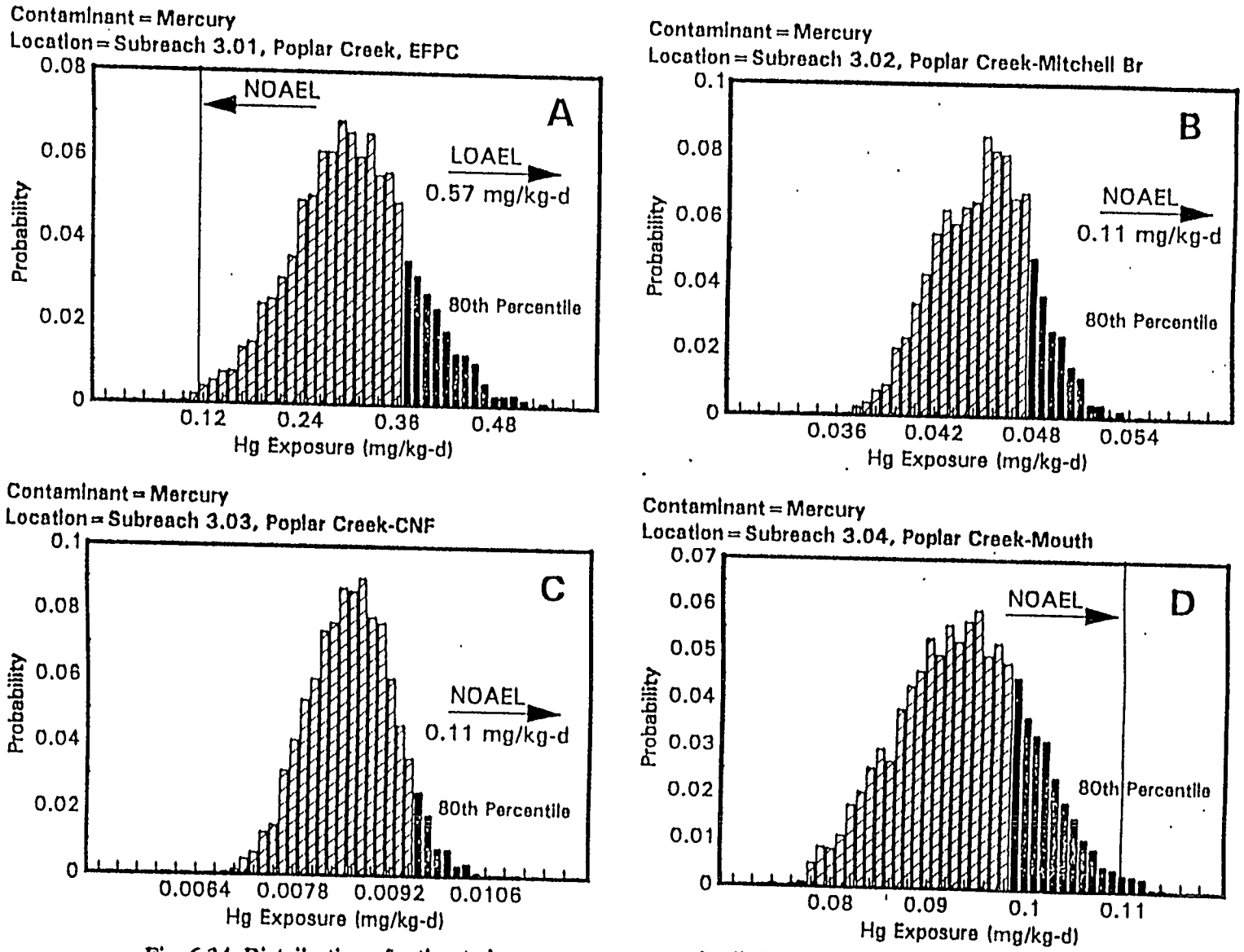


Fig. 6.34. Distribution of estimated mercury exposures for little brown and gray bats.

Table 6.24. Comparison of exposure distributions to NOAELs and LOAELs

Comparison	Meaning	Risk-based Interpretation
NOAEL>80th percentile of exposure distribution	less than 20% of population is experiencing exposures> NOAEL	Individual- and population-level adverse effects are highly unlikely
NOAEL<80th percentile<LOAEL	More than 20% of population is experiencing exposures> NOAEL, but less than 20% is experiencing exposures> LOAEL	While population-level effects are unlikely, individuals exposed to exposures at the high end of the distribution may experience adverse effects.
LOAEL<80th percentile of exposure distribution	More than 20% of population is experiencing exposures > LOAEL	Individual- and population-level adverse effects are likely.

The interpretations described above apply to exposure estimates for populations within a given subreach. In order to determine population-level effects for each endpoint and adequately evaluate risk to the population, home range must be considered. The feeding territory of the rough-winged swallow does not extend over 1/2 mile from the nesting site (Stoner and Stoner 1941). Therefore, it was assumed that there is a colony, equivalent to a distinct population, of rough-winged swallows within each subreach. Consequently, the exposure and effects experienced by individuals may be assumed to be representative of that experienced by the population. In contrast, distinct populations of little brown and gray bats are not likely to be found within single subreaches. Bats have a larger home range and may forage up to 8.5 km upstream or downstream of their caves (LaVal et al. 1977). Therefore, the population level effects must be evaluated based on exposures estimated from foraging within adjacent subreaches or within an entire reach (the entire Poplar Creek). Because the home range of each endpoint is considered in this assessment, population-level effects can be evaluated.

The results from the comparison of exposure distributions with NOAELs and LOAELs are presented in Table 6.25. More than ~60% of the population of rough-winged swallows at subreaches 3.01 may experience mercury exposures in excess of estimated LOAELs (Fig. 6.33a). Consequently, both individual and population-level effects are likely among rough-winged swallows foraging within this subreach. Mercury exposures to swallows foraging from subreach 3.02 exceeded the NOAEL, however, more than 99% of the population experienced exposures less than the LOAEL (Fig. 6.33b). Therefore, it is unlikely that population-level effects would occur. Although unlikely, individual swallows at the upper portion of the distribution could experience adverse effects. Rough-winged swallows foraging from downstream subreaches 3.03 and 3.04 are experiencing mercury exposures less than the NOAEL; thus, adverse effects are unlikely for individuals (Fig. 6.33c and d). The average mercury point estimate exposure (Table F5.8) for swallows foraging in subreach 22 (White Oak Creek Embayment) exceeded the estimated LOAEL by approximately 1.17 times. Therefore, population-level effects could potentially occur if a colony of swallows is foraging in this area.

Table 6.25. Comparison of NOAEL and LOAEL with the exposure distributions of rough-winged swallows and little brown/gray bats

Subreach	Analyte	Percentile > NOAEL	Percentile > LOAEL
Rough-winged Swallows			
3.01	Hg	>99%	~60%
3.02	Hg	~90%	<1%
3.03	Hg	<1%	<1%
3.04	Hg	<1%	<1%
Little Brown/Gray Bats			
3.01	Hg	>99%	<1%
3.02	Hg	<1%	<1%
3.03	Hg	<1%	<1%
3.04	Hg	<5%	<1%

The little brown or gray bat population will unlikely experience adverse effects due to foraging within Poplar Creek. More than 99% of bats feeding in Subreach 3.01, may experience mercury exposures greater than the NOAELs. However, greater than 99% of the exposure distribution was less than the LOAEL (Fig. 6.34a). Therefore, individuals may experience adverse effects if bats forage exclusively from Poplar Creek 3.01. Mercury exposures for bats foraging within subreaches 3.02, 3.03, and 3.04 were less than the NOAEL. Therefore, it is highly unlikely that bats feeding within multiple subreaches are at risk from mercury exposures.

The average mercury and PCB point estimate exposure for little brown or gray bats foraging within subreach 22 was only 60% and 10% of the LOAEL, respectively (Tables F5.13 and F5.14). Therefore, population-level effects are unlikely to occur for bats feeding from subreach 22. However, individuals which are maximally exposed to mercury could potentially experience adverse effects. In contrast, it is unlikely that individuals will experience adverse effects due to PCBs, since the average PCB exposure was equivalent to the NOAEL (HQ=1.01).

Populations of the federally endangered gray bat are generally small and restricted. Therefore, effects which may be experienced by individuals is of particular importance. If more than 20% of the population is experiencing exposures greater than the NOAEL, individuals within that portion of the population could potentially be impacted. Therefore, the local population of gray bats could experience adverse effects from mercury only if foraging occurred exclusively from Poplar Creek 3.01 and White Oak Creek Embayment. Since the bat's home range is much greater than the size of a single subreach, it is highly unlikely that gray bats are at risk.

6.5.3.2 Effects estimation of retained contaminants of concern

Following screening and exposure simulation, mercury was retained as a contaminant of concern for both rough-winged swallows and little brown or gray bats. Additionally, PCBs were retained for gray bats since there is a potential for individuals to experience adverse effects.

Mercury. The NOAEL and LOAEL for rough-winged swallows are based upon a study of the reproductive success and offspring survival of mallard ducks fed methyl mercury for three generations (Heinz 1979). The study was considered to represent chronic exposure; therefore, a subchronic-chronic correction factor was not employed. A single dose level of 0.064 mg/kg/d was administered causing hens to lay fewer eggs, lay more eggs outside the nest box, and produce fewer ducklings. This dose level was selected as the LOAEL. Because an experimental NOAEL was not established, the NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL correction factor of 0.1. The NOAEL and LOAEL for rough-winged swallows are 0.025 and 0.25 mg/kg/d, respectively.

The reproduction of a colony of rough-winged swallows is likely to be impaired due to mercury exposures if they feed exclusively from subreaches 3.01 in Poplar Creek (80th percentile=0.418 mg/kg/d; Fig. 6.33a), and 22 in White Oak Creek Embayment (mean=0.293 mg/kg/d). However, the average mercury exposure experienced by swallows feeding within subreach 22 was only based on one sediment sample collected within White Oak Creek Embayment. Therefore, the potential magnitude of risk estimated within this subreach may not be representative of the entire embayment. Maximally exposed individuals may experience adverse effects as a result of feeding exclusively within subreach 3.02 (80th percentile=0.058 mg/kg/d; Fig. 6.33b). However, since an experimental NOAEL was not established, the nature and exposure level at which effects to individuals may become evident cannot be defined. Also, the effects which may occur, are likely to be less pronounced than that displayed by individuals where exposure greater than the LOAEL.

Both the NOAEL and LOAEL for bats are based upon a study in which reproductive success and offspring survival was observed among rats fed methyl mercury for three generations (Verschuuren et al. 1976a, 1976b, 1976c). The highest dose administered (0.16 mg/kg/d), designated as the LOAEL, resulted in reduction in offspring viability. This exposure also resulted in reduction in growth, increased kidney weight, and altered kidney histochemistry (Verschuuren et al. 1976b). No effects were observed at a dose of 0.032 mg/kg/d. The study was considered to represent chronic exposure; therefore, a subchronic-chronic correction factor was not employed. The NOAEL and LOAEL for little brown bats are 0.114 and 0.56 mg/kg/d, respectively.

The reproduction of individual little brown and gray bats may be impaired due to mercury exposures if bats feed exclusively from subreaches 3.01 in Poplar Creek (80th percentile=0.368 mg/kg/d: Fig. 6.34a) and 22 in White Oak Creek Embayment (mean=0.342 mg/kg/d). However, the average mercury exposure experienced by little brown and gray bats feeding within subreach 22 was only based on one sediment sample collected within White Oak Creek Embayment. Therefore, the potential magnitude of risk estimated within this subreach may not be representative of entire embayment. Additionally, since bats are likely to forage over an area larger than a single subreach, the likelihood that individual bats are at risk from mercury exposure in Poplar Creek and White Oak Creek Embayment is minimal.

PCBs. Both the NOAEL and LOAEL for the little brown bat are based on a study in which reproduction was observed among white-footed mice for 18 months (Linzey 1987). One dose administered, 1.35 mg Aroclor 1254/kg/d in the diet, caused a reduction in the number of offspring per litter and increased the duration between litters. This dosage was considered the chronic LOAEL. A chronic NOAEL was

estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL correction factor of 0.1. The NOAEL and LOAEL for little brown bats were 0.187 and 1.87 mg/kg/d, respectively.

The average point estimates of exposure from PCBs experienced by bats within subreach 22 was only 10% of the LOAEL. Therefore, impacts to the little brown or gray bat populations are unlikely. Furthermore, the average exposure estimate (0.188 mg/kg/d) slightly exceeded the NOAEL having a HQ of only 1.007. Therefore, it is unlikely (although possible) that individuals within the population are experiencing adverse effects. Since an experimental NOAEL was not established, the nature and exposure level at which effects to individuals may become evident cannot be defined. Additionally, other studies have shown that no effects have occurred at much higher levels of exposure for little brown and big brown bats. Clark and Stafford (1981) exposed little brown bats to 15 ppm and 1,000 ppm Aroclor 1260 (5 mg/kg/d and 330 mg/kg/d, respectively) for 40 days. Mortality was only observed within the higher dosage group. Clark (1978) also exposed pregnant big brown bats to 6.36 ppm Aroclor 1260 (4.77 mg/kg/d) for 28 days during a critical life stage. This exposure did not effect the reproductive success (e.g., stillbirths, litter size, litter weight, parturition data) of the bats. Since big brown bats are much larger, and considered more sensitive to toxicants, similar results would be expected for little brown bats. Therefore, it is highly unlikely that adverse effects would result to individuals from exposures experienced within subreach 22.

6.5.3.3 Weight of evidence

Rough-winged swallows. Only one line of evidence, literature toxicity data, was available to evaluate ecological risk to rough-winged swallows. Using only comparisons to benchmarks, the data suggest that reproduction within a colony of rough-winged swallows may be adversely impacted by mercury concentrations in aquatic insects (i.e., mayflies) in subreach 3.01 in Poplar Creek and 22 in White Oak Creek Embayment. Individuals may also be adversely affected from foraging in subreach 3.02 in Poplar Creek. However the magnitude of adverse effects which may occur can not be evaluated. Potential adverse effects which may occur include reduced egg production and hatchability, thinner eggshells, or shell-less eggs.

Little brown and gray bats. Only one line of evidence, literature toxicity data, was available to evaluate ecological risk to bats. Using only comparison to benchmarks, the data suggest that populations of little brown and gray bats are not at risk from contaminant exposure. Although, individuals of little brown and gray bats may be adversely affected by mercury concentrations in aquatic insects (i.e., mayflies) within subreaches 3.01 and 22. Individuals may be at risk only if foraging takes place exclusively within those subreaches. This is highly unlikely since the foraging range of bats is approximately 8.5 km from the roost (LaVal et al. 1977).

6.5.4 Uncertainties Concerning Risks to Insectivorous Wildlife

Bioavailability of contaminants. It was assumed that 100% if the contaminant concentration reported in mayflies and water was bioavailable. Much of the biotic media are bioavailable; however, the uptake efficiencies for wildlife may not be 100%. Therefore, exposure estimates based upon the contaminant concentrations in media are conservative and are likely to overestimate the actual contaminant exposure experienced.

Extrapolation from published toxicity data. There are no published NOAELs for rough-winged swallows and little brown or gray bats. To estimate toxicity of contaminants at the site, it was necessary to extrapolate from NOAELs observed for test species (i.e., mallard ducks and rats). While it was assumed that toxicity could be estimated as a function of body size, the accuracy of the estimate is not

known. For example, rough-winged swallows and bats may be more or less sensitive than mallard ducks and rats.

Additional extrapolation uncertainty exists for those contaminants for which data consisted of either LOAELs or was subchronic in duration. For either case, an uncertainty factor of 10 was employed to estimate NOAELs or chronic data. The uncertainty factor of 10 may either over- or underestimate the actual LOAEL-NOAEL or subchronic-chronic relationship.

Variable food and water consumption. While food consumption by wildlife was assumed to be similar to that reported for the same species in other locations (Nagy 1987 - swallows; Anthony and Kunz 1977 - little brown/gray bats), the validity of this assumption cannot be determined. Food consumption at the CR/PC may be greater or less than that reported in the literature, resulting in either an increase or decrease in contaminant exposure. Similarly, water consumption was estimated according to the allometric equations of Calder and Braun (1983). The accuracy with which the estimated water consumption represents actual water consumption is unknown.

Single contaminant tests vs exposure to multiple contaminants in the field. While swallows and bats at the Clinch River are exposed to multiple contaminants concurrently, published toxicological values only consider effects experienced by exposures to single contaminants. Because some contaminants to which wildlife are exposed can interact antagonistically, single contaminant studies may overestimate their toxic potential. Similarly, for those contaminants that interact synergistically, single contaminant studies may underestimate their toxic potential.

Inorganic constituents or species present in the environment. Toxicity of metal species varies dramatically depending upon the valence state or form (organic or inorganic) of the metal. For example, Arsenic (III) and methyl mercury are more toxic than arsenic (V) and inorganic mercury, respectively. The available data on the contaminant concentrations in media do not report which species or form of contaminant was observed. Because benchmarks used for comparison represented the more toxic species/forms of the metals (particularly for arsenic and mercury), if the less toxic species/form of the metal was actually present in mayflies from the Clinch River or Poplar Creek, potential toxicity at the sites may be overestimated.

Dietary composition of insectivorous wildlife. This assessment assumed that the diet of the little brown and gray bat was composed of 100% mayflies or similar aquatic insects. The concentration found in mayflies was assumed to be representative of other aquatic aerial insects at the site. In contrast, rough-winged swallows feed on a variety of aquatic and terrestrial insects. Beal (1918) documented that only 37.93% of the diet of rough-winged swallows consists of aquatic insects, specifically dipterans and emphemeropterans. Therefore, it was assumed that the contaminant concentrations found in mayflies was representative of the 37.93% of the diet and the remainder of the diet was considered uncontaminated (since terrestrial insects would not have contact with the sediment). Thus, the exposure calculations for both bats and swallows may over or underestimate the contaminant exposure obtained feeding from aquatic insects.

Food source availability. Since the abundance of mayflies vary temporally, it was assumed that concentrations found in mayflies are similar to other aquatic insects at the site. The concentrations in the aquatic insect diet may vary from those used to calculate exposure. Therefore, the exposure may be overestimated or underestimated for swallows and bats.

Monte Carlo simulation. To perform Monte Carlo simulations, distributions must be assigned to parameters. The sediment distribution was assumed to be log normal; this is a standard accepted

distribution for abiotic media concentrations. In cases where a distribution was calculated based on only a few sediment samples, the variance within the model was enhanced.

The literature values used for body weights of each endpoint are nationwide values which may overestimate or underestimate the body weight of species found at the site.

Estimated mayfly concentrations. The concentrations predicted in mayflies with the use of sediment-mayfly uptake factors may underestimate or overestimate exposure depending on the representativeness of the sediment concentrations within each subreach. The uptake factors are only based on an average of measured contaminant concentrations in four mayfly samples from four locations. Additionally, a small sample size for sediments may not be representative of the contaminant concentrations found within an entire subreach. Therefore, the risk predicted may not be representative for that entire foraging area.

Presence of a rough-winged swallow colonies within each subreach. This risk assessment assumed that there was a swallow colony (equivalent to a distinct population) present and foraging exclusively within each subreach. This assumes that there is suitable habitat present for swallows to nest. Although, there may not be adequate burrow locations present within the majority of Poplar Creek or White Oak Creek Embayment, swallows will also utilize bridges and crevices in rock cliffs. Moreover, colonies of swallows have been observed frequently on most locations within these areas.

6.6 RISKS FROM DREDGED SPOIL

6.6.1 Exposure Assessment of Dredged Spoil

This assessment evaluates the hypothetical scenario where sediments within the Clinch River or Poplar Creek are dredged and deposited on land. The dredged spoil would then provide a potential pathway for ecological receptors. Any terrestrial ecosystem that developed on the dredged spoils would be exposed to contaminants in those sediments from which the spoil was derived. The spoil is assumed to be derived from mixed deep water sediments where irrigation will not take place. Vegetation can become established on the spoil, bioaccumulate contaminants, and then be consumed by herbivorous wildlife (e.g., eastern cottontail) (Fig. 6.2). For additional information on this scenario see the human health risk assessment (Sect. 5.2.3.6).

6.6.1.1 Characterization of exposure environment and routes

Plants. The main exposure route for plants is uptake of contaminants from the spoil through the roots. This may occur in a passive mode as the plant takes up water for respiration or by active uptake mechanisms. Volatile organic contaminants in the spoil may potentially enter the plant through leaf stomata or the plant cuticle. Another potential route of exposure is through association of contaminants with airborne spoil particles (dust).

Herbivorous wildlife. Potential routes of exposure for herbivorous wildlife include ingestion of contaminated vegetation and surface water. In addition, some species may ingest soil incidentally while foraging or purposefully to meet nutrient needs. The total exposure experienced by terrestrial wildlife is represented by the sum of the exposure from each individual source (e.g., vegetation, spoil, water).

6.6.1.2 Quantification of exposure

Plants. The contaminant concentrations found in the sediments is assumed to represent the total potential reservoir of elements and compounds available for plant uptake in the future dredge scenario. The future bioavailability of these contaminants which is dependent upon the chemical (e.g., pH, organic carbon) and physical (e.g., clay, moisture content) nature of the spoil can not be addressed for this assessment. This assessment assumes that the measured concentrations in the deep sediments are estimates of exposure equivalent to the soil concentrations causing toxic effects in laboratory studies.

Herbivorous wildlife. The primary pathway of contaminant exposure is through oral ingestion of food and soil. Consumption of surface water, in most cases, is considered a pathway which contributes minimal contaminant exposure. Additionally, it is unlikely that rabbits will be ingesting water from the Clinch River due to inaccessibility from the presence of high river banks. For the purpose of this scenario, it is assumed that wildlife will be obtaining uncontaminated drinking water from smaller bodies of water offsite. Therefore, the total oral exposure model for herbivorous wildlife is as follows:

$$E_j = \left(\frac{IR_v \times C_{v\text{-}j}}{BW}\right) + \left(\frac{IR_s \times C_{s\text{-}j}}{BW}\right)$$

Where:

E_j = exposure to contaminant (j) (mg/kg/d)
IR_v = ingestion rate of vegetation (mg/d)
$C_{v\text{-}j}$ = contaminant concentration (j) in vegetation (mg/kg)
BW = body weight (kg)
$C_{s\text{-}j}$ = contaminant concentration (j) in spoil (mg/kg)
IR_s = ingestion rate of spoil (mg/d)

The eastern cottontail was identified as the herbivorous wildlife endpoint. Species-specific parameters necessary to estimate exposure using the above equation are listed in Table F6.1.

Contaminant concentrations in biotic and abiotic media. Contaminant concentrations in vegetation and sediment are needed to estimate exposure. Deep water sediment data originated from cores during the CRRI Phase 1 (Cook et al. 1992) and Phase 2 (Table F6.2). Individual core concentrations were calculated from mass-weighted averages over the entire length of the core. The 95% UCL or maximum concentration (whichever was lower) from all cores within each subreach (1, 7, 2.04, 3.01, 3.02, 3.03, 3.04, 4.01, 4.02, 4.03, and 4.04) were used to estimate exposure for incidental ingestion. Initially, the maximum sediment concentration was compared to background concentrations (Table F6.3). Reach 13, an upstream reference site, was designated as representive background levels uninfluenced by DOE effluents. For contaminants which exceeded background, the 95% UCL or maximum contaminant concentrations in sediment and vegetation was used to calculate exposure from food ingestion. Leafy vegetables [modeled for the human health risk assessment (Sect. 5.2.3.6)], or soil-plant uptake factors were used to estimate exposure from ingestion of vegetation. Soil-plant uptake factors calculated for flouranthene, dibenzofuran, naphtalene, phenathrene, and acenaptheylene were derived from the log octanol-water partition coefficient (log K_{ow}) using the following equation (Travis and Arms 1988):

$$\text{Log } B_v = 1.588 - 0.578 \log K_{ow}$$

where:

B_v = Bioaccumulation factor for vegetation

K_{ow} = Octanol Water Partitioning Coefficient (Source: Hull and Suter 1994).

Copper and lead soil-plant uptake factors were derived from Baes et al. (1984) and the uranium soil-plant uptake factor was calculated based on concentrations found in collocated soil and vegetation samples on Lower East Fork Poplar Creek (SAIC 1995).

Exposure modeling using point-estimates. To estimate contaminant exposure experienced by eastern cottontails feeding on the spoil in each reach, the following assumptions were made:

(1) body weight = 1.2 kg
(2) food consumption = 0.237 kg/d
(3) spoil consumption = 0.015 kg/d
(4) diet consists 100% of vegetation
(5) 100% of the habitat available is suitable and
(6) home range is smaller than the size of the contaminated area (i.e., 100% of time is spent within the contaminated area.

Using the herbivorous exposure model, assumptions, and data described above, exposure of contaminants was estimated for the eastern cottontail foraging on the future spoil created within each subreach. Exposure estimates for analytes in sediments above background concentrations are presented in Table F6.4.

Exposure modeling using Monte Carlo simulations. Employing point estimates for the input parameters in the Clinch River herbivore exposure model does not take into account the variation and uncertainty associated with the parameters and may over or under estimate the contaminant exposure that endpoints may receive in any given subreach. In addition, calculating the model using point estimates produced a point estimate of exposure. This estimate provides no information concerning the distribution of exposures or the likelihood that individuals within a subreach will actually experience potentially hazardous exposures. To incorporate the variation in exposure parameters and to provide a better estimate of the potential exposure experienced by herbivores in each subreach, the exposure model was re-calculated using Monte Carlo simulations.

Monte Carlo simulations of exposure estimates were performed for all subreach-contaminant combinations where comparison of point exposure estimates to NOAELs produced HQs ≥ 1 (Table 6.26) (NOAELs are presented in Sect 6.6.2.1; Screening of exposure estimates against NOAELs is presented in Sect. 6.6.3.1).

Distributions were used for the following parameters in the spoil herbivore exposure model: (1) eastern cottontail body weight and (2) contaminant concentrations in sediment (spoil). The body weight distributions of the eastern cottontail was assigned a triangular distribution and the sediment distribution was normal (Table 6.27). The vegetation concentrations were either the PLE 95% UCLs or the maximum values. Because wildlife are mobile and are more likely to be exposed to average concentrations and not to the extreme values, the standard error of the mean was used to describe variation for contaminant concentrations. All other distributions employed the standard deviation. The food consumption rate and incidental ingestion of soil rate used in the exposure model were average values.

Table 6.26. Monte Carlo simulations of exposure estimates

SUBREACH	CONTAMINANTS
1: Lower Melton Hill	As, Cd
7: McCoy Branch	As, Cd, Se, Tl, V
2.04: Clinch River (Grassy Creek to Poplar Creek)	As, Cd, Mn, Se,
3.02: Poplar Creek below Mitchell Branch	Cd, Hg
3.03: Poplar Creek below CNF outfall	Cd, Hg
3.04: Poplar Creek Mouth (below ash disposal)	Ba, Cd, Hg, Se, Tl, V
4.01: Clinch River (Poplar Creek to below Brashear Island)	As, Cd, Hg, PCB-1260
4.02: Clinch River (below Brashear Island to Emory River)	As
4.03: Clinch River (Emory River to Kingston City Park)	As, Cd, Hg
4.04: Mouth of Clinch River	As, Cd, Hg

Table 6.27. Herbivorous body weight distribution

Endpoint	Distribution	Mean (kg)	Standard Deviation	Range (kg)	Source
Eastern Cottontail	triangular	1.244		0.842-1.533 based on ♀	Chapman et al. 1980

6.6.2 Effects Assessment of the Dredged Spoil

Effects assessment involves the identification of known effects of contaminants on plants and herbivorous wildlife using ecotoxicological benchmarks. The types, development, and interpretation of appropriate toxicological benchmarks are discussed and available toxicity data relevant to plants and wildlife are summarized in toxicity profiles for COPECs. Conventional toxicity data consists of published values for toxicity of contaminants to test species. These data are used in the development of toxicological benchmarks which are used to determine if biological effects are likely. Contaminant exposures are compared to benchmarks to obtain HQs used in the risk characterization.

6.6.2.1 Toxicological benchmarks

Plants. Contaminant concentrations in the future spoil within each subreach were compared to toxicological benchmarks in order to determine if contaminants could produce adverse effects on the plant community. Tests conducted in natural soils are assumed to be representative of the exposure of plants to contaminants measured in the spoil.

Growth and yield parameters were used from phytotoxicity studies for the derivation of the benchmarks. These parameters are direct estimates of the assessment endpoint for plants. Twenty percent reduction in growth or yield was used as the threshold for significant effects to be consistent with other screening benchmarks for ecological risk assessment. Additionally, the FFA parties adopted this level of effects for ecological endpoints (Suter et al. 1994).

The method used for the derivation of soil benchmarks (Will and Suter 1994) is based on the National Oceanographic and Atmospheric Administration's method for deriving the ER-L (Long and Morgan 1991) which has been recommended as a sediment screening benchmark by EPA Region IV. The ER-L is the tenth percentile of the distribution of various toxic effects thresholds for various organisms in sediments.

The phytotoxicity benchmarks were derived by rank ordering EC_{20} values for plant growth or production and then identifying a number that approximated the tenth percentile (Will and Suter 1994). As with the ER-Ls, statistical fitting was not used because there was seldom sufficient data and because these benchmarks are to be used as screening values and do not require the consistency and precision of regulatory criteria. Screening benchmarks for phytotoxic effects of contaminants present in the future spoils are presented in Table F6.5.

Herbivorous wildlife. To determine if the contaminant exposures experienced by eastern cottontail foraging on future spoils could produce adverse effects, exposure estimates are compared to NOAELs and LOAELs derived according to the methods outlined by Opresko et al. (1994) and EPA (1993b). NOAELs represent the highest exposure at which no adverse effects were observed among the animals tested. LOAELs represent the lowest exposure at which significant adverse effects are observed.

Toxicological studies of the effects of contaminants observed in the spoil were obtained from the open literature. Only studies of long-term, chronic oral exposures were used to estimate the NOAEL. To make the NOAELs relevant to possible population effects, preference was given to studies that evaluated effects on reproductive parameters. In the absence of a reproduction endpoint, studies that considered effects on growth, survival, and longevity were used. The NOAELs and LOAELs for eastern cottontails and the studies which derived them are located in Table F6.6. This table presents only the NOAELs and LOAELs for contaminants which had HQs greater than 1. Specific details on development of the NOAELs and LOAELs for all wildlife endpoints are discussed in Sect. 6.4.2.1.

6.6.2.2 Ecotoxicological profiles for plants

Several elements for which analytical data are available are plant macronutrients and there is no evidence of potential plant toxicity. Therefore, no benchmarks have been established for these elements and no toxicity profiles will be given. These macronutrients include calcium, magnesium, and potassium. Toxicity profiles are presented for chemicals occurring in soil at concentrations exceeding benchmarks and background for toxicity to plants (Table F6.5). There are many organic contaminants which were detected in sediment for which we have no information to offer. These contaminants include: 4,4'-DDD, 4,4'-DDT, 1,4-dichlorobenzene, 2-methylnapthalene, 4-methylphenol, 4-nitrophenol, 4-chloro-3-methylphenol, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, benzoic acid, bis(2-ethylhexyl)phthalate, carbazole, chrysene, delta-BHC, di-n-octylphthalate, dibenzofuran, dibenz(a,h)anthracene, dimethylphthalate, diethylphthalate, fluoranthene, fluorene, heptachlor, indeno(1,2,3-cd)pyrene, methoxychlor, napthalene, N-nitrosodiphenylamine, pentachlorophenol, phenathrene, phenol, pyrene, and toxaphene.

The ecotoxicological profiles for contaminants of potential ecological concern for plants may be found in Appendix F1. Contaminants include arsenic, boron, cadmium, chromium, manganese, mercury, nickel, selenium, silver, uranium, vanadium, and zinc.

6.6.2.3 Ecotoxicological profiles for herbivorous wildlife

The ecotoxicological profiles for contaminants of potential ecological concern for herbivorous wildlife may be found in Appendix F1. Contaminants include arsenic, barium, cadmium, manganese, mercury, PCB-1260, selenium, thallium, and vanadium. There are many organic contaminants which were detected in sediment and modeled in vegetation for which we have no information to offer. These contaminants include: 1,4-dichlorobenzene, 2-methylnapthalene, 4-methylphenol, 4-nitrophenol, 4-chloro-3-methylphenol, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, benzoic acid, carbazole, chrysene, delta-BHC, di-n-octylphthalate, dibenzofuran, dibenz(a,h)anthracene, dimethylphthalate, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, methoxychlor, napthalene, N-nitrosodiphenylamine, pentachlorophenol, phenathrene, phenol, pyrene, and toxaphene. Therefore, potential adverse effects from exposure to these contaminants can not be evaluated.

6.6.3 Risk Characterization for the Dredged Spoil

Risk characterization integrates the results of the exposure assessment (Sect. 6.6.1) and effects assessment (Sect. 6.6.2) to estimate risks (the likelihood of effects given the exposure). Procedurally, the risk characterization in this assessment is performed for each assessment endpoint by (1) screening all measured contaminants against toxicological benchmarks, (2) estimating the effects of the contaminants retained by the screening analysis, (3) listing and discussing the uncertainties in the assessment. There is only one line of evidence, single chemical toxicity data, available to evaluate the risks to plants and eastern cottontails inhabiting the future spoil within each subreach.

6.6.3.1 Single chemical toxicity data for plants

COPECs in the spoil were identified by comparing the maximum chemical concentrations measured in sediments to phytotoxicity benchmarks to derive HQs by the formula

HQ = media concentration / toxicological benchmark.

HQs greater than 1 suggest that the chemical may be hazardous to the plants that may grow on the spoil. HQs less than 1 suggest that the chemical is nonhazardous and need not be considered further. Benchmarks for plants growing in soils, contaminant concentrations found in the future spoil, and HQs for these contaminants are given in Table F6.5. The COPECs which may pose a risk to plants within each subreach are listed in Table 6.28.

The contaminants in sediment within each subreach listed in Table 6.28 exceeded background concentrations and phytotoxicity benchmarks (Will and Suter 1994). These analyte concentrations have caused toxic effects when added to surface soils. The specific effects for each contaminant may be found in the ecotoxicological profiles found in Appendix F1. The magnitude of the COPEC HQ indicates the contaminants which would contribute the most risk to plants inhabiting the spoil.

Table 6.28. COPECs which may pose a risk to plants within each subreach

Subreach	COPEC	Hazard Quotient
1	Arsenic	1.1
7	Arsenic	6.4
	Chromium	58.6
	Manganese	3.2
	Selenium	9.5
	Vanadium	21.3
2.04	Arsenic	1.02
	Manganese	9
	Selenium	2.4
3.02	Mercury	20.3
	Nickel	2.4
	Selenium	1.4
	Uranium	3.3
	Zinc	3
3.03	Cadmium	1.1
	Chromium	44.4
	Mercury	22.2
	Nickel	2.1
	Silver	1.7
	Uranium	1.7
	Zinc	3.2
3.04	Arsenic	9.4
	Boron	87.7
	Cadmium	1.9
	Chromium	39.2
	Mercury	85.6
	Nickel	1.7
	Selenium	1.6
	Uranium	3.2
	Vanadium	29.6
4.01	Mercury	40.5
4.02	Arsenic	1.1
4.03	Chromium	36.9
	Manganese	3.1
	Mercury	11.7
4.04	Arsenic	1.2
	Chromium	33.4
	Manganese	4
	Mercury	18.5
	Zinc	3.1

6.6.3.2 Single chemical toxicity data for herbivorous wildlife

Two types of single chemical toxicity data are available with which to evaluate herbivore contaminant exposure: NOAELs and LOAELs. The total contaminant exposure estimates (Table F6.4) for eastern cottontails feeding on the spoils were compared to estimated NOAELs to determine if adverse effects are possible. The comparison of estimated exposure and the NOAEL acts as a screening tool to identify contaminants of concern which will be further evaluated for possible estimated effects (i.e., exposure modeling using Monte Carlo simulation). LOAELs are compared to the exposure distribution generated by the Monte Carlo simulation. If the LOAEL is lower than the 80th percentile of the exposure distribution, more than 20% of the endpoint population is experiencing contaminant exposures that are likely to produce adverse effects. Consequently, population-level effects to eastern cottontails are likely.

Screening point estimates of exposure. To determine if the contaminant exposures experienced by cottontails feeding on the future spoils along the Clinch River and Poplar Creek are potentially hazardous, the total exposure estimates (Table F6.4) were compared to estimated NOAELs. HQs were calculated to quantify the magnitude of the hazard where: HQ = estimated exposure/NOAEL. HQs greater than one indicate that individuals may be experiencing exposures that are in excess of NOAELs, and may suggest that adverse effects may be occurring. HQs for cottontails are presented along with exposure estimates in Table F6.4.

The spatial distribution of contamination and potential risks to cottontails at spoils for each Clinch River subreach are illustrated in Fig. 6.35. This figure displays the sum of the NOAEL-based HQs (e.g., sum of toxic units or ΣTUs) for the most important contaminants. Arsenic, cadmium, and mercury are the primary contaminants contributing to risk. However, barium, manganese, PCB-1260, selenium, thallium, and vanadium also contribute to overall risk at several locations. Importance of contaminants was determined based on the magnitude of the HQs. River subreaches were arranged from upstream to downstream locations. A summary of the subreaches where HQs greater than 1 were observed is listed in Table 6.29 for each contaminant.

Screening Monte Carlo simulation estimates of exposure. To incorporate the variation present in the parameters employed in the Clinch River herbivorous exposure model, Monte Carlo simulations were performed for subreach-contaminant combinations where HQs greater than 1 were observed. The mean, standard deviation, and 80th percentile of the simulated exposures are presented in Table 6.30. By superimposing NOAEL and LOAEL values on these distributions, the proportion of the population experiencing potentially hazardous exposures, can be identified and the magnitude of risk may be determined. Interpretation of the comparison of exposure distributions to NOAELs and LOAELs is described in Table 6.31. The results from the comparison of exposure distributions with NOAELs and LOAELs are presented in Table 6.32.

The eastern cottontail population may be adversely impacted if foraging occurred on the future spoil within subreaches 1, 7, 3.02 3.03, 3.04, 4.01, 4.03, and 4.04. More than 99% of the population is projected to be exposed to mercury (subreaches 3.03, 3.04, and 4.01) and cadmium (subreaches 1, 7, 3.02, 3.03, 3.04, 4.03, and 4.04) in excess of the estimated LOAELs (Figures 6.36–6.44). Conversely, less than 1% of the population of cottontails feeding at the spoil within reach 7 may experience thallium exposures in excess of the NOAEL. Additionally, less than 10% of the population of cottontails feeding at the spoil in subreach 3.04 may experience barium exposure in excess of the NOAEL. Therefore, adverse individual and population-level effects from thallium and barium exposure in subreaches 7 and 3.04, respectively, are highly unlikely. The exposures for all other contaminants within subreaches 1, 7, 2.04, 3.02, 3.03, 3.04, 4.01, 4.02, 4.03, and 4.04, exceeded NOAELs while not exceeding LOAELs. Therefore, while adverse effects to the population within each subreach is unlikely, adverse effects may be displayed among individuals that experience exposures at the upper extremes of the distributions.

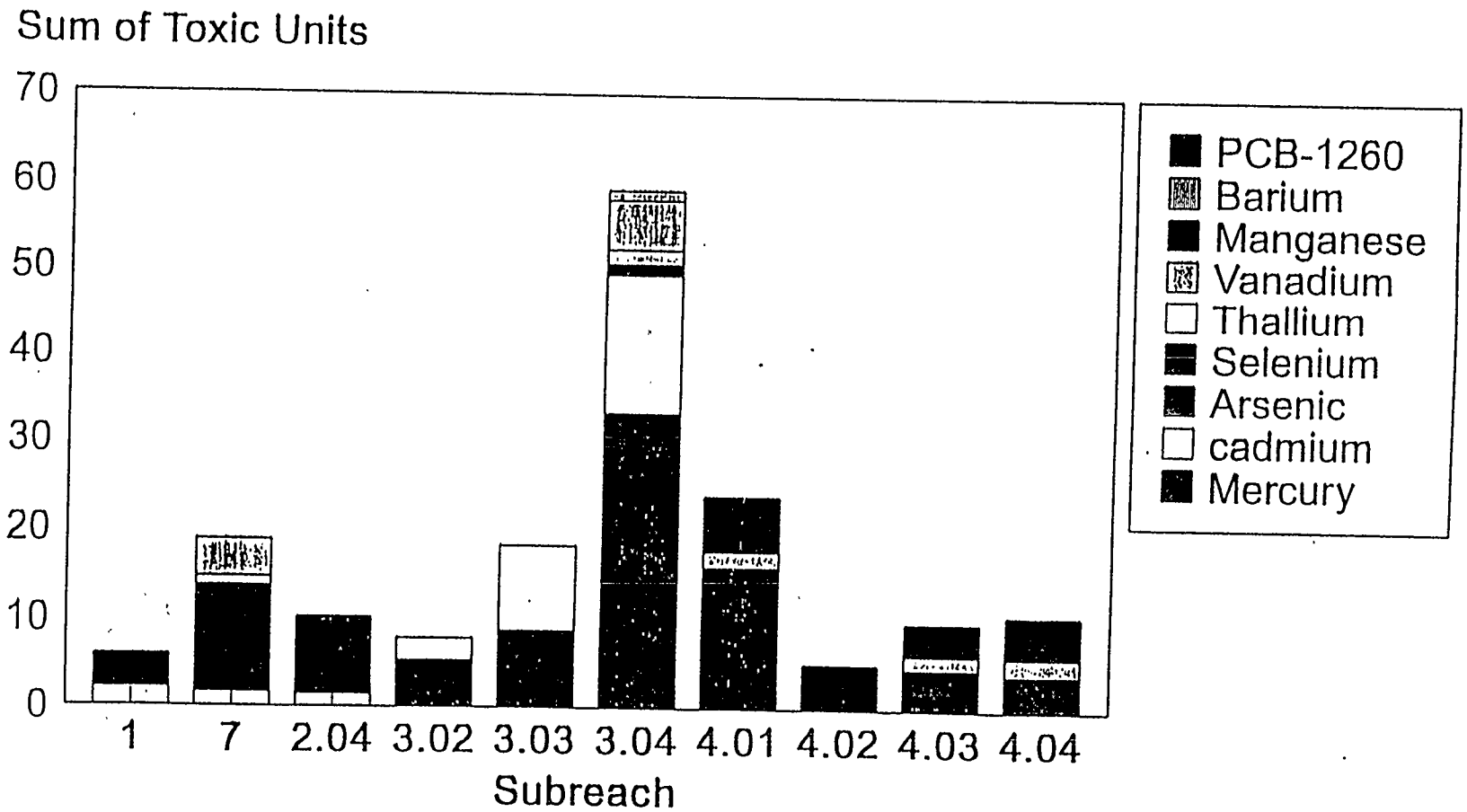


Fig. 6.35. Sum of NOAEL-based toxic units for evaluation of risks to Eastern Cottontails foraging on dredge spoils within each subreach.

Table 6.29. Summary of subreaches where HQs >1 were observed for each contaminant

SUBREACH	COPEC	Hazard Quotient
1	Arsenic	3.8
	Cadmium	2.1
7	Arsenic	9.1
	Cadmium	1.6
	Selenium	2.8
	Thallium	1.1
	Vanadium	4.2
2.04	Arsenic	4.4
	Cadmium	1.4
	Manganese	2.5
	Selenium	1.9
3.02	Cadmium	2.64
	Mercury	5.3
3.03	Cadmium	9.6
	Mercury	8.7
3.04	Barium	1.1
	Cadmium	16.2
	Mercury	33.2
	Selenium	1.2
	Thallium	1.8
	Vanadium	5.8
4.01	Arsenic	4.5
	Cadmium	1.9
	Mercury	15.9
	PCB-1260	1.7
4.02	Arsenic	5.1
4.03	Arsenic	3.6
	Cadmium	1.7
	Mercury	4.6
4.04	Arsenic	4.7
	Cadmium	2.1
	Mercury	4

Table 6.30. Summary of Monte Carlo simulation for eastern cottontails exposed to contaminants in dredge spoils

Subreach	Analyte	Media Concentrations (mg/kg)			Simulation Results (mg/kg/d)			LOAEL Benchmark (mg/kg/d)
		Mean Spoil	Spoil (Standard Deviation)	Vegetation (Mean)	Mean	Standard Deviation	80th Percentile	
1	As	8.02	3.014	0.013	0.104	0.040	0.139	0.37
	Cd	0.572	0.155	0.007	0.009	0.002	0.010	0.007
7	As	16.67	5.374	0.03	0.214	0.073	0.273	0.37
	Cd	0.46	0.057	0.005	0.007	0.001	0.008	0.007
	Se	2.03	0.88	0.095	0.045	0.013	0.055	0.22
	Tl	0.04	0.03	0	0.000	0.000	0.001	0.05
	V	36.75	5.903	0.047	0.472	0.093	0.547	1.3
2.04	As	6.42	1.41	0.011	0.083	0.021	0.100	0.37
	Cd	0.34	0.06	0.005	0.005	0.001	0.006	0.007
	Mn	2716	1067	450	124.121	20.309	140.181	189
	Se	1.06	0.69	0.063	0.026	0.009	0.033	0.22
3.02	Hg	1.68	1.12	0.31	0.083	0.017	0.097	0.11
	Cd	0.51	0.19	0.009	0.008	0.003	0.010	0.007
3.03	Hg	6.67		0.5	0.184	0.023	0.202	0.11
	Cd	3.31	-	0.034	0.049	0.006	0.054	0.007
3.04	Ba	195.4	53.7	0.95	2.679	0.764	3.307	13.2
	Cd	2.39	1.6	0.057	0.042	0.021	0.058	0.007
	Hg	12.45	6.66	1.9	0.534	0.108	0.621	0.11
	Se	1.03	0.27	0.041	0.021	0.004	0.025	0.22
	Tl	0.41	0.16	0	0.005	0.002	0.007	0.05
	V	37.79	11.83	0.065	0.490	0.158	0.616	1.3

Table 6.30 (continued)

Subreach	Analyte	Media Concentrations (mg/kg)			Simulation Results (mg/kg/d)			LOAEL Benchmark (mg/kg/d)
		Mean Spoil	Spoil (Standard Deviation)	Vegetation (Mean)	Mean	Standard Deviation	80th Percentile	
4.01	As	5.38	2.34	0.011	0.070	0.031	0.095	0.37
	Cd	0.36	0.15	0.007	0.006	0.002	0.008	0.007
	Hg	4.56	3.81	0.92	0.241	0.057	0.286	0.11
	PCB-1260	0.7	0.68	0.003	0.009	0.009	0.016	0.16
4.02	As	11.2		0.013	0.144	0.018	0.158	0.37
4.03	As	6.56	1.28	0.009	0.084	0.019	0.100	0.37
	Cd	0.58	0.02	0.006	0.009	0.001	0.009	0.007
	Hg	3.36	0.16	0.27	0.096	0.012	0.106	0.11
4.04	As	9.36	0.536	0.012	0.120	0.016	0.134	0.37
	Cd	0.58	0.078	0.007	0.009	0.001	0.010	0.007
	Hg	2.47	0.33	0.23	0.077	0.010	0.085	0.11

Table 6.31. Comparison of exposure distribution to NOAELs and LOAELs

Comparison	Meaning	Risk-based Interpretation
NOAEL>80th percentile of exposure distribution	less than 20% of population is experiencing exposures> NOAEL	Individual- and population-level adverse effects are highly unlikely
NOAEL<80th percentile<LOAEL	More than 20% of population is experiencing exposures> NOAEL, but less than 20% is experiencing exposures> LOAEL	While population-level effects are unlikely, individuals exposed to exposures at the high end of the distribution may experience adverse effects.
LOAEL<80th percentile of exposure distribution	More than 20% of population is experiencing exposures< LOAEL	Individual- and population-level adverse effects are likely.

Table 6.32. Results from the comparison of exposure distributions with NOAELs and LOAELS

Subreach	Analyte	Percentile> NOAEL	Percentile > LOAEL
1	As	>95%	<1%
	Cd	>95%	~75%
7	As	>99%	<1%
	Cd	>95%	>35%
	Se	>95%	<1%
	Tl	<1%	<1%
	V	>99%	<1%
2.04	As	>99%	<1%
	Cd	>55%	<5%
	Mn	>99%	<1%
	Se	>60%	<1%
3.02	Cd	>90%	>65%
	Hg	>99%	<5%
3.03	Cd	>99%	>99%
	Hg	>99%	>99%
3.04	Ba	<10%	<1%

Table 6.32 (continued)

Subreach	Analyte	Percentile> NOAEL	Percentile > LOAEL
	Cd	>99%	>99%
	Hg	>99%	>99%
	Se	>30%	<1%
	Tl	>50%	<1%
	V	>99%	<1%
4.01	As	>85%	<1%
	Cd	>65%	>25%
	Hg	>99%	>99%
	PCB-1260	~20%	<1%
4.02	As	>99%	<1%
4.03	As	>99%	<1%
	Cd	>99%	>99%
	Hg	>99%	<15%
4.04	As	>99%	<1%
4.04	Cd	>99%	>85%
	Hg	>99%	<1%

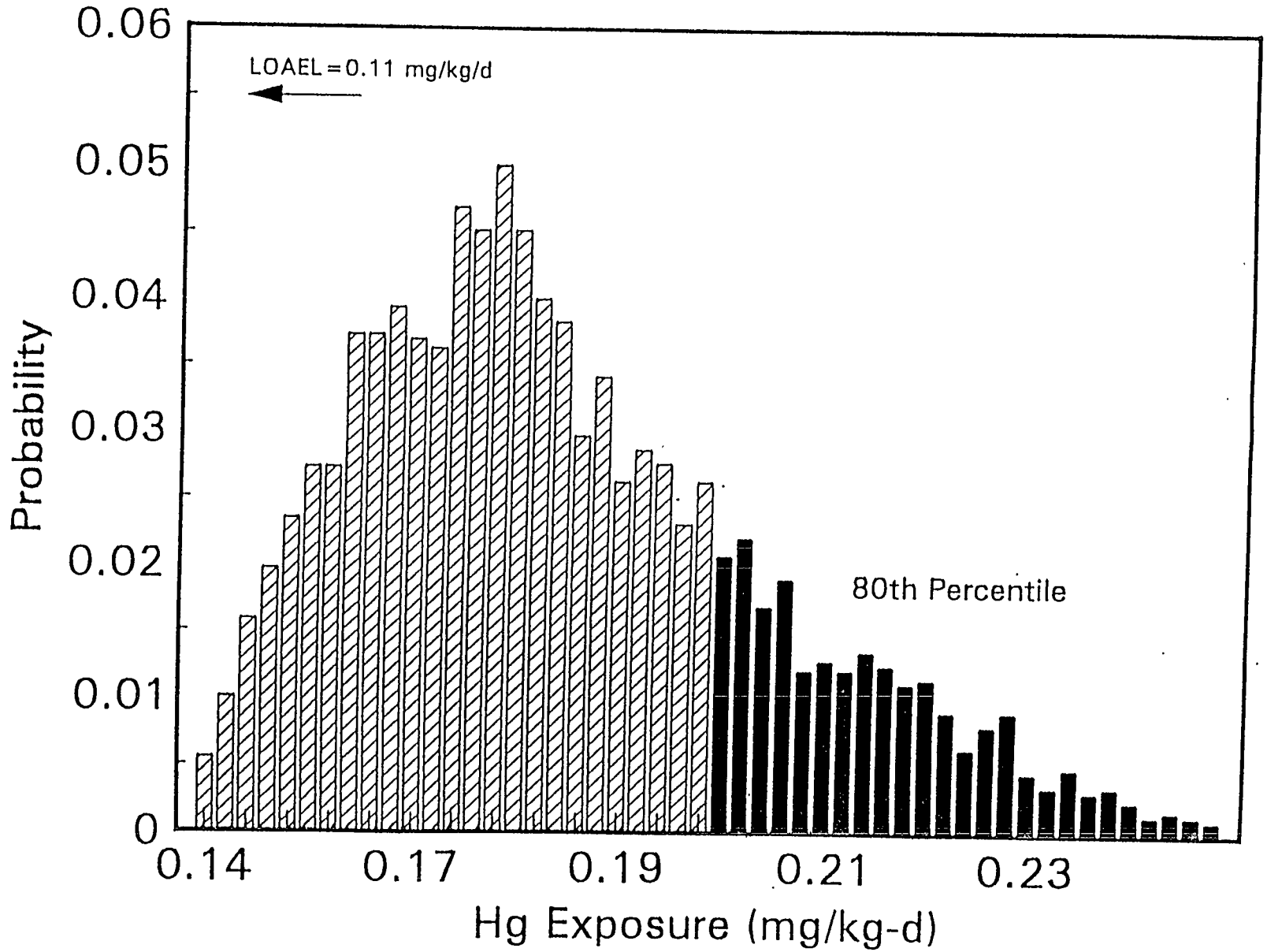


Fig. 6.36. Mercury exposure distribution for eastern cottontails foraging on a future spoil within subreach 3.03 using Monte Carlo simulation.

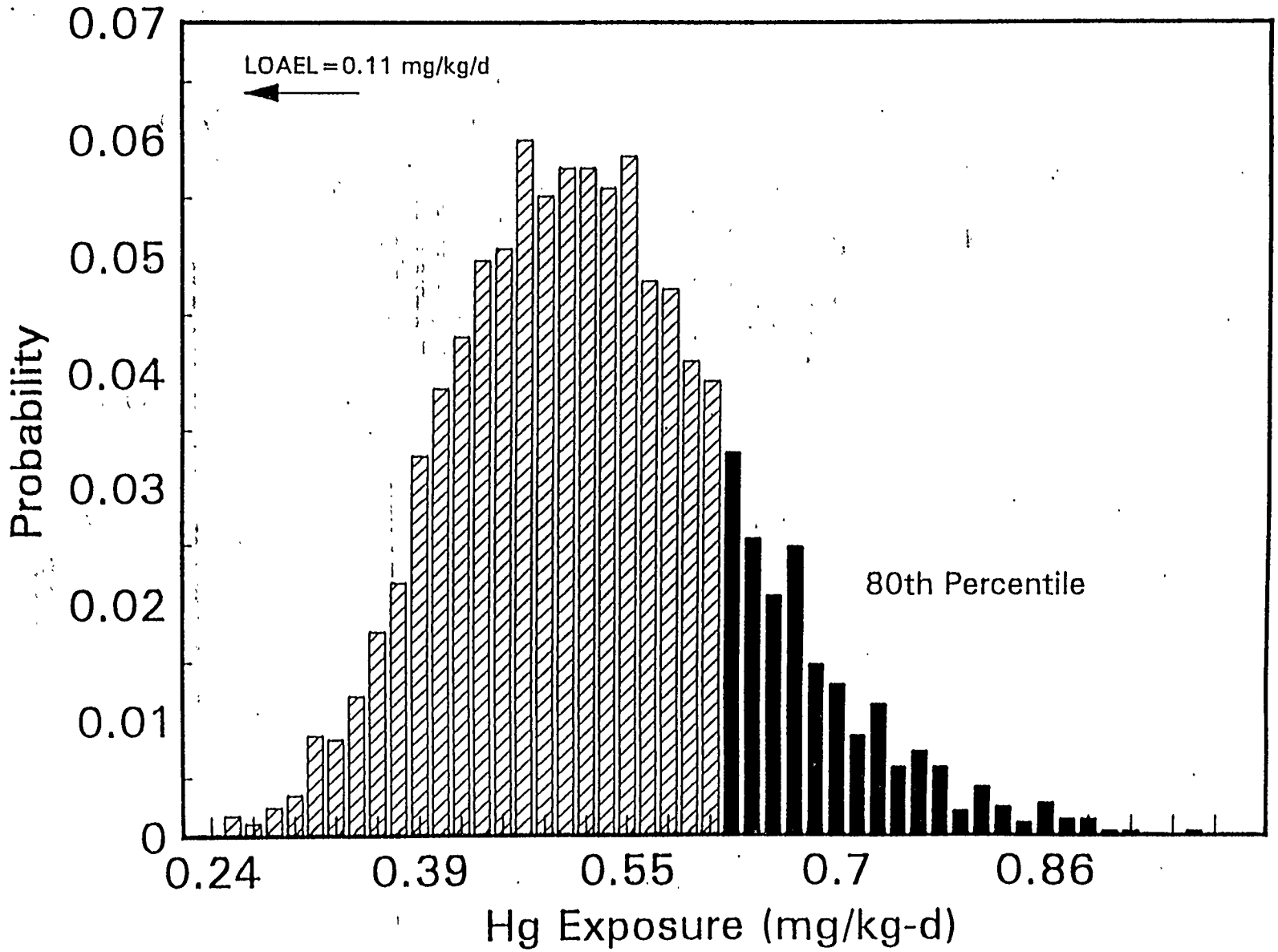


Fig. 6.37. Mercury exposure distribution for eastern cottontails foraging on a future spoil within subreach 3.04 using Monte Carlo simulation.

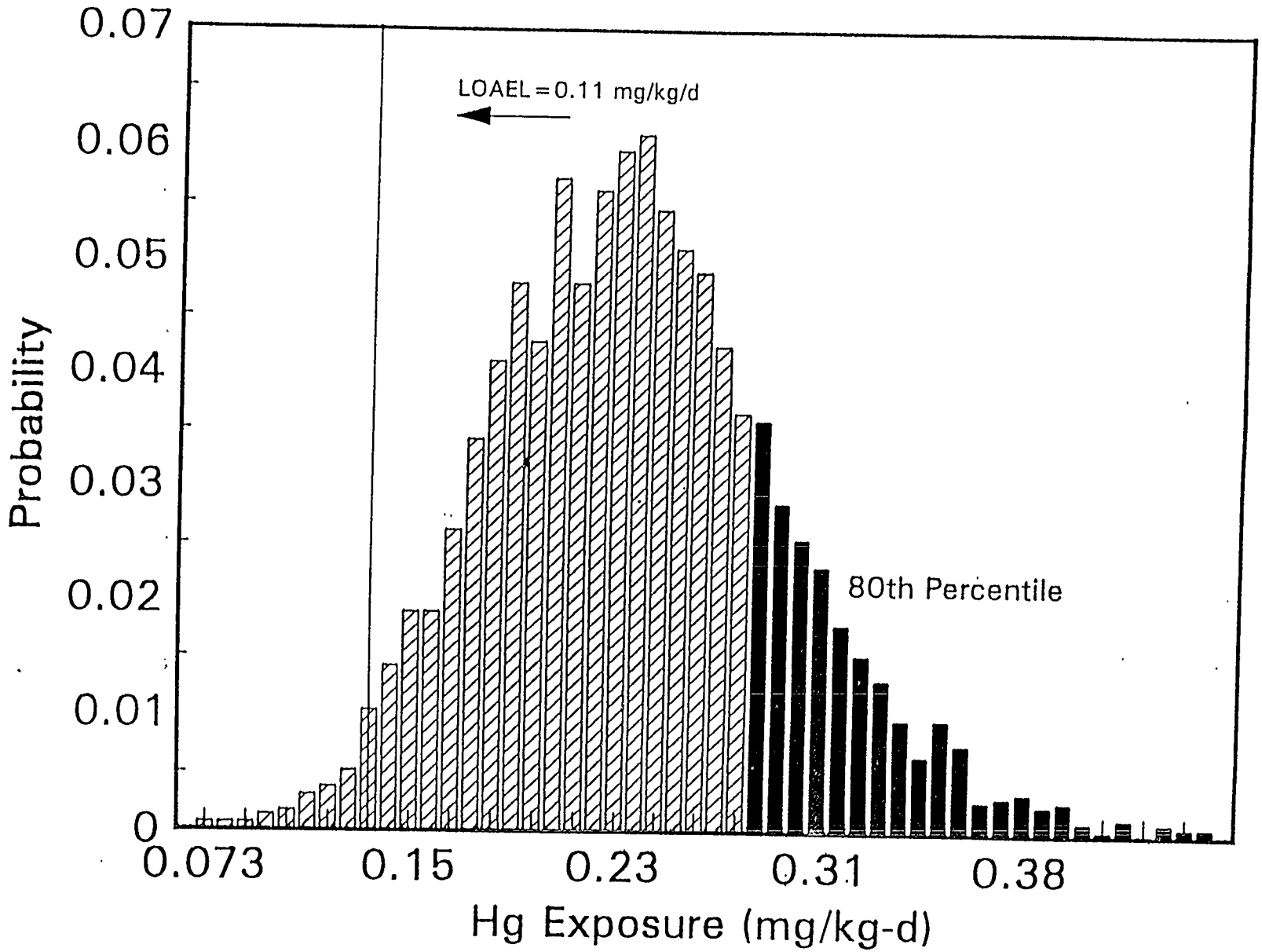


Fig. 6.38. Mercury exposure distribution for eastern cottontails foraging on a future spoil within subreach 4.01 using Monte Carlo simulation.

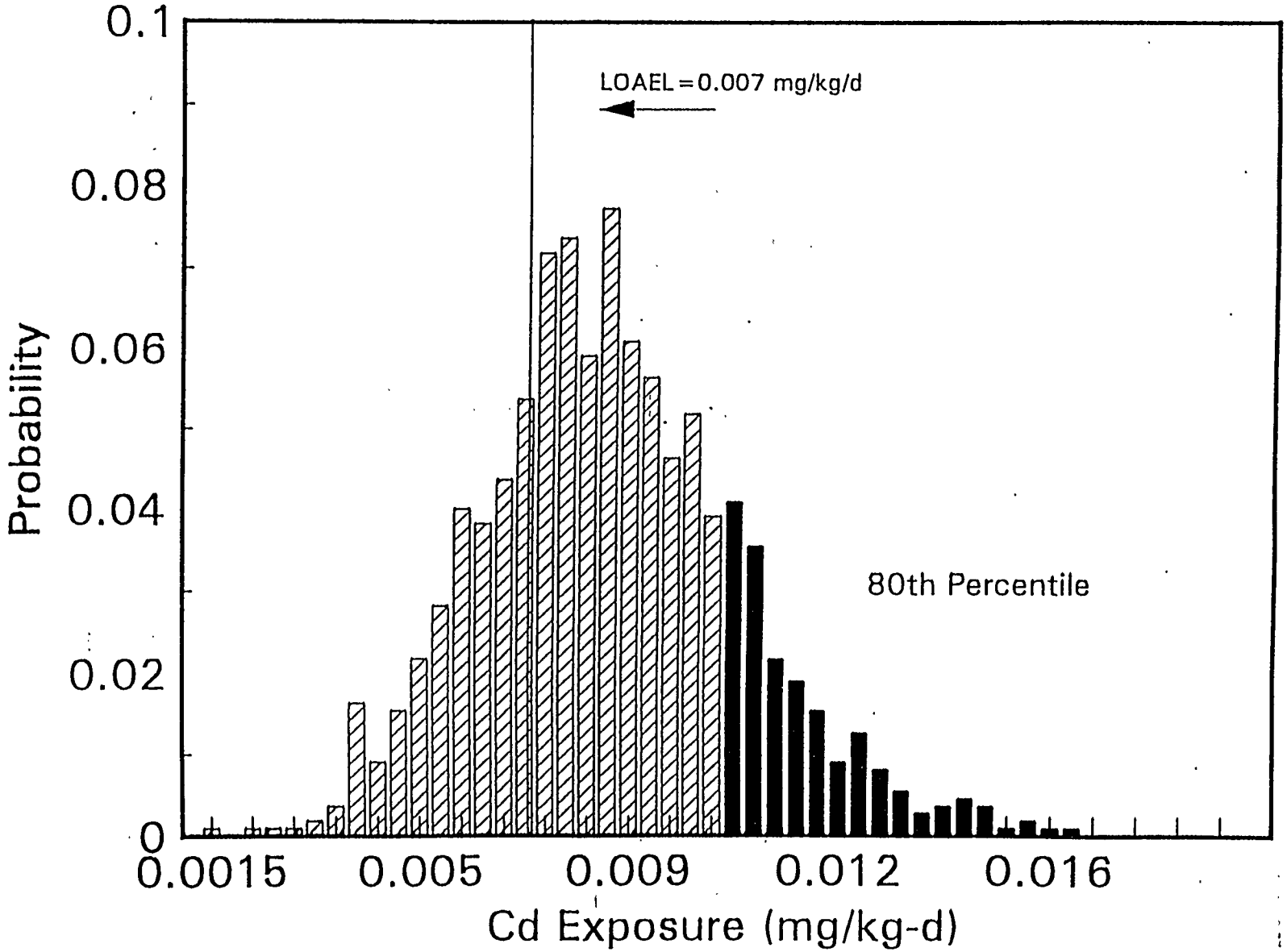


Fig. 6.39. Cadmium exposure distribution for eastern cottontails foraging on a future spoil within reach 1 using Monte Carlo simulation.

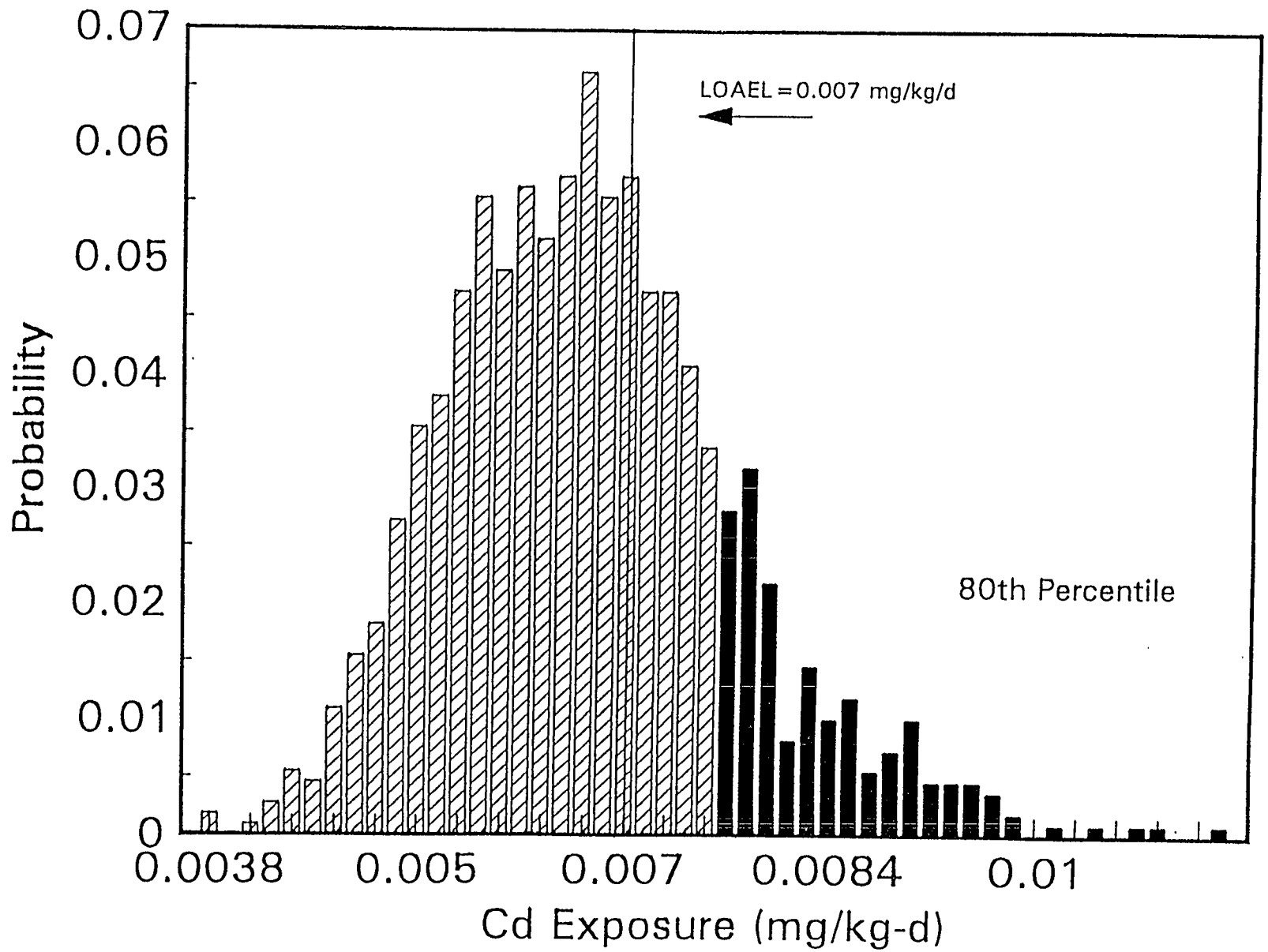


Fig. 6.40. Cadmium exposure distribution for eastern cottontails foraging on a future spoil within reach 7 using Monte Carlo simulation.

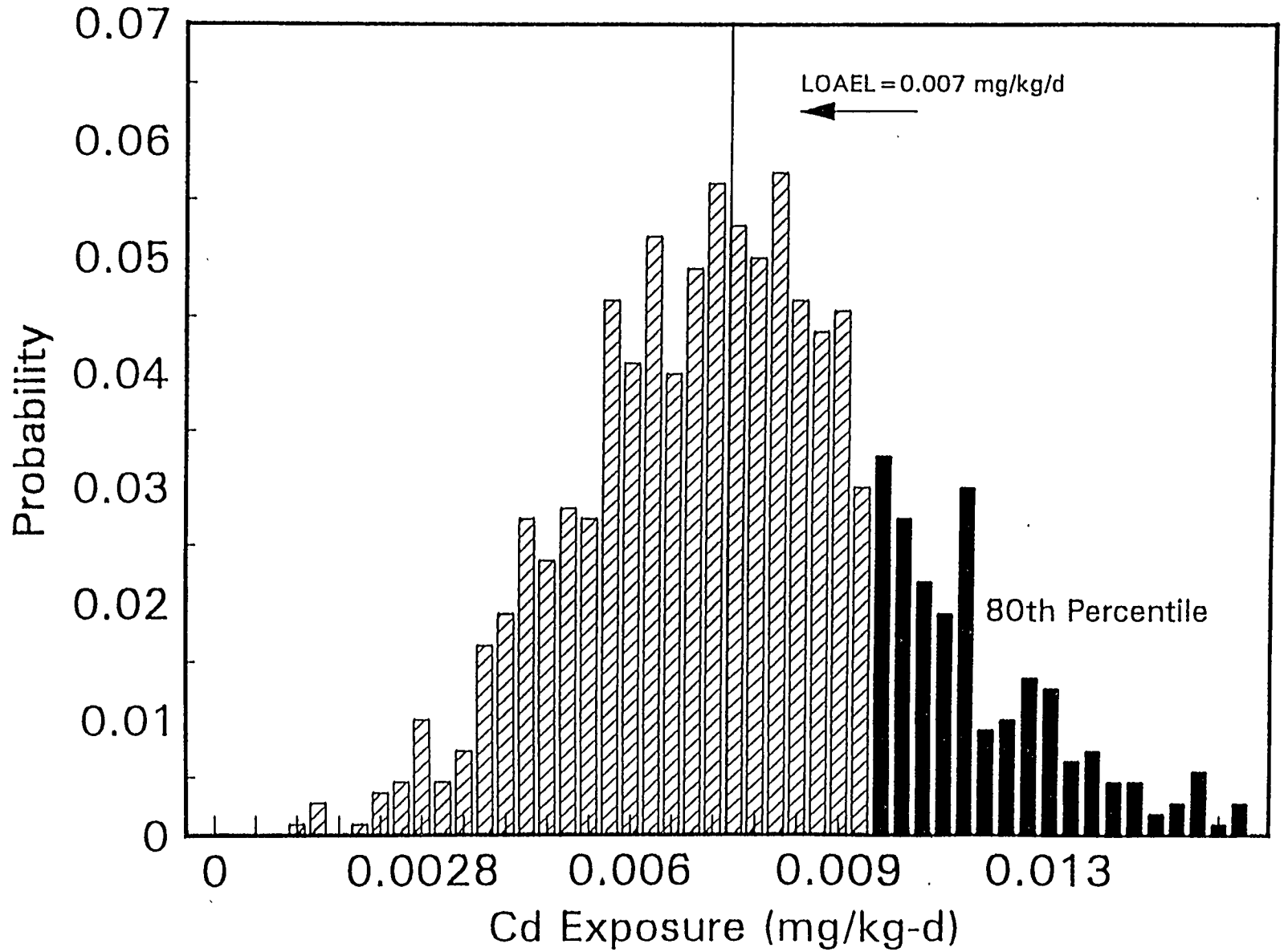


Fig. 6.41. Cadmium exposure distribution for eastern cottontails foraging on a future spoil within subreach 3.02 using Monte Carlo simulation.

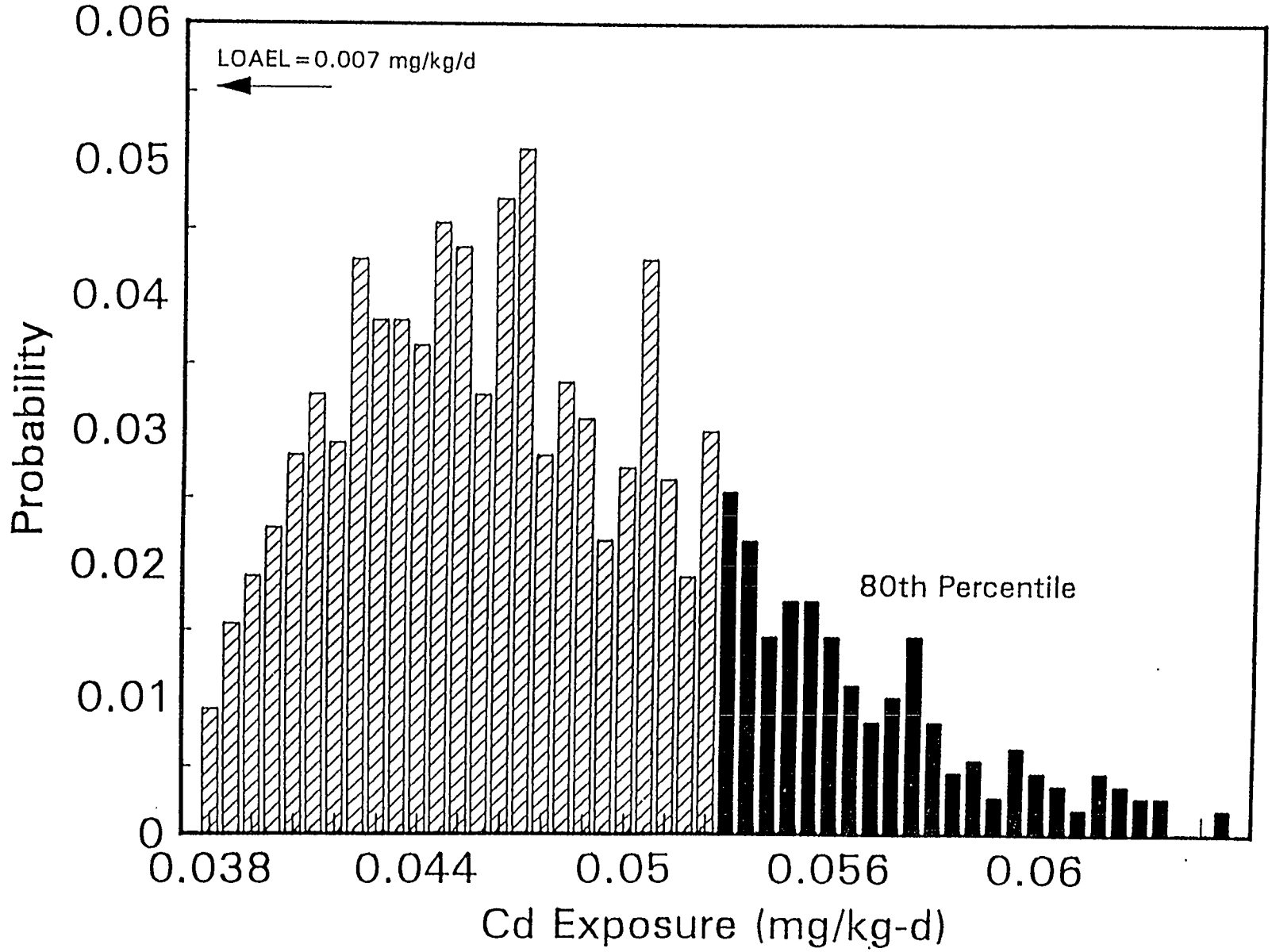


Fig. 6.42. Cadmium exposure distribution for eastern cottontails foraging on a future spoil within subreach 3.03 using Monte Carlo simulation.

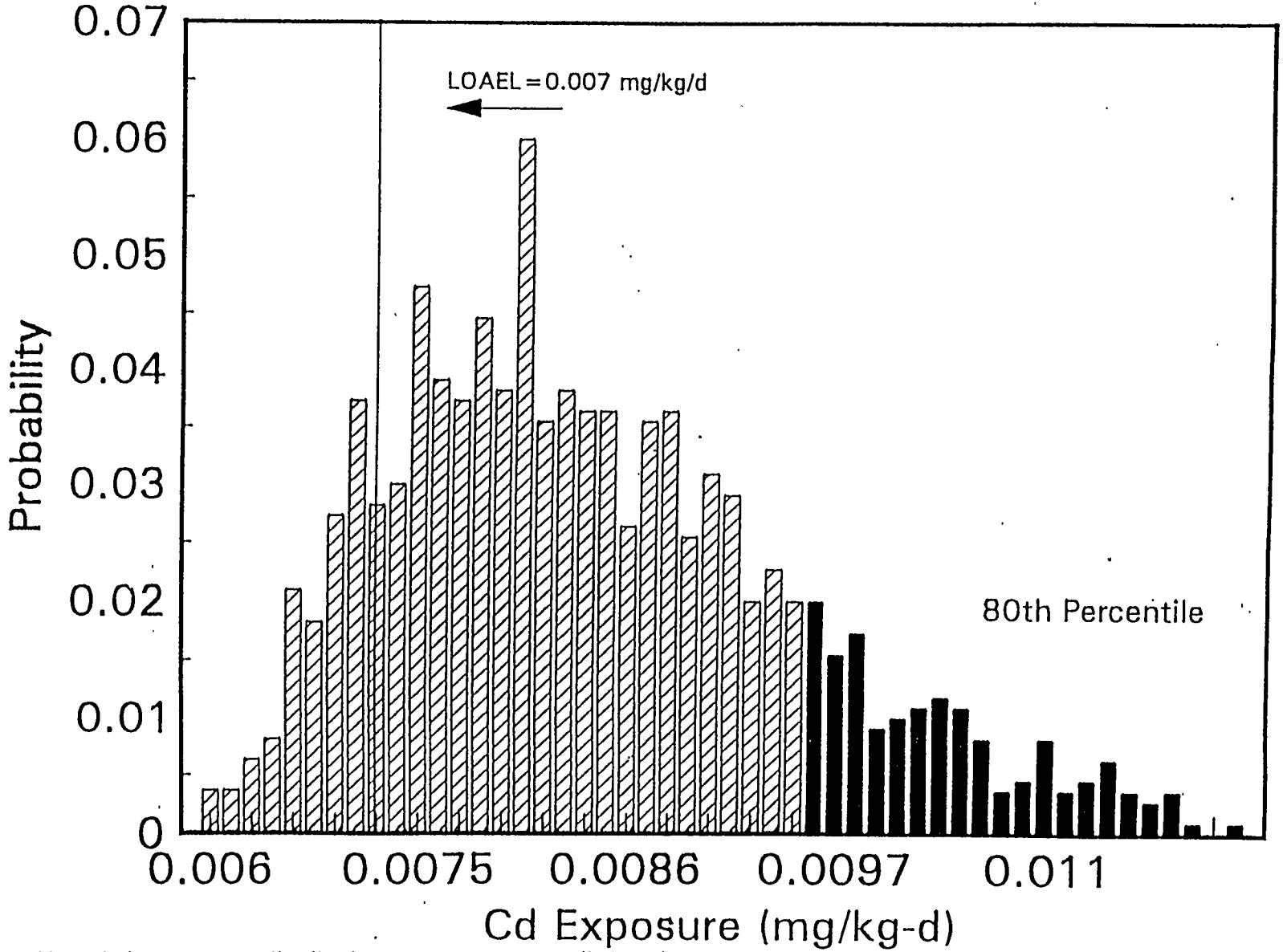


Fig. 6.43. Cadmium exposure distribution for eastern cottontails foraging on a future spoil within subreach 4.03 using Monte Carlo simulation.

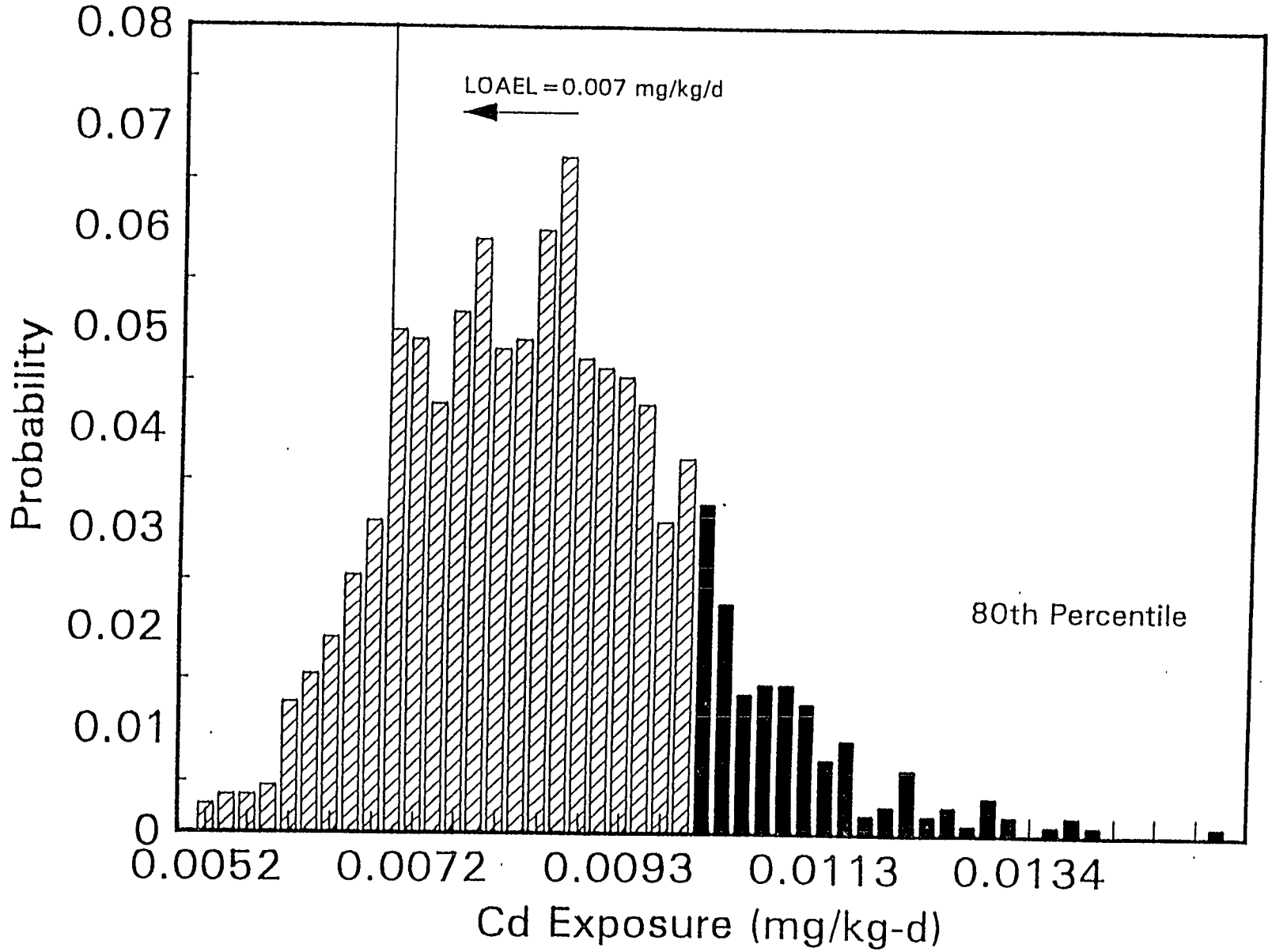


Fig. 6.44. Cadmium exposure distribution for eastern cottontails foraging on a future spoil within subreach 4.04 using Monte Carlo simulation.

6.6.3.3 Estimation of effects for herbivorous wildlife

Arsenic. Both the NOAEL and LOAEL for cottontails are based upon a study in which reproductive success and offspring survival was observed among mice fed arsenic for three generations (Schroeder and Mitchner 1971). One dose level administered (1.261 mg/kg/d), designated as the chronic LOAEL, resulted in declining litter size with each successive generation. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL correction factor of 0.1. The NOAEL and LOAEL for cottontails are 0.037 and 0.37 mg/kg/d, respectively. Because an experimental NOAEL was not established, the nature and exposure level at which adverse effects to individuals may become evident cannot be defined. However, adverse effects suggested by Schroeder and Mitchner (1971) are possible for the higher extremes of exposure on the distribution at subreaches 1, 7, 2.04, 4.01, 4.02, 4.03 and 4.04.

If there is a risk from arsenic exposure to individuals within the population, it would be primarily attributed to direct ingestion of the spoil. Arsenic bioaccumulates in vegetation at relatively low levels (Bioaccumulation factor = 0.004; SAIC 1995). Therefore, the presence of arsenic within the spoil itself would pose a risk through direct ingestion.

Barium. The NOAEL for eastern cottontails is based on a study in which growth, food and water consumption, and hypertension was observed among rats fed barium chloride for 16 months (Perry et al. 1983). Three dose levels were administered in this study. The maximum dose (5.1 mg/kg/d) did not affect growth, food or water consumption and was therefore considered to be a chronic NOAEL. The LOAEL was based on a study which observed mortality in rats fed barium for 10 days (Borzelleca et al. 1988). Four doses were administered and exposure of rats to the highest dose (300 mg/kg/d) resulted in 30% mortality to female rats. The 300 mg/kg/d dose is considered to be a subchronic LOAEL; therefore a chronic LOAEL was estimated by multiplying the subchronic LOAEL by a subchronic to chronic uncertainty factor of 0.1. Less than 10% of the population of cottontails feeding within subreach 3.04 may experience exposures in excess of the NOAEL. Therefore, adverse effects from barium at this location is highly unlikely.

Cadmium. Both the NOAEL and LOAEL for cottontails are based upon a study in which reproductive success was observed among rats fed cadmium for four generations (Wills et al. 1981). Three dose levels were administered in the study. A dose of 0.01 mg/kg/d, designated as the chronic LOAEL, resulted in a 63% reduction in fertility (number litters/number of females). The lowest dose (0.008 mg/kg/d) resulted in no adverse effects and was thus designated the chronic NOAEL. The NOAEL and LOAEL for cottontails are 0.005 and 0.007 mg/kg/d, respectively. Based on results of Wills et al. (1981), cottontails foraging at a spoil within subreach 1, 7, 3.02, 3.03, 3.04, 4.03, and 4.04 may experience a reduction in fertility. The exposure experienced by cottontails foraging within subreach 2.04 is between the NOAEL and LOAEL. Therefore, there is a potential that *individuals* foraging within this subreach may experience impaired reproduction.

Manganese. Both the NOAEL and LOAEL for eastern cottontails are based upon a study in which reproductive success was observed among rats fed manganese for 224 days through gestation (Laskey et al. 1982). Three doses were administered (28, 88, and 280 mg/kg/d) in the study. Pregnancy percentage and fertility among rats exposed to 280 mg/kg/d was significantly reduced; therefore, this dosage was considered the chronic LOAEL. No effects on other reproductive parameters (e.g., litter size, ovulations, resorptions, preimplantation death, fetal weights) were observed at lower dosages. Therefore, the 88 mg/kg/d dosage level was considered the NOAEL. The NOAEL and LOAEL for eastern cottontails are 58.6 and 189 mg/kg/d, respectively. The exposure experienced by cottontails foraging

within subreach 2.04 is between the NOAEL and LOAEL. Therefore, there is a potential that *individuals* foraging within this subreach may experience impaired reproduction.

Mercury. Both the NOAEL and LOAEL for eastern cottontails are based upon a study in which reproductive success and offspring survival was observed among rats fed methyl mercury for three generations (Verschuuren et al. 1976a, 1976b, 1976c). The highest dose administered (0.16 mg/kg/d), designated as the LOAEL, resulted in reduction in offspring viability. This exposure also resulted in reduction in growth, increased kidney weight, and altered kidney histochemistry (Verschuuren et al. 1976b). No effects were observed at a dose of 0.032 mg/kg/d. The study was considered to represent chronic exposure; therefore, a subchronic-chronic correction factor was not employed. The NOAEL and LOAEL for eastern cottontails are 0.021 and 0.110 mg methyl Hg/kg/d, respectively. Based on the results of Verschuuren et al (1976a,b,c), eastern cottontails experiencing exposure at spoils within subreach 3.03, 3.04, and 4.01 are likely to display impaired reproduction. Additionally, because an experimental NOAEL was not established, the nature and exposure level at which adverse effects to individuals may become evident from foraging within subreaches 3.02, 4.03, and 4.04 cannot be defined.

PCBs. Both the NOAEL and LOAEL for eastern cottontails are based on a study in which oldfield mice were fed Aroclor-1254 for 12 months (McCoy et al. 1995). A dose level of 0.68 mg/kg/d, designated as the chronic LOAEL, caused a reduction in the number of litters, offspring weights, and offspring survival. Because an experimental NOAEL was not established, the chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1. The NOAEL and LOAEL for cottontails are 0.016 and 0.16 mg/kg/d, respectively. Approximately 20% of the cottontail population may experience exposures in excess of the NOAEL. Because an experimental NOAEL was not established, the nature and exposure level at which adverse effects to individuals may become evident cannot be defined. However, population-level adverse effects from foraging on a spoil in subreach 4.01 are highly unlikely.

Selenium. The eastern cottontail NOAEL and LOAEL are based on a study in which selenate was fed to mice for 3 generations (Schroeder and Mitchner 1971). An administered dose level of 0.76 mg/kg/d, designated as the chronic LOAEL, caused reduced reproductive success with a high incidence of runts and failure to breed. Because an experimental NOAEL was not established, the chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1. The NOAEL and LOAEL for cottontails are 0.023 and 0.22 mg/kg/d, respectively. Cottontails foraging at spoils in subreaches 7, 2.04 and 3.04 may experience exposures between the NOAEL and LOAEL. Because an experimental NOAEL was not established, the nature and exposure level at which adverse effects to individuals may become evident cannot be defined. However, population-level adverse effects from foraging on these future spoils in subreach 4.01 are highly unlikely.

Thallium. The eastern cottontail NOAEL and LOAEL are based on a study in which rats were fed thallium sulfate for 60 days (Formigli et al. 1986). This study represents subchronic exposures since the duration of the study did not include a critical lifestage. Rats exposed to a single dose, 0.074 mg/kg/d, displayed reduced sperm motility. Since this is a subchronic exposure, a subchronic-chronic uncertainty factor of 0.1 was applied to obtain a chronic LOAEL. To estimate the chronic NOAEL, the chronic LOAEL was multiplied by a LOAEL-NOAEL uncertainty factor of 0.1. The NOAEL and LOAELs for cottontails are 0.005 and 0.05 mg/kg/d, respectively. Cottontails foraging at a spoil in subreach 3.04 may experience exposures between the NOAEL and LOAEL. Because an experimental NOAEL was not established, the nature and exposure level at which adverse effects to individuals may become evident cannot be defined. However, population-level adverse effects from foraging at subreach 3.04 is highly unlikely.

Vanadium. The eastern cottontail NOAEL and LOAEL are based on a study in which rats were fed sodium metavanadate for 60 days prior to gestation, through gestation, delivery and lactation (Domingo et al. 1986). This study represents chronic exposures since it took place during the rat's critical lifestage. Significant effects on reproduction including increased number dead young/litter and reduction in size and weight of offspring were observed at the lowest dose administered, 5 mg/kg/d. Therefore, this dose was considered the chronic LOAEL. To estimate the chronic NOAEL, the chronic LOAEL was multiplied by a LOAEL-NOAEL uncertainty factor of 0.1. The NOAEL and LOAEL for eastern cottontail are 0.13 and 1.3 mg/kg/d, respectively. Cottontails foraging at spoils in subreaches 7 and 3.04 may experience exposures between the NOAEL and LOAEL. Because an experimental NOAEL was not established, the nature and exposure level at which adverse effects to individuals may become evident cannot be defined. However, population-level adverse effects from foraging in these areas is highly unlikely.

6.6.3.4 Weight of evidence for the dredged spoil

Plants. Only one line of evidence, literature toxicity data, was available to evaluate ecological risk to plants. Many contaminants found within sediments potentially available in future spoils exceeded background concentrations and phytotoxicity benchmarks within all subreaches (1, 7, 2.04, 3.02, 3.03, 3.04, 4.01, 4.02, 4.03, and 4.04) with the exception of sediment within subreach 3.01. Therefore, if sediments were dredged and placed along the Clinch River, 1 contaminant within Reach 1 (As); 5 contaminants within Reach 7 (As, Cr, Mn, Se, and V); 3 contaminants within subreach 2.04 (As, Mn, and Se); 5 contaminants within subreach 3.02 (Hg, Ni, Se, U, and Zn); 7 contaminants within subreach 3.03 (Cd, Cr, Hg, Ni, Ag, U, and Zn); 9 contaminants within subreach 3.04 (As, B, Cd, Cr, Hg, Ni, Se, U, and V); 1 contaminant within subreach 4.01 (Hg); 1 contaminant in subreach 4.02 (As); 3 contaminants within subreach 4.03 (Cr, Mn, and Hg); and 5 contaminants within subreach 4.04 (As, Cr, Mn, Hg, and Zn) could potentially pose a risk to plants growing in these spoils. There are also 37 organic contaminants present in the sediment for which no phytotoxicity benchmarks are available. Therefore, the risks from those contaminants cannot be assessed.

This scenario is an extremely conservative estimation of risk for plants in the future. It is assumed that the concentrations found in the current deep sediments would be equivalent to spoil concentrations. Additionally, the contaminants are assumed to be 100% bioavailable for plant uptake in the future spoil. Since contaminants may not be totally bioavailable to plants, the risk to plant growth posed by these contaminants may be lower than suggested.

Herbivorous wildlife. Only one line of evidence, literature toxicity data, was available to evaluate risks to eastern cottontails foraging on spoils produced within each subreach. The comparison of exposure estimates to LOAELs indicate that subreaches 1, 7, 3.02, 3.03, 3.04, 4.01, 4.03, and 4.04 would be a significant risk to eastern cottontail populations foraging on future spoils. The risk is attributable to cadmium and mercury (at subreaches 3.03, 3.04 and 4.01 only), which may be ingested directly from the spoil or from ingestion of contaminated vegetation. The eastern cottontail population feeding on these spoils may be adversely impacted through impaired reproduction.

The remaining contaminants found in the spoil and vegetation within subreaches 1 (As), 7 (As, Se, Tl, and V), 2.04 (as, Mn, and Se), 3.02 (Hg), 3.04 (Ba, Se, Tl, and V), 4.01 (As and PCB-1260), 4.02 (As), 4.03 (As and Hg), and 4.04 (As and Hg) did not produce exposures in excess of the LOAELs. Therefore, *population-level* effects on the eastern cottontails are not likely to be observed from ingestion of these contaminants on the above spoils. However, *individuals* may be adversely affected at the uppermost exposure levels of the distributions.

6.6.4 Uncertainties Concerning Risks to Plants and Herbivorous Wildlife

Factors that create uncertainty in assessing the risk posed by the COPCs in the future spoils of CR/PC sediments are discussed in the following subsections.

Equivalent sediment and spoil concentrations. The scenario assumes that the current contaminant concentrations found in sediments in the CR/PC will be equivalent to the potential spoil deposited on land. The contaminant concentrations will remain present within the spoil over time and be taken up by vegetation. This is an extremely conservative scenario which may overestimate the level of exposure and risk to the flora and fauna living at the future spoil.

Bioavailability of contaminants. It was assumed that 100% of the contaminant concentration reported in sediments and modeled vegetation was bioavailable. The double acid extraction method used to determine sediments concentrations reflect the total potential pool of contaminants. The future bioavailability of these contaminants which is dependent upon the chemical (e.g., pH, organic carbon) and physical (e.g., clay, moisture content) nature of the spoil can not be addressed for this assessment. Therefore, exposure estimates based upon the contaminant concentrations in media are highly conservative and are likely to overestimate the actual contaminant exposure experienced.

Uncontaminated surface water consumption for herbivorous wildlife. This assessment assumed that herbivorous wildlife will not be consuming surface water from the Clinch River or Poplar Creek. Since this is a future scenario, surface water concentrations found in the Clinch River can not be accurately predicted. Moreover, rabbits are likely to consume water from smaller bodies of water such as tributaries, ponds, or small pools. The high banks of the CR/PC also limit access to the water source in many areas. Additionally, the primary purpose of this scenario is to evaluate risks from dredged spoils.

Extrapolation from published toxicity data. There are no published NOAELs for eastern cottontails. To estimate toxicity of contaminants at the site, it was necessary to extrapolate from NOAELs observed for test species (i.e., rats and mice). While it was assumed that toxicity could be estimated as a function of body size, the accuracy of the estimate is not known. For example, eastern cottontails may be more or less sensitive than rats or mice.

Additional extrapolation uncertainty exists for those contaminants for which data consisted of either LOAELs or was subchronic in duration. For either case, an uncertainty factor of 10 was employed to estimate NOAELs or chronic data. The uncertainty factor of 10 may either over- or underestimate the actual LOAEL-NOAEL or subchronic-chronic relationship.

Variable food and water consumption. While food consumption by wildlife was assumed to be similar to that reported for the same species in other locations, the validity of this assumption cannot be determined. Food consumption at the CR/PC may be greater or less than that reported in the literature, resulting in either an increase or decrease in contaminant exposure. Similarly, water consumption was estimated according to the allometric equations of Calder and Braun (1983). The accuracy with which the estimated water consumption represents actual water consumption is unknown.

Single contaminant tests vs exposure to multiple contaminants in the field. While plants and eastern cottontails are exposed to multiple contaminants concurrently, published toxicological values only consider effects experienced by exposures to single contaminants. Because some contaminants can interact antagonistically, single contaminant studies may overestimate their toxic potential. Similarly, for those contaminants that interact synergistically, single contaminant studies may underestimate their toxic potential.

Inorganic constituents or species present in the environment. Toxicity of metal species varies dramatically depending upon the valence state or form (organic or inorganic) of the metal. For example, Arsenic (III) and methyl mercury are more toxic than arsenic (V) and inorganic mercury, respectively. The available data on the contaminant concentrations in media do not report which species or form of contaminant was observed. Because benchmarks used for comparison represented the more toxic species/forms of the metals (particularly for arsenic and mercury), if the less toxic species/form of the metal was actually present in modeled vegetation or sediment from the Clinch River or Poplar Creek, potential toxicity at the sites may be overestimated.

Food source availability. This assessment assumed that the spoil deposited on land would revegetate at a level sufficient to maintain foraging area for a population of herbivores (i.e., eastern cottontails).

Monte Carlo simulation. To perform Monte Carlo simulations, distributions must be assigned to parameters. The sediment distribution was assumed to be log normal; this is a standard accepted distribution for abiotic media concentrations. In cases where a distribution was calculated based on only a few sediment samples, the variance within the model was enhanced.

The literature values used for the body weight of the eastern cottontail are nationwide values which may overestimate or underestimate the body weight of species found at the site.

6.7 RISKS FROM EXPOSURE TO RADIONUCLIDES

6.7.1 Exposure Assessment

6.7.1.1 Sources of exposure

Sources of radioactivity in the environment include naturally occurring radionuclides, fallout from atmospheric testing, runoff from watersheds that have received atmospheric deposition, and radioactive effluents from medical, industrial, and nuclear facilities discharged either routinely or accidentally. The discharge of radioactive effluents to the environment has the potential for contaminating terrestrial and aquatic environments, which results in long-term, low dose rate exposures to an ecosystem and its components. Sources of radionuclides in the CR/PC system are discussed in Sect. 3.2. Native biota receive external radiation exposure from radionuclides in air, water, soil, sediment, and other biota, such as vegetation. Organisms also receive internal radiation exposure from radionuclides ingested via food and water and from radionuclides absorbed through the skin and respiratory organs (Templeton et al. 1971, IAEA 1976, Blaylock and Trabalka 1978, Woodhead 1984). Evaluation of the resulting radiation doses received by biota requires quantitative information on the radionuclides to which they are exposed. In all cases the radiation source must be known in terms of the quantity of each specific radionuclide and the corresponding energy released per disintegration. Special factors to correct for size, biological concentration, elimination, etc., are applied when appropriate.

Radiation doses were calculated for representative species of biota in the CR/PC. Estimates of radiation dose to aquatic biota were made using the methodology reported by Blaylock et al. (1993), which is based upon the "Point Source Dose Distribution" methodology recommended by the International Commission on Radiological Protection and the National Council on Radiation Protection and Measurements (IAEA 1976, 1979, NCRP 1991). For terrestrial organisms the methodology developed by Soldat et al. (1974) and Baker and Soldat (1992) was modified to calculate radiation dose to terrestrial biota. Equations used to estimate doses to biota in this investigation are listed in Appendix F7.

Since dose calculations are species-specific, representative species were selected for the endpoint communities. They are: the mayfly *Hexagenia bilineata*, the epibenthic fish, which represents fish such as carp (*Cyprinus*), redhorse and suckers (*Moxastoma*), and catfish, (*Icthlurus*) the great blue heron (*Ardea herodias*), and the eastern cottontail (*Sylvilagus floridanus*).

6.7.1.2 Radiation dose to benthic invertebrates

Sediments are the environmental medium with the highest radionuclide concentrations. Invertebrate biota which live most of their life cycle in sediments probably represent a maximum exposure scenario. The mayfly, *Hexagenia bilineata*, is chosen as a representative benthic invertebrate. This large sediment-burrowing mayfly is common to the Clinch River, Poplar Creek, and Watts Bar Reservoir. In these waters, it usually takes one year for mayflies to complete their life cycle, which extends from deposition of eggs to hatching of adults. Nymphs are an important food source for fish. Adults hatch during summer months, but almost all adults die within one day after hatching and leaving the water. During that short time they attract fish, birds and mammals which gorge on the hatch.

Annual radiation doses were calculated for mayfly larvae completely submerged in sediments from each reach of the OU (Table 6.33). The equations for the calculation appear in Appendix F7. Sediment concentrations of radionuclides appear in Tables B16–B21. Continual, complete submergence was chosen as a conservative scenario, maximizing the estimated dose. Wright et al. (1982) reported that nymphs from Watts Bar Reservoir stock range in size from 20 to 25 mm when they have reached the large wing-pad stage of development. This size range was taken into consideration in the dosimetry calculations. The highest calculated dose rates are 490 and 280 mrad/year for larvae living in sediments sampled from Reaches 2 and 4, respectively. The principal radionuclide contributing to dose rate at these locations is ^{137}Cs and its daughter product, ^{137m}Ba. The next highest dose rate was 200 mrad/year for larvae living in sediments at Reach 1, with 92 percent of the dose coming from ^{60}Co. The dose rate to larvae at Reach 3 was slightly less at 180 mrad/year and was due mostly to the presence of ^{137}Cs in sediments. Larvae at Reach 7 were estimated to receive an annual dose of 31 mrad, less than for any other reach.

Table 6.33. Radiation dose rates (mrad/year) to mayfly larvae (*Hexagenia bilineata*) living in sediments

Reach	Number of Radionuclides Detected	Principal Radionuclide and Contribution to Dose Rate (percent)	Dose Rate (mrad/year)
1	2	60Co (92%), 137Cs/137mBa (8%)	200
2	14	137Cs/137mBa (93%), 90Sr/90Y (5%)	490
3	13	137Cs/137mBa (89%), 235U (5%)	180
4	13	137Cs/137mBa (91%), 60Co (5%)	280
7	3	90Sr/90Y (79%), 137Cs/137mBa (31%)	31

6.7.1.3 Radiation dose to epibenthic fish

A model epibenthic fish was used to estimate the total dose received from exposure to radionuclides in sediments, water, and internal tissues. Radionuclide concentration data are found in Tables B16–B21 (sediment) and Appendix A (surface water). For internal tissue concentrations, general bioaccumulation factors were used instead of actual measurements. Representative epibenthic fish include carp (*Cyprinus*), suckers and redhorse (*Moxastoma*), and catfish (*Ictalurus* and *Ameiurus*) which are

common at all sampling locations. Detailed dosimetry equations applicable to a model, large (length = 45 cm) epibenthic fish are listed as equations 3 to 7 in Appendix F7. These equations were adapted from Blaylock et al. (1993), and used to calculate the annual dose rate to a model epibenthic fish as the sum of gamma dose rates from water immersion and sediment surface, and beta and gamma dose rates from internally deposited radionuclides. The beta component of immersion in water and exposure to sediment surfaces was neglected because of self absorption and shielding.

The calculated dose rates (mrad/year) are listed in Table 6.34 and indicate that the doses to fish are less than 100 mrad/year, or approximately a factor of ten less than the doses calculated for mayflies. The principal radionuclides contributing to dose rate are $^{137}Cs/^{137m}Ba$, $^{90}Sr/^{90}Y$, and ^{60}Co.

Table 6.34. Radiation dose rates (mrad/year) to epibenthic fish from exposure to radioactive sediments, water, and food

Reach	Number of Radionuclides Detected	Principal Radionuclides and Contribution to Dose Rate (Percent)	Dose Rate (mrad/year)
1	6	60Co (91%), 90Sr/90Y (7%)	32
2	16	90Sr/90Y (52%), 137Cs/137mBa (36%)	33
3	14	137Cs/137mBa (84%), 90Sr/90Y (10%)	56
4	15	137Cs/137mBa (76%), 60Co (13%)	22
7	3	90Sr/90Y (61%), 137Cs/137mBa (26%)	5

6.7.1.4 Radiation dose to great blue heron

The great blue heron (*Ardea herodias*) was chosen to represent fish-eating birds. Biological and dosimetric parameters describing the model heron are given in Appendix F7. The total dose received by a heron would be the sum of external exposures from contaminated shoreline, external exposure from wading in contaminated water, and internal exposure from eating contaminated fish. Measurements of radionuclide concentrations in fish tissues were used from Phase 1 of the Clinch River Remedial Investigation (Cook et al. 1992). The model assumes that 100 percent of the great blue heron's diet is composed of fish. Equations 9 to 11 in Appendix F7 were used to perform the dosimetry calculations.

Although up to 15 parent radionuclides contribute to radiological exposures, ^{137}Cs and ^{90}Sr (including daughter products) contribute almost all of the dose rate at any one reach (Table 6.35). The highest dose rate of 5400 mrad/year occurs for a heron feeding at Reach 2. This was the highest dose determined for any of the representative biota. Dose rates for Reaches 3 and 4 are more than a factor of ten times less, and ^{90}Sr is the principal radionuclide.

Table 6.35. Radiation dose rates (mrad/year) to great blue heron from radioactive contamination in fish, water, and sediments

Reach	Number of Radionuclides Detected	Principal Radionuclides and Contribution to Dose Rate (Percent)	Dose Rate (mrad/year)
1	6	137Cs/137mBa (~100%)	23
2	15	137Cs/137mBa (~100%)	5400
3	14	90Sr/90Y (79%), 137Cs/137mBa (21%)	350
4	15	90Sr/90Y (77%), 137Cs/137mBa (23%)	320
7	3	137Cs/137mBa (60%), 60Co (33%)	<1

6.7.1.5 Radiation dose to rabbit

A model eastern cottontail rabbit (*Sylvilagus floridanus*) weighing 1.2 kg was assumed to be a resident of a hypothetical terrestrial habitat established on a soil base of dredged sediments at each river reach. The scenario is described in detail in the human health risk assessment (Sect. 5.2.3.6) As in the assessment of nonradiological contaminants in Sect. 6.6, the spoil is assumed to be derived from mixed deep sediments where irrigation will not take place. If deep sediment is taken from the river bed and spread on shore, the organisms are potentially exposed to high concentrations of ^{137}Cs. Vegetation can bioaccumulate contaminants and be consumed by herbivores, such as rabbits. In this assessment actual radio-analytical results for sediments sampled at each reach were used in the calculations. It was assumed that each reclaimed area was large enough for a rabbit to live its entire life cycle.

The exposure scenario of dosimetric and biological assumptions for calculating rabbit exposures should lead to conservative dose estimates (over estimation of actual doses if the sediments were used to establish new terrestrial habitats). Conservative assumptions include: (1) the residence of the rabbit in a burrow for half of the time and (2) high inhalation and ingestion rates. Both internal and external exposures were assumed to occur for the model rabbit which resides in a burrow one-half of the time and spends the other half of its time above ground. Both of these situations result in external exposure from the contaminated soil and sediment mixture. All vegetation which is consumed as food becomes radioactive through soil-root uptake. Additional internal exposure is assumed to occur through inhalation of sediment/soil-derived dust which has the same radionuclide content as the dredged sediments. Assumed intake rates for ingestion of fresh vegetation and inhalation of air are 0.24 kg/day and 0.63 m^3/day, respectively (USEPA 1993). A mass loading rate of 0.0001 kg/m^3 was used for the inhalation pathway. Equations for the dose rate calculations and further assumptions are given in Appendix F7.

Dose rates computed for the four pathways of exposure are listed in Table 6.36 and range from a minimum of 11 mrad/year at Reach 1, to maxima of 1500 mrad/year and 1400 mrad/year at Reaches 2 and 4, respectively. At Reach 3 the dose rate is 530 mrad/year, and the dose rate to the rabbit at Reach 7 is 90 mrad/year. The principal radionuclides contributing to the estimated dose rates include $^{137}Cs/^{137m}Ba$ and $^{90}Sr/^{90}Y$.

Table 6.36. Radiation dose rates (mrad/year) to rabbit from vegetation consumed, air breathed, soil surface, and burrow

Reach	Number of Radionuclides Detected	Principal Radionuclides and Contribution to Dose Rate (Percent)	Dose Rate (mrad/year)
1	2	137Cs/137mBa (96%), 60Co (4%)	11
2	5	137Cs/137mBa (90%), 90Sr/90Y (8%)	1500
3	7	137Cs/137mBa (78%), 90Sr/90Y (17%)	530
4	6	137Cs/137mBa (98%), 90Sr/90Y (2%)	1400
7	2	90Sr/90Y (80%), 137Cs/137mBa (20%)	90

6.7.2 Effects Levels for Radionuclides

The discharge of radioactive waste into the environment results in long-term, low dose exposure to organisms. In most cases, acute mortality can be discounted. Any potential increase in morbidity and mortality that might result from the exposure to chronic irradiation above background is unlikely to be detected because of natural fluctuations in the size of populations. The DOE's official guideline for radiation received from environmental sources limits the dose rate to 1.0 rad per day (NCRP 1991) for aquatic organisms. The International Atomic Energy Agency (IAEA) recommends limiting the dose for terrestrial organisms to 0.1 rad per day (IAEA 1992).

6.7.3 Risk Characterization for Organisms Exposed to Radionuclides

A brief description of the life cycle, size of the organism, and methodology used in the dose calculations is given in Sect. 6.7.1. Based on the relatively low doses calculated for representative biota (Sect. 6.7.1) and the recommended limit of 1.0 rad per day for aquatic biota (NCRP 1991) and 0.1 rad per day for terrestrial biota (IAEA 332), detectable radiation effects on individuals or populations of organisms are not expected in the biota of the CR/PC.

More specifically, (1) the highest radiation dose rate for benthic invertebrates is over three orders of magnitude lower than the DOE guideline of 1.0 rad per day (Table 6.33). Therefore, no significant effects would be expected to result to the abundant populations of this important benthic invertebrate species. (2) All dose rates for epibenthic fish (Table 6.34) are far below any level that would be expected to produce bioeffects and are therefore of no radiological concern. (3) Even at the highest estimated dose rate of 5400 mrad/year (5.4 rad/year) for herons, no bioeffects would be expected (Table 6.35). (4) Sincethe maximuml annual dose rates for rabbits is calculated to be only 1.5 rad/year, no biological effects would be expected (Table 6.36).

Results of the specific dose calculations for these representative organisms are discussed in Sect. 6.7.1. Several details are worth noting. A dose of 5.4 rad per year which was calculated for the great blue heron in Reach 2 was the highest dose determined for any of the representative biota. For all representative biota, ^{137}Cs and its daughter radionuclide ^{137m}Ba were the major dose-contributing radionuclides. All representative biota in Reach 2 received the highest calculated radiation doses, except for the epibenthic fish which received the highest calculated dose from Reach 3.

6.7.4 Uncertainties Concerning Risks from Radionuclides

The methodology used to estimate radiation doses to biota is believed to overestimate the doses that would be received if the exposure scenarios actually existed. Whereas some information necessary to implement the methodology is well known, so much is unknown or unspecified statistically. This paucity of information dictates a conservative, but reasonable, approach to model assumptions and radiological exposure scenarios in order not to underestimate the risk to biota.

Factors used in the dosimetry methodology can be divided into three categories: (1) biological information including life history parameters of the organism and characteristics of the environment in which it lives, (2) analytical measurements of radionuclides in media which expose the organism, and (3) dosimetry parameters used to translate the radionuclide concentrations in organism and environment into the quantity of energy absorbed (dose) by the biota. These factors are discussed below in the context of their major uncertainties as they apply to the four representative biota for which radiation doses were calculated.

Radiation dose to mayflies. The dosimetry exposure model for benthic invertebrates assumed that mayfly nymphs spend one year developing in radioactive sediments before before leaving sediments and water to become free-flying adults. Unusually high water temperatures could hasten development and thus reduce exposure to radioactive sediments. Unfavorable conditions might, instead, prolong exposure to sediments if growth and development are retarded. A reasonable upper limit might be two years of exposure in radioactive sediments and a resultant doubling of the dose compared to the model assumptions. Radionuclide concentrations are known to vary appreciably in the Clinch River with highest concentrations in the main channel and lower concentrations in shallower and shoreline areas. Edmonds et al. (1976) stated that mayflies are most abundant in shallow sediments but are found in lesser numbers down to maximum depths of about eighteen meters. Since the radionuclide concentrations used in the calculations are not for deep water sediments, the assumed exposures would probably not be exceeded for any appreciable part of the population. However, a number of simplifying assumptions for the mayfly dosimetry model are not easily verified and thus there could exist actual conditions that could lead to higher doses than calculated.

Radiation dose to epibenthic fish. Generic bioaccumulation factors were used instead of actual measured concentrations in fish flesh. It is unknown how the generic factors compare to actual bioaccumulation factors for the different fish. Each radionuclide represents an independent statistic, so some degree of uncertainty is associated with the overall effect on total dose rate. This uncertainty could be quantified by comparing results from the use of bioaccumulation factors to radioanalytical results for the flesh of epibenthic fish from the reference locations. A dominating conservative assumption in the dosimetry model is that the epibenthic fish is always in close proximity to the contaminated sediments. In reality, whenever the fish is swimming more than 60 to 100 cm above the bottom sediments the relatively non-contaminated water would act as a shield in reducing or eliminating the radiation dose from bottom sediments. The extent to which this dose-reducing swimming behavior occurs is unknown.

Radiation dose to great blue heron. Almost all of the radiation dose received by the model great blue heron comes from consumption of contaminated fish. A fish consumption rate of 0.42 kg/day (USEPA 1993) was assumed for this important exposure pathway. Also, it was assumed that 100 percent of the diet was composed of radioactively-contaminated fish. The calculated annual dose rate to the great blue heron would increase or decrease proportionally for any deviation from this food intake rate, and any consumption of non-contaminated fish would decrease the radiation dose rate proportionally. Modelling assumptions required that the daily time used to carry out normal activities be apportioned in order to estimate external radiation doses from different activities. Thus, one-third of the time was assumed for exposure to contaminated sediments, one-third of the time for external exposure to contaminated water, and one-third of the time for no external exposure. These assumptions were also used by Baker and Soldat (1992), but their choice of partitioning of time was arbitrary also.

Radiation dose to eastern cottontail rabbit. In the absence of documented observations, it was assumed that the model rabbit spent one-half of the time in a burrow and the other one-half of the time above ground. The radiological dosimetry assumptions result in a dose rate from irradiation in a burrow constructed in radioactive deep dredge spoils that is double the dose when the rabbit is on the land surface. Any deviations from these simplifying exposure assumptions would change the dose rates proportionately. The dose rate calculations revealed that the predominant pathway of exposure to the model rabbit was from direct intake of contaminated sediments, especially through inhalation of spoils-derived dust. Because of the lack of actual measurements on the quantities of spoils-derived dust expected to be inhaled, a conservative estimate of mass loading was made for the air breathed by the model rabbit. A mass loading rate of 0.0001 kg/m^3 was chosen for spoils-derived contamination of air breathed by the rabbit. While considerable uncertainty exists as to what the actual value might be for a rabbit living under the scenario developed for the dosimetry model, it is probably not reasonable to

assume a larger sustained mass loading factor because of physical limitations. The fact that the inhalation pathway dominates estimated radiological exposures to the rabbit is most likely an indication of the conservative nature of the mass loading rate assumption.

6.8 SUMMARY AND CONCLUSIONS

Significant ecological risks were identified in the Poplar Creek embayment (Reach 3) but not in the Clinch River. Although potentially toxic concentrations of chemicals, significant toxicity test results, or elevated levels of bioindicators of contaminant exposure in fish were observed in other reaches, only in Poplar Creek was the weight of evidence consistent with significant risks.

Although risks to fish in Poplar Creek is not high, the weight of evidence indicates that toxic effects are causing a significant risk of a 20% reduction in fish species richness and abundance. Reach 3 water was toxic to fish embryos and concentations of dissolved metals episodically reached toxic levels. In addition, although PCBs were detected on only one occasion in Reach 3, PCB concentrations in whole catfish were estimated to reach concentrations that are toxic to that species in the laboratory. That result is consistent with the discovery of liver histopathologies in largemouth bass that are characteristic of PCB exposure. Fish species richness and abundance were relatively low in upper Reach 3, which is consistent with toxic effects, but may also be due to habitat factors.

Although risks to fish in Poplar Creek is not high and the evidence is not consistent, the weight of evidence indicates that toxic effects are causing a significant risk of a 20% reduction in benthic invertebrate species richness and abundance. Reach 3 sediments contained several metals and organic chemicals at concentrations that have been reported to be toxic in most studies at other sites. Sediment pore water and water above sediments were not found to be toxic, but some whole sediment samples from all subreaches of Reach 3 were acutely lethal to an amphipod. That result suggests that sediment toxicity is highly heterogeneous and is due to chemicals that are highly associated with the solid phase. Benthic community characteristics were highly variable among sites and could not be used to imply or refute the occurrence of a 20% reduction in species richness or abundance.

Risks to fish-eating wildlife inhabiting Poplar Creek embayment are estimated to be insignificant. Great blue heron and osprey reproduction are high and mink fed 50% Poplar Creek fish or less displayed no toxic effects. Modelled exposures and effects were consistent with these results.

Risks to bats inhabiting Poplar Creek embayment are estimated to be insignificant, but swallows were estimated to be significantly at risk of a 20% reduction in population production. The risks to swallows are based on exposure of a colony on subreach 3.01 to mercury in emergent aquatic insects.

The risk to cottontail rabbits foraging on a hypothetical area consisting of dredge spoil from Poplar Creek was estimated to be significant. The risk was due entirely to mercury.

6.9 REMEDIAL GOAL OPTIONS FOR ECOLOGICAL ENDPOINTS

6.9.1 Remedial Goal Options for the Fish Community

Fish are exposed to contaminants primarily by direct exposure to contaminated water. The CR/PC OU is not a potential source of aqueous contaminants unless contaminants are being remobilized from sediments. However, that does not appear to be occurring to a significant extent. Therefore, no actions

would be taken in the CR/PC OU to remediate water. However, since significant toxic effects are occurring in Poplar Creek (Reach 3) and since the ORR is a unitary CERCLA site, it is necessary to consider what actions are needed in upstream OUs to remediate the risks to the fish community in that reach. No RGOs are proposed for other reaches because the risks to the fish communities in those reaches were judged to be acceptable.

Episodically high concentrations of chemicals were observed in Poplar Creek that exceeded National Ambient Water Quality Criteria or other ecotoxicological benchmarks. Actions should be taken to ensure that dissolved-phase concentrations do not exceed acutely lethal levels at any time or chronically toxic levels during periods when fish are spawning in the embayment. These levels are listed in Table 6.37 for those chemicals that were observed at excessive concentrations in Reach 3 during the RI.

The clearest indications of toxic effects on fish are the results of the toxicity tests with medaka and redbreast sunfish. However, because of limitations of the water sampling and analysis and of the available toxicity data base for fish embryos, it is not clear what chemicals are causing the toxicity. A toxicity identification and evaluation (TIE) should be performed for the medaka test following the EPA methodology. The TIE should indicate which chemicals are causing the toxicity to fish embryos and at what concentrations, thereby indicating what remedial actions are needed.

Table 6.37. RGOs for reducing risks to fish from contaminants in water (mg/L)

Chemical	Acute RGO	Chronic RGO
Copper	0.018[a]	0.012[b]
Mercury	0.0024[a]	0.0002[c]
Nickel	1.4[a]	0.011[d]
Silver	0.0041[a]	0.00012[c]

[a] Acute NAWQC
[b] Chronic NAWQC
[c] CV for fathead minnow.
[d] CV for *C. dubia*

6.9.2 Remedial Goal Options for the Benthic Invertebrate Community

Benthic invertebrates are exposed to contaminants primarily by direct exposure to contaminated sediment and sediment pore water. The weight of evidence indicates that Poplar Creek (Reach 3) is the only reach in which contaminated sediments are a significant risk to the benthic invertebrate community. Therefore, RGOs are proposed for Reach 3 only.

Whole sediment and pore water concentrations of chemicals were observed in Poplar Creek that exceeded ecotoxicological benchmarks. Actions should be taken to ensure that chemicals in sediment do not occur above concentrations at which effects are expected. Whole sediment concentrations should not exceed the lesser of the ER-M and the 50th percentile of the effects distributions presented in Appendix F3. Pore water concentrations should not exceed the chronic NAWQC, or lowest chronic value for Daphnids if NAWQC are not established. These concentrations are presented in Table 6.38 for those chemicals that were characterized as presenting a significant risk in Reach 3. RGOs are not presented

for chemicals that present a greater risk above the OU (Reach 13) than in Reach 3 (e.g., 2-methylnaphthalene, acenaphthene, total PAHs). Although the 50th percentile of the community level effects distribution was the lowest RGOs available for arsenic, it was not used because it was based on only two data points. Rather, the next lowest available RGO, the 50th percentile of the lethal effects distribution, was used for arsenic.

Table 6.38. RGOs for reducing risks to benthic invertebrates from contaminants in sediment (mg/kg) and pore water (mg/L)

Chemical	Sediment RGO	Pore Water RGO
Arsenic	6.2[a]	N/A
Chromium	90[a]	N/A
Mercury	0.150[a]	N/A
Nickel	22[a]	N/A
Silver	0.8[a]	N/A
PCBs (Total)	0.180[b]	N/A

N/A Not applicable, because this chemical is not a significant risk in this medium or the observed concentrations are below the RGOs.
[a] 50th Percentile from community level or lethal effects distribution, whichever is lower.
[b] ER-M

7. PURPOSE AND ORGANIZATION OF THE FEASIBILITY STUDY

This feasibility study (FS) identifies Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial actions that eliminate, reduce, or control risks to human health and the environment. The FS process, as defined in the National Contingency Plan (NCP) (42 *United States Code* 9601 et seq.), develops remedies that protect human health and the environment, maintains protection over time, and, to the extent practical, treats waste to reduce mobility, toxicity, or volume. U.S. Environmental Protection Agency (EPA) guidance [*Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (Interim Final) EPA 540/5-89/004, Office of Solid Waste and Emergency Response Directive 9355.3-01, October 1988] and the NCP provide criteria for evaluating remedial technologies and alternatives. The primary requirements for the final remedy are protection of human health and the environment and compliance with applicable or relevant and appropriate requirements (ARARs).

Following EPA and Tennessee Department of Environment and Conservation (TDEC) concurrence with the FS, the U.S. Department of Energy (DOE) will prepare a proposed plan for public comment. After consideration of input from the public and regulators, DOE will issue a record of decision (ROD) in which decision makers consider site problems, potential alternatives, and outcomes and select the remedial action that best satisfies statutory goals.

This FS follows the information presented in the remedial investigation (RI), which includes site conditions, nature and extent of contamination, and risks from contaminants. The RI divides the operable unit (OU) into reaches along certain physical boundary points. Because of variability in the contaminant profile, river conditions, and/or risks, subreaches are used to identify areas with consistent characteristics. This FS assembles remedial alternatives that address conditions sitewide, when possible, and address conditions by reach and subreach, as necessary. Following is a review of the reaches and subreaches in the Clinch River/Poplar Creek OU.

- Reach 1: Lower Melton Hill [Clinch River mile (CRM) 23 - 51.3]

- Reach 2: Clinch River from Melton Hill Dam to Poplar Creek (CRM 12.1 - 22)

- Reach 3: Poplar Creek from East Fork Poplar Creek (EFPC) to Clinch River [Poplar Creek mile (PCM) 0 - 5.5]

  — Subreach 3.1: Poplar Creek below EFPC (PCM 4.8 - 5.5)

  — Subreach 3.2: Poplar Creek below Mitchell Branch (PCM 3.1 - 4.6)

  — Subreach 3.3: Poplar Creek below the Y-12 Plant Central Neutralization Facility (PCM 1.3 - 2.9)

  — Subreach 3.4: Poplar Creek below the ash disposal area (PCM 0 - 1)

- Reach 4: Clinch River from Poplar Creek to Lower Watts Bar Reservoir (CRM - 0 - 11.8)

- Reach 7: McCoy Branch Embayment [McCoy Branch Embayment mile (MBM) 0.2 - 0.4]

  — Subreach 7.1: Upper McCoy Branch (MBM 0.4)
  — Subreach 7.2: Lower McCoy Branch (MBM 0.2)

Based on baseline assessments of human health and ecological risks provided in Chapters 5 and 6, Chapter 8 defines remedial action objectives (RAOs) for the site and identifies pathways of concern, contaminants of concern (COCs), and remedial goal options (RGOs). General response actions, potential remedial technologies, and process options are developed and screened for technical implementability. Those general response actions, technologies, and process options that do not satisfy implementability are described briefly and not discussed any further. Those that meet the criteria are carried forward into an evaluation of effectiveness, implementability, and cost.

Chapter 9 combines the retained technologies and process options to develop a range of remedial alternatives consistent with RAOs. Each assembled alternative is evaluated for its implementability, effectiveness, and cost. Alternatives that best satisfy these criteria are carried forward for detailed description and analysis. Alternatives that do not satisfy these criteria will be screened out and justification offered for not carrying them forward into detailed analysis.

Chapter 10 provides a detailed analysis of each alternative carried forward from Chapter 9. This will enable decision makers to choose an appropriate site remedy. Each alternative is

evaluated individually on the basis of seven of the nine CERCLA criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, and/or volume of wastes or contaminants through treatment; (5) short-term effectiveness; (6) implementability; and (7) cost. State acceptance and community acceptance are evaluated as part of the ROD. A comparison among the alternatives, using the same criteria, follows the individual evaluation.

8. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This chapter identifies, screens, and evaluates technologies and process options. Based on information presented in the RI, RAOs for the OU are developed (Sect. 8.1) and potential response actions, used either independently or in combination with other response actions, are identified.

8.1 REMEDIAL ACTION OBJECTIVES

This section develops RAOs for the Clinch River OU. RAOs are media-specific goals for protecting human health and the environment. Objectives outlined in this section are as specific as possible while retaining flexibility in the development of remedial alternatives. RAOs are generally expressed in terms of a combination of contaminant levels and exposure routes. However, as presented later, RAOs are expressed in terms of exposures routes only.

This approach is consistent with *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988) and recognizes that protection of human health and the environment can be achieved by reducing or eliminating human exposure to a given medium (through implementation of a selected remedial alternative) in addition to reducing contaminant levels in that medium, if applicable. For example, if ingestion of contaminated near-shore sediment represents a significant risk to human health, this risk can be reduced by (1) reducing the potential for ingestion of sediment by restricting access to the contamination or (2) implementing a remedial alternative that reduces contaminant levels in near-shore sediments. The importance of protecting human health and the environment through preserving or restoring environmental media (i.e., reducing contaminant levels) serves as the main objective where technically feasible.

Risks to human health and the environment (assessed in Chapters 5 and 6, respectively) are evaluated for all chemicals detected in the Clinch River OU. These assessments are based on the operational history of ORR, results of previous investigations, and results of the RI. Risk quantification is based on the defensible laboratory data generated during the RI.

The primary driver for conducting an FS for the Clinch River OU in terms of human health depends on whether the sediment largely contained beneath the river and additional layers of deposited sediment is considered a medium of potential human exposure. As noted in the human health baseline risk assessment, two types of sediment access where evaluated for several areas (subreaches) along the OU river system (1) dredging of sediments for land application and

farming and (2) direct access to near-shore sediments during periods of low pool. Of these, only direct access to near-shore sediments is considered a viable exposures pathway because dredging for agricultural land application is not generally practiced. Dredging in the TVA waterways system is tightly controlled by TVA and the U.S. Army Corps of Engineers (COE). Unauthorized dredging is prohibited. While the baseline human health risk assessment evaluated exposures, assuming a residential land use (i.e., contact is considered to occur throughout the entire period of low pool exposing near-shore sediments), all the subreaches evaluated in the RI are within the ORR controlled by DOE. In addition, no private properties have been identified with near-shore sediment contamination in excess of risk thresholds; thus, no current unacceptable residential exposures occur.

Ingestion of fish caught within the Clinch River OU is also a driver for the FS because risks associated with fish consumption (largemouth bass and catfish) exceed risk thresholds.

For the purposes of this FS, it is conservatively assumed that the residential exposure scenario evaluated in the baseline human health risk assessment is viable. Based on the results of that assessment, Subreach 3.02 exceeds EPA criteria for identifying chemicals of concern (COCs). The total excess lifetime cancer risk (ELCR) calculated under this scenario just exceeds the criterion of 1×10^{-4} (cumulative ELCR is 2×10^{-4}). The applicable COCs include: Cr, As, Be, ^{238}U, ^{234}U, ^{235}U, ^{137}Cs, and ^{60}Co. While Subreaches 3.04 and 4.02 are associated with a cumulative ELCR of 1×10^{-4}, this value does not exceed the EPA criterion. The fish ingestion scenario is also considered viable; although fish advisories are currently in place. The applicable COCs include: As, Hg, Be, Se, PCBs, ^{137}Cs, ^{90}Sr, aldrin, chlordane, and 4,4'-DDT. Therefore, if the near-shore sediments are considered a likely exposure medium under a residential scenario and the fish consumption scenario is considered without the current fish advisories, the primary purpose of remedial actions would be to limit exposure to the sediments and fish.

Results of the baseline ecological risk assessment suggest that significant ecological risks occur in Reach 3, but not the Clinch River. This is based primarily on weight-of-evidence indicating a 20 percent reduction in fish species richness or abundance. However, it is recognized that community characteristics can be highly variable; therefore, the results may be uncertain.

The remedial action alternatives developed and analyzed in Chapters 9 and 10 are designed to meet the following RAOs.

- If near-shore sediments are a likely exposure medium under a residential scenario, prevent direct access to contaminated sediments to eliminate ingestion, inhalation,

external exposure, and dermal contact exposure routes. This would avoid the potential need for active remediation because sediment removal may cause resuspension and transport of contaminated sediment that could result in contaminant concentrations that exceed surface water quality criteria and destruction of benthic invertebrates.

- If deep sediments are a likely exposure medium under a dredging/agricultural application scenario, prevent active dredging and land application of the contaminated portions. This will eliminate ingestion, inhalation, external exposure, dermal contact, and ingestion of meat, milk, and vegetable routes of exposure. This would avoid the potential need for active remediation because sediment removal may cause resuspension and transport of contaminated sediment that could result in contaminant concentrations that exceed surface water quality criteria and destruction of benthic invertebrates.

- Prevent exposure to fish potentially contaminated with COCs.

- Continue monitoring ecological communities for potential impacts in conjunction with actions taken in upstream OUs to prevent ongoing releases to the Poplar Creek and Clinch River OUs.

To meet these RAOs, technologies and process options described in the following sections, as well as alternatives which follow in later chapters, will not attempt to actively remediate deep sediments, but will address controls that will enable these sediments to remain in place and undisturbed.

8.2 IDENTIFICATION, SCREENING, AND EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS

Technology groups and process options can be identified from several sources. The Y-12 Plant Technology Logic Diagram (Energy Systems 1994), ReOpt version 2.1 (Battelle Memorial Institute); the *Remedial Investigation/Feasibility Study Report for Lower Watts Bar Reservoir Operable Unit*; *Dredging '94, Proceedings of the Second International Conference on Dredging and Dredged Material Placement*, Vols. 1 and 2; *Review of Removal, Containment, and Treatment Technologies for Remediation of Contaminated Sediment in the Great Lakes*; and the *Y-12 Plant-Bear Creek Valley OU 2 FS* were tools used to develop a list of technologies and process options that apply to the media of interest.

Identified technologies and process options have progressed beyond the laboratory research and development stages and are potentially applicable to the source areas of the OU. As shown in Figure 8.1, the general response actions previously listed are broad categories that address similar problems. The general response action of containment, for example, includes technology groups such as capping and vertical barriers. Each of these technology groups contains several process options that may be used (e.g., capping includes Armorform, bentonite/soil cap, clean sediment, and geomembrane).

General response actions have been developed to protect human health and the environment from site contaminants. These include:

- no action,
- institutional controls and advisories,
- source containment,
- removal,
- turbidity minimization,
- ex situ treatment, and
- disposal.

These actions address the environmental and public health impacts of contaminants, possible migration pathways, and exposure routes for sources. A combination of general response actions may prove more effective in meeting the RAOs than a single action.

As specified in the RI/FS guidance (EPA 1988), two steps are taken to reduce the number of technology groups and process options that are developed into alternatives. First, each process option is evaluated for technical applicability by comparing capabilities against the characteristics of the OU and its contaminants. Site conditions, against which each process option is assessed in this screening step and the following screening step, are shown in Table 8.1. Some options may not be applicable to site conditions (depth of contamination or types of contaminants). Process options that are not technically applicable are eliminated from further consideration. In some cases, none of the process options for a given technology is considered technically applicable at the OU, and the entire technology will be eliminated. Eliminated options or technology groups will not be discussed in this document. Each technology that passes the first screening step will have one or more process options. Eliminated process options are indicated in Figure 8.1 with cross-hatched boxes. A brief description is given to indicate why the option is not considered technically applicable to the site.

Table 8.1. Site physical and contaminant characteristics for the Clinch River/Poplar Creek Operable Unit

Parameter	Physical site characteristics
Climate	Humid, temperate, minor freeze/thaw
Sediment properties	Typically soft silts and clays, with some sand; discontinuous depositional areas; bedrock exposure and/or boulders present in some areas
Reservoir pool	Summer (ft MSL) / Winter (ft MSL)
(above Melton Hill Dam)	790 / 795
(below Melton Hill Dam)	741 / 735
Flow rate	Controlled reservoir, 0–1,215 m^3/second at Melton Hill Dam
Terrain	Variable, mostly riverine with some lacustrine characteristics in downstream areas near the confluence with the Tennessee River
Accessibility	Varied by combination of terrain, water depth and speed, and point of entry
Parameter	**Contaminant characteristics**
Contaminants of concern	Cr, As, Mn, ^{137}Cs, ^{234}U, ^{238}U, ^{40}K, PCBs, pesticides
Waste form	Sediment: particulate association Biota: tissue Surface water: in solution and particulate association
Previous actions	Source controls under CERCLA and institutional controls by other statutory authorities
Persistence	Metals, high PCBs, high-bioconcentrating Rads, half-life dependent
Mobility	Low in sediment under normal conditions; high in surface water; moderate in fish, which tend to inhabit ranges approximately within a 2-mile radius up or downstream
Natural degradation	Good for organics, poor for PCBs, and not applicable to metals
Radioactivity	Low at surface sediments, fish, and surface water; moderate in deep sediments

As = arsenic
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
Cr = chromium
Cs = cesium
DDT = dichlorodiphenyltrichloroethane
ft = foot
K = potassium
m = meter
Mn = manganese
MSL = mean sea level
PCB = polychlorinated biphenyl
Rad = radioactive
Tc = technetium
U = uranium

During the second step, the remaining process options are evaluated more closely to determine which process options and technologies will be developed into remedial alternatives. This evaluation selects a single process option or combination of process options to represent each technology group so an estimated cost can be developed for each alternative. The single process

option or combination of options that appears to offer the best blend of effectiveness, implementability, and cost is carried forward for development into remedial alternatives in Chapter 9. These process options are indicated in Figure 8.1 with double-outlined boxes.

Process options or technology groups not carried forward to development of alternatives remain technically site applicable, but under current conditions do not offer the best blend of effectiveness, implementability, and/or cost. Although these will not be carried forward for remedial alternative development, they can be reevaluated during the proposed plan, the ROD, or the remedial design. These process options are indicated in single-outlined boxes.

A comprehensive discussion of all process options remaining after the first screening step for technical applicability is provided in Appendix I. The discussion includes a technical description of the option, effectiveness, implementability, cost, and the rationale for determining the representative process options carried forward into remedial alternative development.

General Response Action	Remedial Technology Type	Process Options	Description	Discussion
1.1 No Action	1.1.1 None	None	National Contingency Plan (NCP) requires the no action alternative to be carried through the detailed analysis	Required for comparative purposes by NCP
1.2 Institutional Controls and Advisories	1.2.1 Access and Use Restrictions	Deed Restrictions	Restrictions and notifications placed in the deeds of impacted properties	Potentially viable; effective in preventing improper development
		Public Advisories	Post and publish advisories describing fish consumption limits and/or water contact warnings	Viable and in place
		Permit Programs	Require permits for all sediment dredging or similar activities that may liberate contaminated sediments	Viable and in place
		Land Purchase/Condemnation	Contaminated land may be acquired by purchase or condemnation	Potentially viable; not representative because no near shore sediment contamination identified on private property
		Physical Barriers	Barriers such as fencing, signs, and other access limiting measures	Potentially viable for shallow areas
	1.2.2 Maintenance and Monitoring	Monitoring	Monitoring of contaminant levels in water, sediments and biota	Potentially viable; useful for detecting changes in OU conditions
		Surveillance and Maintenance	Routine physical site surveys and maintenance	Potentially viable; cost effective means to ensure and verify integrity of engineered controls or devices

1.2 Representative Process Option

Reference section number in Appendix I.

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Fig. 8.1

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Results of process option screening

DOE - Clinch River OU- Oak Ridge, Tennessee

DOCUMENT ID: 35H830
5302-10 / FS
DRAWING ID:
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SEPTEMBER 14, 1995 TR

General Response Action	Remedial Technology Type	Process Options	Description	Discussion
1.3 Source Containment	1.3.1 Capping (Horizontal Barriers)	Bentonite and Soil Caps	Clay- and soil-based cap is a single-layer unit that relies on low permeability clay to inhibit infiltration of precipitation through contaminated soil	Not applicable because unsuitable for saturated sediment conditions
		Armorform	Double-layer woven fabrics engineered exclusively to serve as forms for casting concrete erosion control revetments and linings	Potentially viable; not representative because large main channel applications are impractical
		Geomembrane	An impermeable synthetic liner placed over sediments to isolate contaminants	Potentially viable for near-shore sediments
		Clean Sediment	Clean sediments are placed over contaminated sediments to isolate contaminants	Potentially viable; not representative because river currents and biotic action may compromise cap integrity or reliability
	Vertical Subsurface Barrier	Soil-Bentonite Slurry Wall	Trench excavated above and/or around contaminated area and filled with bentonite or soil-bentonite slurry to create a low-permeability barrier to shallow subsurface flow	Not necessary; not applicable because groundwater outside of operable unit programmatic boundary
		Vibrating Beam Sheet Pilings	Chemical or cement grout injected between parallel sheet pilings to create low-permeability barrier to shallow subsurface flow	Not necessary; not applicable because groundwater outside of operable unit programmatic boundary
		Grout Curtains	Low-permeability barrier of chemical or cement-based grout injection in a series of overlapping vertical wells to create a low-permeability barrier to shallow subsurface flow	Not necessary; not applicable because groundwater outside of operable unit programmatic boundary

1.3 Representative Process Option — Screened Out

Reference section number in Appendix I.

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Fig. 8.1

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Results of process option screening

DOE - Clinch River OU - Oak Ridge, Tennessee

DOCUMENT ID: 3511830
5302-10 / FS
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SEPTEMBER 14, 1995 TR

General Response Action	Remedial Technology Type	Process Options	Description	Discussion
1.4 Removal	1.4.1 Excavation	Mechanical	Removal of soil or sediments with mechanically operated equipment such as backhoe, bulldozer, etc.	Mechanical excavation will be necessary for relocation of any surface sediment
	1.4.2 Dredging	Mechanical	Removal of soft, cohesive sediment	Potentially viable; proven applicable to contaminated sediments. Not representative due to extreme difficulty in implementability and cost effectiveness for near shore sediments.
		Hydraulic	Removal of bulk materials, sediments,and granular materials using barge- or surface-mounted hydraulic pumps	
		Pneumatic	Removal of liquids by using compressed air to pump slurry through a pipeline	
1.5 Turbidity Minimization	1.5.1 Water Turbidity Minimization	Caissons, Dikes, and Cofferdams	Physical barriers are installed around the area of sediment removal to intercept the resuspended sediments not captured by the process itself	Not needed for the expected site conditions
		Silt Curtains	Impervious barriers that extend vertically from the water surface to a specified depth	Potentially viable; not representative because effectiveness limited to submerged applications
		Silt Screens	A synthetic geotextile fabric that allows water to pass through small openings in the fabric but retains suspended solids	Potentially viable; not representative because effectiveness limited to submerged applications
	Surface Water Collection	Collection Sumps, Dams, Levees and Basins	Surface water collectors for capture of sediments	Not applicable because not suitable for expected site conditions

1.5 Representative Process Option — Screened Out

Reference section number in Appendix I.

JE®

Fig. 8.1

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Results of process option Screening

DOE - Clinch River OU - Oak Ridge, Tennessee

DOCUMENT ID: 35H830
5302-10 / FS
DRAWING ID:
95-11697.XLS
SEPTEMBER 14, 1995 TR

General Response Action	Remedial Technology Type	Process Options	Description	Discussion
1.6 Ex Situ Treatment	1.6.1 Physiochemical	Chemical Extraction/Soilwashing	Contaminants which tend to associate with finer-grained particles are separated out during this process	Potentially necessary following a removal of sediments; not representative due to minimal reduction of waste material to be treated
		Solidification/Stabilization	Sediments are mixed with cement-like matrix that immobilizes contaminated sediments	Potentially necessary following a removal of sediments
		Dehalogenation	A chemical reaction that breaks the carbon halogen bond	Not applicable to aqueous wastes, soils, sludges, or sediments; not applicable because of the reagents reactivity with water
		Chemical-Precipitation/ Flocculation	Addition of chemicals to precipitate metals from solution and mechanical techniques to enhance flocculation and settlement	Potentially viable for water remediation; not representative due to inadequate treatment facilities
		Ion Exchange	A volume and toxicity reducer that removes ionic species, principally inorganics, from aqueous waste streams	Potentially viable in treating inorganics in solutions; not representative due to inadequate treatment facilities
	1.6.2 Thermal	Incineration	The incinerating of incomplete combustion, volatile, or off-gases in a device commonly referred to as an afterburner	Potentially viable; mercury would be volatilizied; not representative due to strict operation controls
		Thermal Desorption	Moderate temperature vaporization using rotary drums or pug mills to separate volatile metals from the sediment	Potentially viable; mercury would be volatilizied
		Pyrolysis	The thermal degradation of organic matter in the absence of oxygen	Potentially viable; mercury would be volatilizied; not representative due to strict operation controls
		Infrared Thermal	Treatment of organics occurs in a primary combustion chamber where contaminated material is exposed to infrared radiation	Potentially viable; mercury would be volatilizied; not representative due to strict operation controls

1.6 Representative Process Option — Reference section number in Appendix I.

Screened Out

JE®

Fig. 8.1

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Results of process option screening

DOE - Clinch River OU - Oak Ridge, Tennessee

DOCUMENT ID: 3511830
5302-10 / FS
DRAWING ID:
95-11697.XLS
SEPTEMBER 14, 1995 1R

General Response Action	Remedial Technology Type	Process Options	Description	Discussion
1.6 Ex Situ Treatment *(continued)*	Biodegradation	Biobeds	Biodegradation in a lined treatment bed	Unsuitable; not applicable because organics in near- shore sediment are not COCs
		Landfarming	Natural biodegradation is promoted by spreading contaminated material on the ground surface	
		Bioreactor	A bioreactor or treatment vessel where contaminated material can be rapidly biodegraded in a controlled environment	
		Composting	Organic carbon sources and bulking agents; woodchips, straw, etc., are mixed with contaminated soil and optimum condition maintained to promote biodegradation	
	1.6.3 Dewatering	Belt Filter Press	Compresses sediment slurry to remove free water producing sediment cakes	Potentially viable; not representative because sediment and/or water may require additional treatment and/or disposal
		Settling Ponds	Uses large areas constructed to allow for gravitational settling and liquid/solid separation	
		Fly Ash	Use of fly ash to physically combine with slurry to absorb free water	Potentially viable; not representative because substantially increases volume of contaminated material to handle
		Sloping Dewatering Pad	Constructed sloping concrete pad to place dredged sediments onto and allowing water to drain out of sediment	Potentially viable; effective in dewatering sediments passively using natural processes

1.6 Representative Process Option — Screened Out

Reference section number in Appendix I.

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Fig. 8.1

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Results of process option screening

DOE - Clinch River OU - Oak Ridge, Tennessee

DOCUMENT ID: 3511830
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DRAWING ID:
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SEPTEMBER 14, 1995 TR

General Response Action	Remedial Technology Type	Process Options	Description	Discussion
1.7 Disposal	1.7.1 On-Site Sediment Disposal	ORNL Interim Waste Management Facility	Storing solid low-level waste sediments to effectively reduce site risks to humans and ecological receptors	Potentially difficult due to WAC and landfill capacity; does not accept mixed waste
		Y-12 Plant Landfill VI or VII	Disposal of "special waste"	Must comply with waste acceptance criteria and TDEC approval; does not accept mixed waste
		Beneficial Re-Use	Used as aggregate for roadway/runway fill, if release of the material is acceptable	Not representative because release of material may present certain liabilities
		Reclamation/Recycling	Recovery of contaminants of high concentrations for economic re-use	Not cost-effective; not representative because the treatment of sediment to recover the available be very expensive
	1.7.2 Off-Site Sediment Disposal	Envirocare	Disposal of mixed waste at off-site facility with adequate capacity and applicable waste acceptance criteria	Potentially difficult due to extreme costs of disposing mixed waste
		Nevada Test Site (NTS)	Disposal of defense-related low-level waste	Accepts only defense-related waste; not representative because it does not accept mixed waste
	1.7.3 Water Disposal	Y-12 Plant West End Treatment Facility	Treatment and disposal facility for contaminated water removed from dewatered sediment	Must comply with acceptance criteria and TDEC approval
	1.7.4 Waste Transportation	Trucks	Vehicles used to haul material (sediment/water) for treatment or disposal	Potentially viable for hauling contaminated material
		Rail	Transport of dewatered sediment for long distance, mixed waste disposal	Potentially viable; representative for shipments to Envirocare

1.7 Representative Process Option

Reference section number in Appendix I.

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Fig. 8.1

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Results of process option screening

DOE - Clinch River OU - Oak Ridge, Tennessee

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9. DEVELOPMENT OF ALTERNATIVES

This chapter presents the development of remedial alternatives assembled from combinations of technologies and representative process options evaluated in Chapter 8. Section 9.1 presents the rationale for the development approach, waste type criteria, common factors to the OU, and media-specific criteria. Section 9.2 describes the alternatives, including outlines of process options and technologies used to assemble each alternative. Section 9.3 screens alternatives based on effectiveness, implementability, and cost. The alternatives that remain following the Section 9.3 screening are described in detail in Section 9.4, including process options, areas by reach or subreach where an alternative is proposed, and descriptions of process options, as applied.

Alternatives not currently selected for detailed description and subsequent detailed analysis may be reevaluated in the future for potential implementation.

9.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

9.1.1 Approach for Developing Remedial Alternatives

EPA guidance (EPA 1988) establishes an approach to develop appropriate remedial action alternatives. Using this approach, the scope, characteristics, and complexity of the specific conditions at the Clinch River/Poplar Creek OU site are considered in developing a range of alternatives that protect human health and the environment. Protection may be achieved by eliminating, reducing, or controlling risks posed by each pathway at a site.

The NCP lists the following preferences in developing and screening remedial action alternatives:

- use of treatment to address the principal threats posed by a site, wherever practical;
- use of engineering controls, such as containment, for waste that poses a relatively low, long-term threat and for which treatment is not practical;
- implementation of a combination of actions, as appropriate, to achieve protection of human health and the environment (e.g., in appropriate site situations, treatment of principal threats would be combined with engineering controls, such as containment, and institutional controls for treatment of residuals and untreated waste);

- use of institutional controls, such as drinking water supply controls and deed restrictions, to supplement engineering controls for short- and long-term management to prevent or limit exposures to hazardous substances; and

- selection of an innovative technology when the technology offers the following: the potential for comparable or better treatment performance or implementability, fewer, or lesser magnitude, adverse impacts than other available approaches, or lower costs than demonstrated technologies for similar levels of performance.

9.1.1.1 Common factors

Naturally occurring processes can affect, directly or indirectly, the effectiveness of implemented alternatives. Natural sedimentation will further the buildup of "clean" sediments over contaminated deep sediments and initially cover contaminated shallow sediment. With enough clean sediment cover, benthic organisms will no longer feed on contaminated sediment, thus reducing contaminants available in the food web. This process will continue to isolate and further reduce availability of the contaminants. In spite of the benefit natural sedimentation gives with respect to contaminant isolation, too much sedimentation can eventually result in a sediment-clogged reservoir and an unnavigable waterway. Excess sediments must be periodically cleared from the channel to maintain the waterway. Moreover, if contributing sources continue to add contaminants to the system, then some remedial options designed to reduce risks from contaminants presently in place may become ineffective over time. Protection from (currently) contaminated sediments may be short-lived depending on the sedimentation rate and contaminant influx. Alternative assembly considers the good and bad aspects of natural sedimentation.

The second naturally occurring process common throughout the OU is the natural degradation of the contaminants, including biodegradation and radioactive decay. The toxicity of some metals and organics diminishes with time as naturally occurring bacteria in the sediment consume the material producing less toxic by-products. Natural processes reduce the chemical mobility of metal ions and radioactive isotopes. The combination of natural sedimentation and natural degradation can ultimately reduce risk from ingestion of fish and exposure to shallow and deep sediments.

9.1.1.2 Media-specific criteria

Contaminated media targeted for alternative development include: (1) sediments of Subreach 3.02 at the mouth of Mitchell Branch and (2) various fish species in Reaches 1, 2, 3, and 4.

The following criteria discussion is intended to tailor alternatives to best fit the needs of the various media, pathways, and contaminants.

Alternative assembly for the remediation of contaminated biota was based on the following:

- Time, preventing contaminant migration, and natural degradation of contaminants are the only reasonable solutions to an overall biotic remediation in this OU. To expedite the biological recovery in the ecosystem, elimination or reduction of contaminant input from ORR and other sources to the river system would lower bioavailability of contaminants and reduce ecological risk levels.

- The fish pathway of concern (to humans) is based on the consumption of contaminated fish. If release of contaminants to the reservoir and its tributaries cease, then contaminant levels in the fish population will decline. For the near term, interruption of this pathway is the primary focus that each remedial alternative will have with regard to human health risk reduction.

Alternative assembly for the remediation of contaminated shallow sediments was based on the following:

- Near shore sediments are submerged at summer pool under as much as 6 ft of water. Some portion of the sediment profile is exposed during drawdown of the reservoir until its lowest drawdown elevation, winter pool, when all of the shallow sediments are without water coverage. Certain portions of the OU, like Poplar Creek, may have lead and lag times in response to precipitation events and discharge events from upstream tributaries and down stream dams. It is assumed that water elevations may exceed summer pool elevations (i.e., floods), but will not be less than winter pool elevation (i.e., dried up).

Alternative assembly for the remediation of contaminated deep sediments was based on the following:

- Deep sediments are immobile under current daily river conditions and fluctuations.

- Deep sediments <u>do not</u> pose unacceptable risk to human populations or biota when left in place during either summer or winter pool.

- Deep sediments could pose unacceptable risk to humans and biota when dredged and used untreated, exclusive of surrounding clean sediments/soils.

9.2 DESCRIPTION AND SCREENING OF ALTERNATIVES

The following sections present abbreviated descriptions of all alternatives developed for Clinch River and Poplar Creek. The descriptions are based on preliminary designs developed for this FS. For detailed descriptions of process options used in the following alternatives see Appendix I.

The NCP requires that alternatives be screened primarily on the basis of effectiveness and implementability, and to a lesser extent on cost. Following the screening of alternatives, each of the retained remedial alternatives is summarized, including contingencies.

9.2.1 Alternative 1—No Action

As required by the NCP, the no action alternative provides a comparative baseline against which other alternatives can be evaluated. Under this alternative, no action would be implemented and the contaminated sediments in Clinch River and Poplar Creek would be left "as is," without implementing any control, containment, removal, treatment, or other mitigating actions.

This alternative would be effective if all existing controls could be assumed to remain in place. Some reaches are essentially upstream of DOE source areas and sediment depositions in these areas are not known to exceed unacceptable risk levels. Any DOE-derived contaminated sediments upstream of DOE source areas are likely the result of backflow conditions during raising or lowering of the reservoir. Sampling efforts and the baseline risk assessment results indicate no sediment contamination at unacceptable levels in the upstream reaches. The baseline risk assessment does, however, indicate that some fish species in Reaches 1, 2, 3, and 4 present unacceptable risk to human health. Sediments in portions of Poplar Creek and Clinch River may be a threat to ecological health. Discontinuing fish consumption advisories may allow humans to consume fish in sufficient quantities to cause harm. Unregulated sediment-disturbing activities may cause fugitive sediment to deposit in clean areas unnoticed and pose unacceptable risk to human and ecological receptors.

Implementability of this alternative is technically feasible. No construction or monitoring activities would be performed. There are no associated capital or operation and maintenance (O&M) costs.

9.2.2 Alternative 2—Institutional Controls and Advisories

Alternative 2 is proposed as a means to manage contaminants in place and without treatment. Long-term management of these contaminants must continue because the contaminants would remain in place. This alternative would address the entire area of both OUs. Components of Alternative 2 include:

- deed restrictions,
- public advisories,
- permit programs,
- monitoring, and
- surveillance and maintenance.

Institutional controls and advisories would be protective of human health by managing contaminants left in place. Sediment disturbance would be regulated with other statutory authorities to keep risks from potential contaminant migration to humans and other biota low. Fish consumption advisories would continue under the state of Tennessee to protect the public from contaminated fish. Monitoring will confirm the effectiveness of the other institutional controls by gaging the control benefits and yielding the necessary information to modify the controls, as needed. Surveillance and maintenance can be used to patrol effected areas, postings, etc. for proper maintenance. Should a larger area of contamination be identified, the advisories and controls (at small additional cost) would be expanded to address the new threat.

This alternative is effective. The low-level threat contaminants within the OU can be managed with relative ease. Covenants and permit programs will allow shallow and deep sediments to remain undisturbed with little or no unacceptable risk. Approved sediment-disturbing activities would require additional sediment sampling to adequately define the vertical and horizontal extent of contaminated material in the area planned for disturbance. Thus, selective dredging or other sediment-disturbing activities can occur, leaving ORR peak release layers with minimal or no disturbance. Casual or recreational users would not be at risk because they do not receive the same amount of exposure as an on-site resident would receive. Monitoring of fish and sediment is an effective tool to detect changes in the system, such as erosion of contaminated sediment and increased bioavailability, or changes to the system, such as increased input of contaminants. Early detection (best detected with surface water monitoring near the contaminant sources) of these changes will allow for proper response time with appropriate measures.

This alternative is technically implementable. Materials for monitoring and trained technicians to sample fish and sediment are available locally. Administrative implementability is considered to be moderately difficult. Meetings and information exchange among DOE, COE, and TVA regarding sediment-disturbance permits, monitoring data, and implementation of deed restrictions all require an organized effort to remain effective at long-term management of in situ contaminants.

Cost for this alternative is considered moderate. Direct capital costs include administrative costs for implementation of covenants, public advisories, and permit programs. Indirect capital costs include costs from remedial action and remedial design work plans and report preparations. Long-term costs include monitoring supplies and equipment, sampling effort labor, and laboratory costs.

9.2.3 Alternative 3—Source Containment

Alternative 3 is proposed as a means to provide an additional component of source containment for shallow sediments where contaminants exceed risk thresholds. Alternative 3 consists of institutional controls and advisories and geomembrane capping.

Institutional controls and advisories would be the same as described in Alternative 2. Geomembrane capping (described below) would be used in lieu of institutional controls when technically feasible. Access restrictions such as fencing and signs would be used only where site conditions such as steepness of shore slopes are too great to implement source containment measures.

Geomembrane capping would place an impermeable barrier over contaminated shallow sediment to impede availability of these sediments to biological and human receptors. Potential wind and water erosion would be minimized to prevent redistribution of contaminants. Geomembrane capping within Poplar Creek would consist of approximately 44,000 ft^2 of geotextile, membrane, and rip-rap.

Protection of the public from contaminants is further enhanced by adding a horizontal barrier which isolates contaminants from potential receptors, human (now and future on-site resident) and ecological receptors. Shallow sediments would be protected from erosion and thus potential redistribution of contaminants would be minimized. Should a larger area of contamination be identified, advisories, controls, and containment options (at potentially significant additional cost) would be expanded to address the new threat.

This alternative is considered effective. All of the institutional control options in Alternative 2 are applied again for this alternative. Containment of shallow sediments will offer a greater degree of protection from those sediments currently exposed at winter pool. Contaminated deep sediments will continue to be protected from disturbance with permit programs. Fish consumption advisories will remain in effect. Covenants will continue to protect property from improper development, and monitoring will continue to track system conditions. If the property were developed into a residential area the capped portion of the shoreline would protect humans from contact with contaminants thereby keeping risks well below unacceptable levels. Aquatic plants would be displaced during the construction phases. Fish, benthos, and species that feed on these would initially be displaced too, but may ultimately recover, recolonize the area, and benefit by no longer residing in contaminated sediment. Long-term effectiveness of this alternative should be very good because contaminants exceeding risk thresholds would be isolated, leaving no realistic pathway of concern.

Technical implementability for Alternative 3 is moderately difficult. Capping construction requires considerable amounts of vegetative clearing for site access and area preparation. Materials and labor for the cap option are readily available.

Costs associated with this alternative are medium. Direct capital costs for the cap include materials and associated labor, administrative costs for implementation of covenants, public advisories, and permit programs. Indirect capital costs will include costs from remedial action and remedial design work plans and report preparations. Long-term costs will include monitoring supplies and equipment, sampling effort labor, and laboratory costs. Costs for cap maintenance include annual surveillance to ensure cap integrity. Costs for cap repairs are not included in this estimate because of the historical durability of the cap design and the unlikelihood of storms or floating debris causing damage to the cap. Some cap maintenance costs may be expected after that period. Adequate monitoring will detect early deterioration in the cap and allow for less costly repairs, if they become necessary.

9.2.4 Alternative 4—Removal, Treatment, and Disposal

Alternative 4 is proposed as a means to permanently remove approximately 14,000 yd^3 of source contaminants in shallow sediments within Poplar Creek. The main components of this alternative are:

- institutional controls and advisories, as described in Alternative 2;
- mechanical excavation;
- a sloping dewatering pad;
- thermal desorption;

- solidification/stabilization; and
- disposal.

Mechanical excavation of shallow sediments would be performed while the reservoir is at winter pool to minimize the amount of water removed with the sediment. Mechanical excavation would have a very high rate of sediment resuspension if conducted while the sediment is covered with water. Precipitation and run-on could remobilize sediments in uncontrolled erosion, depending on the intensity of the precipitation. A daily cover, such as a tarp, would divert direct precipitation from entering the excavation area. Silt fencing would be tied to staked straw bales installed at the top and bottom of the slope to control run-on and runoff, respectively.

A sloping dewatering pad would be used to dewater sediment. The pad would be bermed on three sides with the open side having the highest elevation. Trucks will bring in the excavated sediment, accessing the open side, and dump it. A collection trench on the lowest side of the pad would allow for the collection of the water draining from the sediment and any seepage through the pad. Only small amounts of pore water are expected, but a means to collect the water is needed. Uncontrolled discharge of this water would be unacceptable.

Thermal desorption is proposed for some of sediments removed from Poplar Creek. Mercury concentrations exceed acceptable risk levels and potentially exceed allowable Toxicity Characteristic Leaching Procedure (TCLP) concentrations.

Solidification/stabilization is proposed as a contingent action for arsenic in McCoy Branch Embayment sediments. Existing data are inconclusive with regard to the extent of arsenic contamination that would fail TCLP tests. Confirmatory stockpile sampling of the sediment may reveal which areas, if any, need solidification/stabilization treatment before disposal.

Disposal options remain uncertain. Suitable disposal areas hinge mainly on the contaminant profile of the sediment and the ability of the facilities to accept, or have the capacity to accept, contaminated material. Although radionuclides are not a serious human or ecological risk concern, they severely limit the options when disposal of sediments is considered. A combination of waste facilities may be necessary to handle different segments of waste streams to accommodate all waste materials. Each of the following disposal options can handle certain contaminant types. All disposal options require that sediment be dewatered (i.e., no free liquid). Additional treatment, such as those proposed previously, may be necessary for the waste to meet individual disposal site waste acceptance criteria (WAC).

Oak Ridge National Laboratory Interim Waste Management Facility (IWMF) may be used to store sediment as a solid low-level radioactive waste only. If removed sediment has radioactivity above background values, but metal contaminants are below TCLP concentration maximums for the facility WAC or the metals component is properly treated and meets these criteria, then storage of the material here is a potential disposal option. This facility cannot accept mixed waste.

Y-12 Plant Landfill VI or VII may be used to dispose of material as an untreated "special waste" if the radioactivity of the material is at or below background values, concentrations of the metals are relatively low, and regulatory officials will grant special waste permit status. Normally Landfill VI or VII is a construction waste landfill, but special waste status will allow the material to be disposed there. This facility cannot accept mixed waste.

Envirocare, Inc. (Envirocare) of Utah is permitted to accept Class A mixed waste. No treatment, other than dewatering, would be necessary before transport to Envirocare. Envirocare would treat the sediments as necessary for legal disposal.

The Y-12 Plant West End Treatment Facility is proposed to treat and dispose of any water drained from removed sediments. The water would be treated, as necessary, for legal discharge.

Trucks are proposed to be the principal on-site means to move contaminated sediment or water to appropriate treatment and/or disposal areas. Spills and leaks from wet sediment must be avoided. Liners or suitable substitutes will be used to protect potential receptors from contaminants dripping onto roadways. Tanker trucks will be used to collect water drained from sediment, accumulate treatable quantities, and deliver water for treatment.

Rail shipments are only proposed for off-site shipments of sediments to Envirocare. Shipments will be packaged in "7 ANV" B-25 boxes and loaded onto rail cars at a suitable railroad spur. If other subreaches are found to be contaminated, or the known contamination is deeper than originally thought, then the removal area or depth can be expanded (at potentially significant additional cost) to address the new threat. If previously unknown contaminants are identified at significant levels, then treatment (or additional treatment) may be necessary to meet acceptance criteria for disposal of the waste sediments.

Effectiveness of this alternative is expected to be good. Removal of the contaminated shallow sediments will ultimately eliminate risks to human and ecological receptors associated with those contaminants. Deep sediments pose no unacceptable risk because they are protected from sediment-disturbing activities through use of a permit program. Fish consumption

advisories would remain in effect. Covenants would remain to protect against improper development although reliance on them would sharply diminish as contaminated shallow sediments are gone. Monitoring of system conditions would remain effective. Long-term protection to humans and the environment would be very good because shallow sediment contaminants would be removed.

Implementing Alternative 4 will be difficult. Implementation around a limited window of opportunity, the winter pool water level, will require proper planning and materials staging so that execution of the task can be accomplished quickly and efficiently. The level of effort to get in to excavate and get out before the reservoir begins filling will create an explosion of activity focused on a few small areas during a relatively short time period. Administrative implementability too would be difficult. Meetings and information exchange among DOE, COE, and TVA regarding sediment-disturbance permits (CWA Section 404 and the Rivers and Harbors Act), tracking of personnel, equipment, and materials will require much effort to initiate and sustain the level of effort needed.

The cost for this alternative will be high. Treatment of Poplar Creek sediments is expected. All sediments will, at a minimum, require dewatering before any additional treatment (such as thermal desorption) to meet WAC. Each step from removal of sediment to dewatering pad to final disposition will involve repeated waste-handling activities. Direct capital costs include heavy equipment to excavate and haul the material, erosion control devices, dewatering pad materials, construction equipment, and labor. Large amounts of indirect capital costs would be associated with remedial design and work plan reports because of the technical complexity of the alternative.

9.3 SUMMARY OF REMEDIAL ALTERNATIVES

Alternatives 1, 2, and 3 are retained for detailed evaluation for various parts in the Clinch River/Poplar Creek OU previously described. Alternative 1 is retained to meet NCP requirements, and will be carried forward for a detailed description and analysis. Alternatives 2 and 3 are retained for possible implementation in the OU. Each will be carried forward for a detailed description and analysis. Alternative 4 will not be carried forward for a detailed analysis at this time for the following reasons:

- Property Ownership—No private properties have been identified with shallow surface sediment contamination in excess of risk thresholds; therefore, no current on-site residents are at risk.

- Short-Term Impacts—Extensive impacts on the ecosystem will result if this alternative is implemented. Aquatic and terrestrial habitat will be destroyed by the level of invasion necessary for excavation and site preparation. Risks to biota will increase because fugitive sediment within contained areas will further contaminate benthic organisms and the fish which feed on them.

- Implementability—The engineering and planning necessary to implement this alternative would be immense relative to the other alternatives. The reservoir, although controlled when water is released and stored, remains a dynamic system. Excavation is difficult due in part to the measures needed to contain fugitive sediment in uncontrolled run-off. Administrative implementability will also be difficult because meetings and information exchange among DOE, COE, and TVA regarding sediment-disturbance permits (as per CWA Section 404) may be required to implement actions in state or federal waterways.

- Risks From Transport—Transport of approximately 58,300 yd^3 of contaminated sediments from the site to the dewatering pad and then from the dewatering pad for approximately 10 miles along public roads to the disposal site may cause traffic hazards because 11-yd^3-capacity dumptrucks would likely transport this material. Potential traffic accidents may be a concern due to spillage of contaminated material.

- Limited Landfill Space Availability—The expected quantities of sediments to be removed from the OU is approximately 58,300 yd^3. Landfill space at all on-site facilities are limited. Additional disposal space would possibly need to be constructed to accommodate the amount of excavated sediment.

- Cost—The approximate minimum direct capital cost for removal, treatment, and placing the treated soil was estimated, using liberal assumptions, at $18,000,000. When transportation, monitoring, personal protective equipment (PPE), and other potential direct cost and indirect activities such as engineering, project management, and quality assurance are included, the estimated cost for Alternative 4 is three or four times greater than any of the other proposed alternatives.

9.4 DETAILED DESCRIPTION OF ALTERNATIVES

Following is a description of each alternative and the manner in which it is intended to be implemented for the OUs.

9.4.1 Alternative 1—No Action

As required by the NCP, the no action alternative provides a comparative baseline against which other alternatives can be evaluated. Under this alternative, the contaminated sediment in Clinch River and Poplar Creek would be left as is, without implementing any containment, removal, treatment, or other mitigating actions. This alternative does not provide for the monitoring of sediment, surface water, or groundwater, and does not provide any support for existing institutional controls to reduce the potential for exposure. Existing controls could not be removed, but they would not be replaced or maintained by DOE.

9.4.2 Alternative 2—Institutional Controls and Advisories

Alternative 2 would manage contaminants in both OUs in situ and without treatment. Long-term management of these contaminants must continue because they would remain in place and only minor reduction of risk levels would occur due to natural sedimentation and natural degradation of the contaminants. Because the contaminants in the OUs are low-level wastes they could be managed fairly easily because some of the proposed options are already in place (public advisories for fish consumption and permit programs that regulate sediment-disturbing activities). The remaining options in this alternative strengthen management of the contaminants, protection of the public, and monitoring of the ecosystem with minimal activities in the sediment (sampling) and only limited action on the shore (fencing).

9.4.2.1 Deed restrictions

The limited contaminant data obtained from shallow sediment sampling locations along Clinch River will not allow for discrete areas TBC independently. For this reason, deed restrictions are recommended for all DOE properties along Clinch River Reaches 1, 2, 3, and 4 to provide blanket coverage for properties that may be released in the future. Covenant-specific activities should include, but are not limited to, restrictions on drinking water well installations, excavations, or other activities that may elevate risk in association with other DOE activities that presently or formerly took place.

The liability for contamination remaining in place (sediments or soils) or in a transient condition (groundwater) will continue to be held by DOE as long as the next owner abides by the conditions set forth in the covenant. Failure to abide by the conditions may absolve DOE from either full or partial responsibility for any damages incurred.

9.4.2.2 Public advisories

Public advisories for fish consumption throughout the OU, and water contact advisories for Poplar Creek, are proposed to remain in effect until future monitoring indicates that contaminant levels in affected fish populations have abated. Administration of these advisories is currently managed by the TDEC. This FS assumes that TDEC management will continue.

9.4.2.3 Permit program

Restrictions on sediment-disturbing activities are jointly managed by TVA and COE. For this FS, it applies to the deep sediments in the main channel and the shallow sediments. Statutory programs that restrict sediment-disturbing activities are in effect for Clinch River and Poplar Creek, limiting the locations and depths to which sediments can be dredged or disturbed. Permitting is proposed to remain in effect indefinitely for the OUs.

9.4.2.4 Monitoring

Monitoring options proposed for all areas of Clinch River and Poplar Creek include additional sediment, surface water, and fish sampling. Monitoring of sediments at the Clinch River/Poplar Creek site would be performed annually to observe system conditions.

Fish monitoring would be conducted semi-annually. Analysis of fish data will allow proper warnings to be applied to the OUs. In the event that input sources increase or existing sources become more bioavailable causing contaminants in fish to increase risk levels, modifications in advisories can be issued. Conversely, decreases in contaminants in fish may result in the lifting or lessening of the restrictions on fish consumption.

9.4.3 Alternative 3—Source Containment

Options provided in Alternative 2 cannot physically isolate contaminated sediments from potential receptors. The options rely on the voluntary compliance to warnings, signs, and staying out of fenced areas.

Infrequent visitors probably are not at risk because risk scenarios developed in the RI are built on the daily ingestion and/or inhalation of sediment contaminants. Only under the residential scenario does exposure to sediments pose unacceptable risk. However, the sediments are under as much as 6 ft of water for a portion of the year and daily exposures are not likely to occur. In this case, containment of the sediments may be necessary to lower the risk potential by isolating the contaminants and removing the pathway for the future on-site resident.

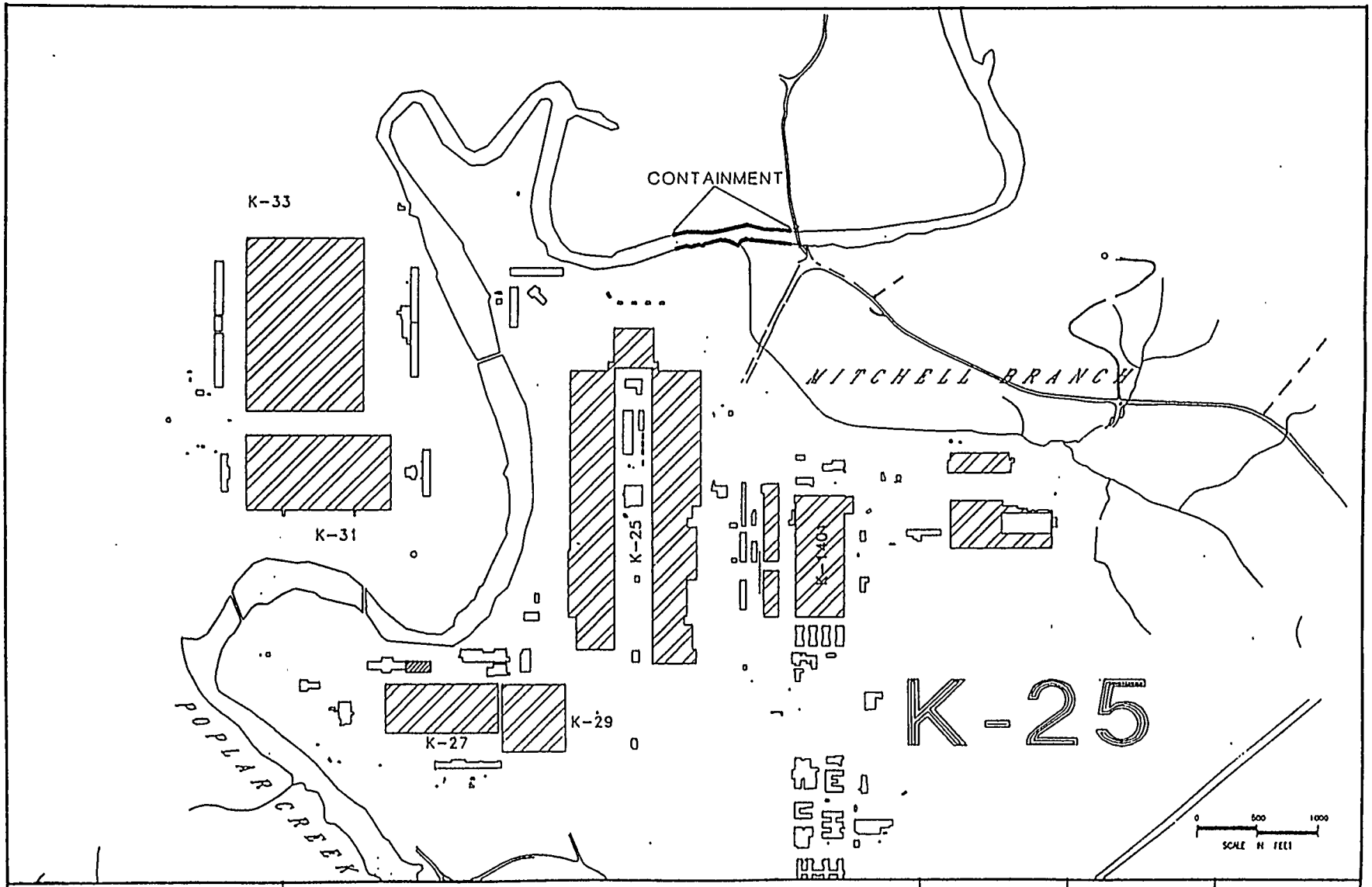
The geomembrane cap would place a physical barrier between the contaminated sediment and the receptor and remove the pathway of concern. Risks presented by the shallow sediments would be diminished sharply because no complete exposure route would remain. Alternative 3 is composed of the same institutional control elements as outlined in Alternative 2 plus shallow sediment containment. Deep sediments remain in place and protected from disturbance with the use of institutional controls. Public advisories are also planned to advise and protect the public by supplying fish consumption advisories.

Deed restrictions, public advisories, permit programs, and monitoring are the same as in Alternative 2.

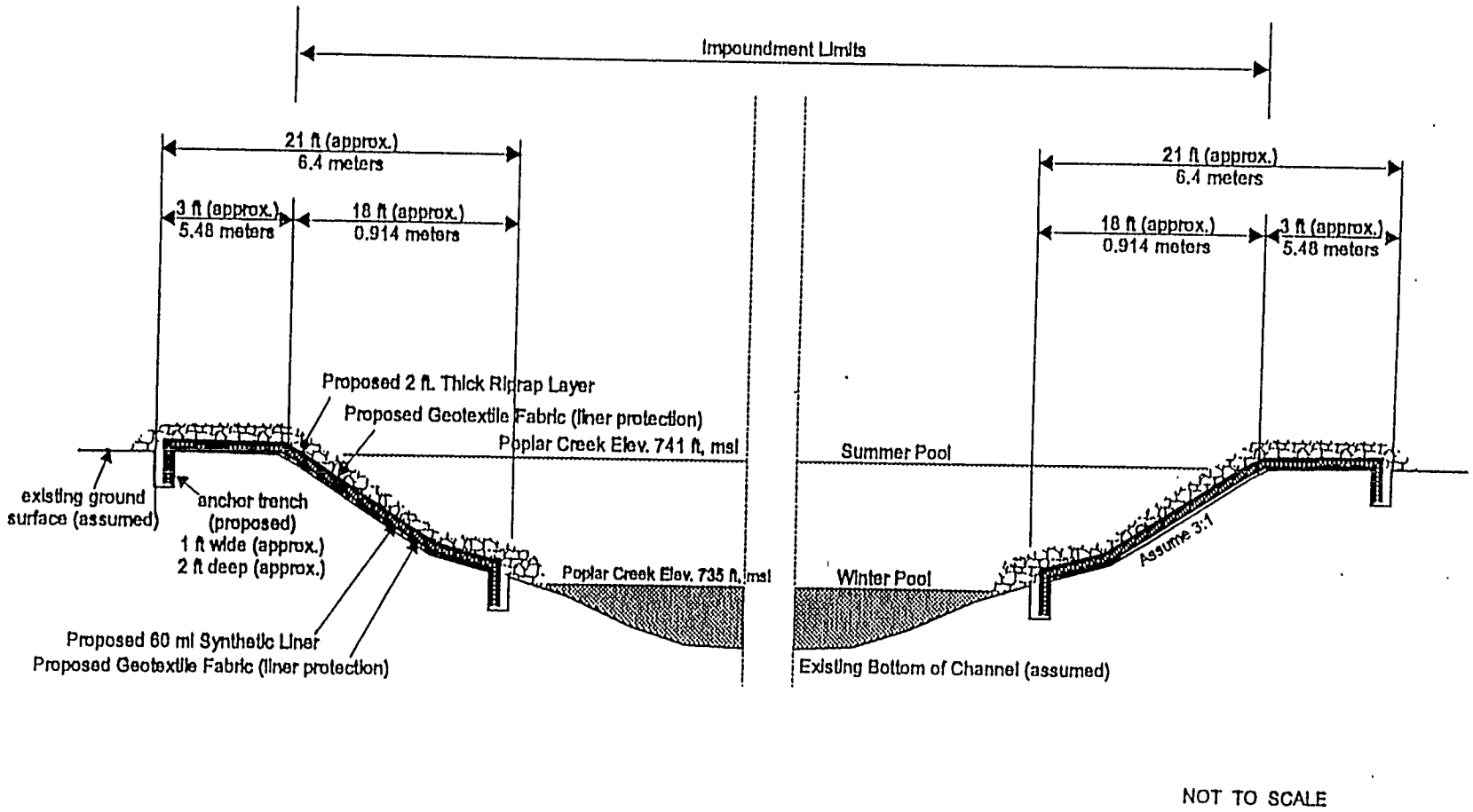
Physical barriers, such as fencing, may be used for areas where capping is determined to be technically infeasible (e.g., shore slopes too steep to install the cap).

Routine inspections of installed devices such as signs or physical barriers, will be conducted annually. Additionally, inspections of the shoreline geomembrane cap would be performed annually. The most appropriate inspection time would be when the winter pool drawdown is near 100 percent complete, which will expose as much of the cap area as possible and allow easier visual inspections for erosion.

The geomembrane cap combines the low permeability of a synthetic geomembrane layer and the erosion resistance of riprap to cover and isolate contaminants in place and reduce risk of either direct exposure or redistribution of contaminants by erosion). The area to be capped, as shown in Figure 9.1, will be cleared of vegetation to allow a smooth surface on which to place the geomembrane. An anchor trench 0.3 m (1 ft) wide and 0.6 m (2 ft) deep will be cut into the top of the cap area at least 0.9 m (3 ft) beyond the top of the creek bank and at the toe of the area to be capped. The ground surface will be stripped and smoothly graded to remove any objects that may cause any breaks or punctures to the geomembrane. However, no grading to significantly alter the degree of creek bank slope is proposed. As shown in Figure 9.2, a geotextile fabric liner will first be laid over the prepared surface to give the geomembrane bottom protection; second, the geomembrane will be placed; third, a geotextile fabric liner will be placed on top of the geomembrane for upper surface protection. Each layer of material will be overlapped into the anchor trenches. Riprap will then be placed on the geotextile surface overlapping the anchor trenches. Riprap thickness will be 0.6-m (2 ft) minimum. Any remaining uncapped disturbed areas shall be mulched and seeded to minimize erosion.



JE Fig. 9.1	Poplar Creek cap limits (plan view) DOE - Clinch River and Poplar Creek OUs - Oak Ridge, Tennessee	DOCUMENT ID: 35H830 5301-10 / FS	DRAWING ID 95-12069.DWG	DRAWING DATE: SEPTEMBER 11, 1995 TR



JE	Fig. 9.2	Poplar Creek - Alternative 3 (containment detail) DOE - Clinch River OU - Oak Ridge, Tennessee	DOCUMENT ID: 35H830 5301-10 / F8	DRAWING ID: 95-11623.CDR-1	DRAWING DATE: SEPTEMBER 5, 1995 8a

The conceptual sequence of construction activities for Alternative 3 is presented in the following list.

1. Install erosion and turbidity control material (e.g., silt fencing and straw bales).

2. Install the shoreline construction stability mat over areas where heavy equipment will be used adjacent to the shore.

3. Clear vegetation and vegetative root systems where cap and trench would be installed.

4. Proofroll the site (repair soft spots and create smooth surface).

5. Excavate anchor trenches top and bottom.

6. Install a bottom-protective geotextile layer over the smoothed surface.

7. Install a geomembrane layer over the area.

8. Install a upper-protective geotextile layer over the geomembrane.

9. Place 0.6 m (2 ft) of riprap over the geotextile.

10. Seed and mulch any construction disturbed areas that extend beyond capping limits.

Postclosure monitoring would be conducted annually to ensure the cap remains reliable and performing as designed. Following detection, repairs to the cap should be made as soon as possible. It is anticipated that this cap design can last at least 30 years before maintenance is necessary. Monitoring would also include monitoring for sediments accumulating over the cap that might be contaminated and might raise risk levels.

The containment portion of Alternative 3 would be implemented for Subreach 3.02 of Poplar Creek. The Alternative 3 controls and advisories are for the entire area of both OUs.

10. DETAILED ANALYSIS OF ALTERNATIVES

This chapter presents information used for selecting an alternative and preparing a ROD. Section 10.1 describes the NCP criteria for each alternative. Section 10.2 presents results of the analysis of each alternative. Following the individual analysis, a comparative analysis of the alternatives is presented in Section 10.3. This analysis highlights key advantages, disadvantages, and tradeoffs of each alternative.

10.1 CRITERIA FOR ANALYSIS

The CERCLA criteria used to compare the alternatives are described as follows.

10.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether an alternative eliminates, reduces, or controls threats to public health and the environment.

10.1.2 Compliance with ARARs

Compliance with ARARs addresses whether an alternative meets federal and state environmental laws and regulations.

10.1.3 Long-Term Effectiveness and Permanence

Long-term effectiveness considers the ability of an alternative to protect public health and the environment long after remedial action is complete.

10.1.4 Short-Term Effectiveness

Short-term effectiveness considers the time needed for an alternative to achieve remedial response objectives and the risks posed to workers, residents, and the environment during the implementation of the remedial action.

10.1.5 Reduction of Toxicity, Mobility, or Volume

Reduction of toxicity, mobility, and volume through treatment evaluates an alternative's use of treatment to reduce the harmful nature of contaminants; the contaminants' ability to move in the environment; and the amount, or volume, of contamination present. As described in Chapter 9, no treatment options are planned at this time.

10.1.6 Implementability

Implementability addresses the feasibility of an alternative from a technical and administrative standpoint.

10.1.7 Cost

Cost considers the amount of money it takes to design, construct, operate, and maintain the alternative.

10.1.8 State Acceptance

State acceptance addresses TDEC comments concerning the alternatives considered.

10.1.9 Community Acceptance

Community acceptance addresses written and oral public comments on the alternatives being considered. A Responsiveness Summary to public comments will be included in the ROD.

10.2 INDIVIDUAL ANALYSIS

10.2.1 Analysis of Alternative 1—No Action

Under Alternative 1, no further action would be taken at the site. The contaminated sediment would remain as is without implementing any removal, treatment, containment, or mitigating technologies. Institutional controls are assumed not to exist, and no provision is made to monitor sediments, surface water, or biota. This alternative provides a baseline for comparison purposes.

10.2.1.1 Overall protection of human health and the environment

The no action alternative does not provide controls necessary to protect human and ecological receptors from fish consumption or future contaminant disturbance/migration. Alternative 1 is not protective to humans who may catch and eat unacceptable amounts of fish from the OU. Exposure to humans and piscivorous wildlife of contaminated fish would remain at current risk levels under current conditions. Should concentrations of existing contaminants increase or new contaminants be introduced to the system, risks to humans and piscivorous wildlife may increase as a result of either new contaminants in fish populations or fish populations in uncontrolled areas being consumed at unacceptable quantities.

In the absence of monitoring, no action would not protect humans or the environment should deep sediments be disturbed and redistributed in the OU or perhaps elsewhere

downstream. Exposure for contaminated sediment and biotic populations may elevate in response to increases of currently known contaminants or new contaminants introduced to the system going undetected, thus potentially increasing human health and/or ecological risks.

There are no short-term risks associated with implementing this alternative since no actions would occur.

Investigations have shown current potential adverse effects to ecological receptors. Ambient toxicity tests on medaka embryos suggest a significant risk to sensitive fish populations in Reach 3 of Poplar Creek. Maximum concentrations of COPECs in pore water appear to be acutely toxic in only four subreaches and chronically toxic in all reaches except Subreach 2.03. Maximum and median concentrations of COPECs in whole sediment appear to be toxic in every reach. Fish from Poplar Creek appear to adversely affect piscivorous wildlife. Mink fed fish from Poplar Creek experienced weight reduction, reduction in litter size, and increase in liver ethoxyresorufin-o-deethylase activity. Insectivorous birds, such as the rough-winged swallow, may be adversely effected by mercury concentrations in aquatic insects in Subreaches 4.01, 4.02, and 4.03 in the Clinch River.

10.2.1.2 Compliance with ARARs

CERCLA Section 121 cleanup standards, including compliance with ARARs, apply only to remedial actions EPA decides should be taken under CERCLA authority; therefore, there are no ARARs for this alternative.

10.2.1.3 Long-term effectiveness and permanence

The no action alternative would not provide an effective or permanent long-term solution for the OU. The risk assessment indicates that contaminant levels in certain fish species exceed the cancer risk threshold of 1.0×10^{-4}. No risk reduction would occur under the no action alternative for either fish or sediment.

The no action alternative would not provide controls for existing contamination, and would not reduce existing site risks. Future risks to the environment may increase if the deep sediment is disturbed, is redistributed without notice, or if existing public advisories are discontinued (assumed to be possible under a no action alternative).

10.2.1.4 Reduction of toxicity, mobility, or volume through treatment

There would be no reduction of toxicity, mobility, or volume of contaminants through implementation of Alternative 1 because this alternative does not include treatment.

10.2.1.5 Short-term effectiveness

Under the no action alternative, no remedial action would be taken; therefore, short-term effectiveness criteria do not apply. There would be no increase in short-term risks to workers or the community and no short-term environmental impacts. There would be no short-term unavoidable adverse impacts to humans, the environment, socioeconomics, or cultural resources as a result of construction activities. Cumulative impacts from construction would not exist because there would be no construction. Risk to humans and the environment would remain at current baseline risk assessment and BERA levels.

10.2.1.6 Implementability

Because no remedial action would be taken under Alternative 1, it is implementable. There would be no difficulties nor uncertainties with construction. The no action alternative is included in the individual analysis of alternatives as a baseline comparison.

10.2.1.7 Cost

There are no costs associated with Alternative 1.

10.2.2 Analysis of Alternative 2—Institutional Controls and Advisories

The implementation of this alternative would include deed restrictions, continuance of public advisories, permit programs, monitoring, and surveillance and maintenance. Engineering detail in Chapter 9, Section 9.4.3, provides the basis for cost-estimating purposes. If this alternative is selected, the substantive components of the monitoring plan would be finalized during the design phase, consistent with the requirements of the ROD.

10.2.2.1 Overall protection of human health and the environment

Alternative 2 meets the RAOs and RGOs listed in Chapter 8 and protects human health. Alternative 2 maintains the existing institutional controls that provide this protection.

Institutional control would include the adoption of deed covenants for all areas with sediment contamination in the event of sale or other release of DOE properties. Continued federal ownership of the site would restrict future on-site residential and agricultural land uses that could result in direct exposure to the sediments through intrusive actions, including dredging.

No risks to workers are expected during implementation of this alternative. Over time, samples would be taken from the surface water, sediments, and biota. With appropriate health and safety controls, none of these activities would result in elevated health risks to workers.

Environmental risks would remain at current levels for sediment contamination and would be protected from undetected increases in contaminant input with long-term monitoring of site conditions. The restrictions on sediment disturbance will protect ecological receptors by preventing contaminant migration while natural sedimentation decreases the bioavailability of the peak contamination sediment layer.

10.2.2.2 Compliance with ARARs

This alternative would comply with any ARARs or TBCs. TBCs for Alternative 2 are the long-term management plans for the residual radioactive material and for the management of contamination left in place, as found in DOE Order 5400.5(IV)(6)(c) and 40 *Code of Federal Regulations* (CFR) 300.430(e)(3), respectively. Identified TBCs (Appendix C) would be met by this alternative.

10.2.2.3 Long-term effectiveness and permanence

Alternative 2 meets the RAOs of preventing future residential exposure to sediments. Long-term protection of human health would be provided by deed restrictions, sediment-disturbing permit requirements, and long-term monitoring. Unacceptable future risks identified by monitoring at the site would be reduced by eliminating the exposure pathway. For instance, in an area previously below risk levels found to have contaminants in excess of risk thresholds, the exposure pathway can be removed by implementing additional access restrictive controls. Environmental protection would be enhanced by monitoring the system for changes that could trigger actions or other controls such as those in Alternative 3 to protect biota (see Table 9.1). Limitations set forth in sediment-disturbing restrictions would also protect the environment from exposure to deep sediments that could be released and became bioavailable.

Under Alternative 2, institutional controls and advisories would be reliable in the long term if coordination of all concerned regulating bodies, in a cooperative effort to keep the deep sediments in place and undisturbed, is maintained. These sediments provide little risk to humans because there are no exposure pathways under the current conditions.

Institutional controls would be reliable for preventing unauthorized disturbance of sediments and potential future exposure. Posted warnings would be reliable for advising people of the potential health hazards of fish consumption. Periodic monitoring of surface sediment samples, water, and biota will provide a reliable means to identify changes in the reservoir

system, such as new sources or sediment migration. This alternative is only as effective as the implementing agency's ability to enforce the alternative or the residents willingness to comply with the options outlined in the alternative.

Consistent with the required 5-year CERCLA reviews conducted by EPA, performance of the controls would be monitored. The 5-year reviews may indicate the need for components of this alternative to be maintained, modified, or replaced.

10.2.2.4 Reduction of toxicity, mobility, or volume

There is no treatment as part of Alternative 2; therefore, there would be no reduction of toxicity, mobility, or volume of contaminants.

10.2.2.5 Short-term effectiveness

Alternative 2 would protect the community during implementation through the use of administrative controls. The contaminated sediments would not be disturbed; therefore, there would be no increased potential for off-site migration of contaminants as a result of remedial activities.

This alternative does not involve handling contaminated sediments; therefore, there is little risk of potential exposure to workers. Risk of occupational injury is considered negligible. It is anticipated that workers conducting monitoring would use standard monitoring procedures and wear PPE to provide worker safety. There would be no change in the worker population or traffic of the Oak Ridge area during implementation because the existing work force could be used.

This alternative protects the environment in the short term by not disturbing the contaminants. Environmental risk would remain at current levels. As stated earlier, no reduction of toxicity, mobility, or volume, except by natural attenuation, would occur under this alternative. No environmentally sensitive resources would be affected by this alternative.

The duration of sign posting activities will vary according to the extent of the area selected for implementation.

10.2.2.6 Implementability

Alternative 2 is technically feasible to implement. All activities would be performed using conventional methods. Maintaining public advisories and permit programs, along with

implementation of long-term monitoring and deed restrictions, would be easily implementable. Fencing is implementable although certain areas are heavily vegetated and may require brush clearing during construction.

Alternative 2 would be conducted on site and would not require any permits. There are no known administrative barriers or difficulties associated with implementation of Alternative 2.

Materials and services required for implementation of Alternative 2 are readily available.

10.2.2.7 Cost

The present worth cost of Alternative 2 is approximately $6.1 million. Table 10.1 provides a detailed breakdown of the escalated project costs. More detailed information is provided in Appendix H.

Direct Capital Cost. The escalated cost for the direct capital cost is estimated at $778,000. Direct capital cost includes deed restrictions, public advisories, and permit programs.

Indirect Capital Cost. Escalated indirect capital cost, including contingency, is estimated to be $409,000. Indirect capital cost includes remedial action integration, remedial design work plan, remedial design report, and remedial action work plan.

O&M Cost. Escalated cost, including contingency, for O&M is estimated to be $12.5 million. O&M cost includes monitoring of fish, water, and sediment for approximately 30 years. Monitoring would support the required CERCLA 5-year reviews conducted by the regulators.

10.2.3 Analysis of Alternative 3—Source Containment

The institutional controls and monitoring to be implemented under Alternative 3 are the same as those previously discussed for Alternative 2 with modifications, as necessary, and the augmentation of capping with physical barriers when conditions dictate. Capping would be for the area shown in Figure 9.1.

The geomembrane cap is expected to eliminate releases of contaminants by wind or water erosion and direct contact with surface and subsurface contaminants by humans and biota. The cap would consist of an impervious geomembrane layer protected by a geosynthetic fabric. The outermost layer, consisting of riprap, will serve to weight the geomembrane and protect it from wind and water erosion and biotic intrusion.

Table 10.1. Alternative 2—cost estimate

Project Cost Item	Cost ($Thousands)[a]
CAPITAL COSTS	
Direct Cost:	
Deed Restrictions	17
Public Advisories	727
Permit Programs	34
Direct Cost Total (rounded)	778
Indirect Cost:	
Remedial Action Integration	81
Remedial Design Work Plan	16
Remedial Design Report	58
Remedial Action Work Plan	18
Contingency—25 percent	236
Indirect Cost Total (rounded)	409
TOTAL CAPITAL COST	1,187
MONITORING AND MAINTENANCE COSTS	
Monitoring	10,030
Contingency—25 percent	2,510
TOTAL O&M COST	12,540
TOTAL PROJECT ESCALATED COST	13,727
TOTAL PROJECT PRESENT WORTH[b]	6,076

[a]Escalated.
[b]Present Value Cost based on 30-year present value, 7 percent discount rate.

Note: Costs presented in table are rounded.

O&M = operation and maintenance

10.2.3.1 Overall protection of human health and the environment

Alternative 3 meets the RAOs developed for Clinch River/Poplar Creek by ultimately minimizing direct contact of humans with the contaminants in shallow sediments by physically isolating contaminated sediments from the surface, rendering them unavailable for ingestion.

Alternative 3 also prevents migration of contaminants through sediment erosion and contaminant redistribution caused by physical disturbance of deep sediments. The level of environmental protection offered by this alternative is increased by the isolation of shallow sediments. These sediments would no longer be in a pathway for biota to contact thus reducing long-term ecological risks.

10.2.3.2 Compliance with ARARs

Although DOE Orders are not ARARs, the radiation exposure limits of 100 mrem/year for exposure of the public, environment, and workers defined in DOE Order 5400.5 would be met. This Order is the primary contaminant-specific TBC for this alternative.

Under the COE authority Nationwide Permit 38, "Cleanup of Hazardous and Toxic Waste," requires wetlands delineation as part of notification for discharges into special aquatic sites. The substantive requirements would be applicable to all activities related to capping. If adverse effects to the wetlands are determined, consultation with the COE and mitigation would be required (e.g., banking) under 33 CFR 330, Appendix A (C)(13). Nationwide Permits 13 (Bank Stabilization) and 18 (Minor Discharge) could also apply.

All remedial activities for Alternative 3 would comply with the TDEC Aquatic Resource Alteration regulations by being as conservative as possible in disturbing soil, sediment, and vegetation.

Before construction activities begin, specific occurrences in soil and sediment disturbance areas of the tall larkspur (*Delphinium exaltatum*) must be identified. The tall larkspur is a state-listed endangered species and a federal candidate for listing as threatened and endangered. If found, consultation with the state would help determine potential mitigation. Probable mitigation would be to transfer the plant(s) to another area of suitable habitat in which no disturbance would occur.

No historic sites or sites eligible for listing on the National Register of Historic Places are known to occur in the area. Cemeteries and known archaeological sites are located near the Poplar Creek containment areas. All containment activities will allow for at least a 50-ft buffer around the cemeteries. If additional archaeological resources are discovered during installation of fences or access roads or during capping, appropriate measures would be taken to comply with the Archaeological Resources Protection Act. The state archaeologist would be contacted and an assessment performed to determine the proper course of action to take.

No other environmentally sensitive resource has been identified in or near the remedial areas.

Reasonable precautions would be implemented to prevent particulate matter from becoming airborne during soil disturbance activities. Fugitive dust, as a visible emission beyond property boundary lines, would be limited to no more than 5 minute/hour or a total of 20 minute/day (TDEC 1200-5-8-.010). Control of sediment erosion and turbidity would comply with 40 CFR 122 and TDEC 1200-4-10-.05 through the use of silt fences, straw bales, or temporary perimeter drainage ditches.

If soil or sediment excavated from the anchor trench areas is determined to be a hazardous, mixed, and/or PCB-contaminated waste, storage, treatment, and/or disposal regulations under the Resource Conservation and Recovery Act and/or the Toxic Substances Control Act would be triggered.

10.2.3.3 Long-term effectiveness and permanence

Magnitude of Residual Risks. Shallow sediment risks are significantly reduced as all pathways are eliminated both currently and for the potential on-site resident. Residual risk from Alternative 3, source containment, is the same as from Alternative 2, institutional controls and advisories, for deep sediments. Fish consumption risks remain the same as in Alternative 2, institutional controls and advisories.

Adequacy and Reliability of Controls. Alternative 3 is adequate in meeting RAOs. The cap would be designed so that all slopes would be of proper grade for optimum wear and long-term structural stability. Lack of periodic inspections and timely repairs could result in the failure of the geomembrane cap and associated uncontrolled access to contaminants from McCoy Branch Embayment and/or Poplar Creek. The reliability of Alternative 3 is very good so long as repairs are made and cap integrity remains intact.

10.2.3.4 Reduction of toxicity, mobility, or volume through treatment

Alternative 3 would not reduce toxicity, mobility, or volume of the waste through treatment, because no treatment is applied to the waste materials.

10.2.3.5 Short-term effectiveness

Protection of the Community During Remedial Action. Alternative 3 would protect the community during implementation through access controls (e.g., physical barriers, administrative controls) and engineering controls during construction. As with any construction activities the

potential for disturbing site sediments exists. The contaminated sediments would not be overly disturbed; however, engineering controls for run-on, direct precipitation, and run-off would be used to minimize sediments escaping; therefore, minimal potential for off-site migration of waterborne contaminants during remedial activities would occur. There is the potential for dust migration from earth-moving activities that would occur during placement of the cap. The baseline risk assessment indicates that fugitive dust emission is not currently a pathway of concern. In addition, considering the moisture content of the sediments, fugitive dust emissions by construction activities is expected to be minimal. However, appropriate dust control methods (e.g., wetting of the sediment) would be implemented to minimize the off-site migration of dust to ensure protection of the community.

There is expected to be an increase in traffic during implementation as access road construction materials are brought in. Most of the traffic would occur on DOE properties and not in the surrounding communities. Traffic would increase slightly as dump trucks report to the site. There would be no change in the worker population of the Oak Ridge area during implementation because the existing work force could be used.

Protection of Workers During Remedial Action. The short-term risks associated with Alternative 3 are higher than those associated with Alternative 2 because of greater potential for direct contact with contaminated sediments. However, this contact would be minimal. Occupational injury and dust inhalation pose the most significant risks to remediation workers. Remediation workers placing the cap would use standard construction and monitoring equipment and PPE to provide worker safety as specified in the construction health and safety plan. Fugitive dust emissions from heavy equipment movement would be controlled by using surface wetting or dust suppressants to minimize inhalation risks. On-site monitoring during construction would assess the potential effects on workers from construction and determine if additional protection would be needed.

Environmental Impacts. Short-term impacts to ecological receptors would be higher under Alternative 3 than for Alternative 2 during cap installation. The environmental effects would be disruption of habitat and potential sediment resuspension during construction activities.

Disruption of habitat would be permanent for aquatic plants and most benthic organisms in shallow sediments. Deep water plants and animals should not be affected because construction will occur on exposed winter pool sediments and not extend into deep water. Waterfowl, amphibians, reptiles, and piscivorous animals are expected to recover and return to remediated areas. Avoiding destruction of habitat would be the first consideration in remediating these areas, followed by relocation to a suitable habitat elsewhere. Replacement of diverse vegetation will

be likely in order to restore areas on which capping is implemented following the close of cap construction. However, while these remedial activities may affect individuals of a species, they are not anticipated to have any effects at the community level.

The effects of containment on the floodplain would be minimal. Some grading and slope alteration will be inevitable; however, existing shoreline slopes would remain as close to the current natural slope and cap construction should conform to the lay of the slope wherever possible. If areas are encountered that cannot be capped without significantly altering the floodplain, then other remedial options may necessitate a substitution.

Wetland areas could also be encountered in the area intended for implementation of capping. Construction in a wetland to accommodate the cap construction, associated road improvements, etc. would be avoided to the extent possible. However, wetland areas throughout the subreach could be destroyed, causing adverse effects. A wetland assessment will be required if this alternative is chosen as the preferred alternative. Potentially, constructing a wetland elsewhere to replace the loss of habitat at the capped site would be required.

Because the contaminated sediments would be disturbed to some extent, there is potential for contaminants to migrate from the site during implementation due to erosion and fugitive dust. Appropriate engineering controls will minimize this effect. Appropriate uses of silt fences, staked straw bales, and tarps during construction would control the effects on surface water quality from fugitive silt caused by construction. Dust suppression measures, such as surface wetting, will minimize fugitive dust.

Accidental spills or leakage of engine fuels, oils, hydraulic fluids, and coolants from equipment could result in minor soil contamination. Equipment exhaust is anticipated to have negligible effects on air quality. Standard construction management practices such as equipment maintenance and timely removal of spills would minimize the environmental effect of implementation activities.

Duration of Remedial Activities. Construction activities under Alternative 3 are anticipated to last 1 year. Administrative duration is the same as in Alternative 2 for institutional controls.

10.2.3.6 Implementability

Alternative 3 is technically feasible to implement. All activities would be performed by conventional methods. Construction of the geomembrane cap and appropriate anchor trenches would be straightforward, but only during the period of the year when the reservoir water level is lowered to winter pool. Construction at any other time will be substantially more difficult if at all possible. Thus preparation and material staging will be very important to meet this critical timing.

Although Alternative 3 would be conducted on DOE property, waterways adjacent to the ORR are co-managed under the statutory authority of other federal and state authorities. Permits would be needed to regulate waterway traffic as the areas of concern for capping are in the areas managed by TVA, COE, and TDEC.

Materials required for implementation of Alternative 3 include geomembrane, geotextile, and riprap; earth-moving and compaction equipment; silt fences; and sampling equipment. All of these are readily available materials.

10.2.3.7 Cost

The project present worth cost of Alternative 3 is approximately $7.5 million. Table 10.2 provides a detailed breakdown of the escalated project costs. More detailed information is provided in Appendix H.

The escalated direct capital cost is estimated at $1.7 million. Direct capital cost includes deed restrictions, public advisories, permit programs, physical barriers, and capping.

The escalated indirect capital cost, including contingency, is estimated to be $1 million. Indirect capital cost includes remedial action integration, remedial design work plan, remedial design report, and remedial action work plan.

Total escalated cost, including contingency, for O&M is estimated to be $12.4 million. O&M cost includes fence maintenance and monitoring of fish, water, and sediment for approximately 30 years. Monitoring would support the required CERCLA 5-year reviews conducted by the regulators.

Table 10.2. Alternative 3—cost estimate

Project Cost Item	Cost ($ Thousands)[a]
CAPITAL COSTS	
Direct Cost:	
Deed Restrictions	16
Public Advisories	722
Permit Programs	34
Resource Surveys	322
Capping	621
Direct Cost Total (rounded)	1,715
Indirect Cost:	
Remedial Action Integration	118
Remedial Design Work Plan	64
Remedial Design Report	227
Remedial Action Work Plan	72
Contingency—25 percent	548
Indirect Cost Total (rounded)	1,029
TOTAL CAPITAL COST	2,744
O&M COSTS	
Monitoring	9,943
Contingency—25 percent	2,486
TOTAL O&M COST	12,429
TOTAL PROJECT ESCALATED COST	15,173
TOTAL PROJECT PRESENT WORTH[b]	7,487

[a]Escalated.
[b]Present Value Cost based on 30-year present value, 7 percent discount rate.

Note: Costs presented in table are rounded.

O&M = operation and maintenance

10.3 COMPARATIVE ANALYSIS

A summary of the comparative analysis of alternatives for Clinch River/Poplar Creek is presented in Table 10.3.

10.3.1 Overall Protection of Human Health and the Environment

Alternative 1, no action, would least protect human health or the environment because no action would be taken. The risk assessment indicates unacceptable risk from exposure to contaminants in certain shallow areas with contaminated surface sediments, when deep sediments

Table 10.3. Detailed analysis summary and assessment

Assessment criteria	Alternative 1: No Action	Alternative 2: Institutional Controls and Advisories	Alternative 3: Containment
Overall protection			
Human health	No	Yes	Yes
Environment	No	Yes	Yes
Compliance with ARARs			
Chemical-specific	Not applicable	None	Complies
Location-specific	Not applicable	None	Complies; however, complicated or extensive efforts may be required to avoid adverse effects to wetlands, threatened and endangered species, cultural resources
Action-specific	Not applicable	Complies	Complies
Long-term effectiveness and permanence			
Residual risk	Risks may become unacceptable	Risks remain at current level to humans and biota	Low; contaminant pathway eliminated by isolating contaminated sediment
Adequacy of controls	Not applicable; no controls provided	Adequate	Adequate with proper maintenance
Reliability of controls	Not applicable	Reliable	Reliable, but requires periodic inspection and repairs
Short-term effectiveness			
Worker protection	No risk	Low risk	Moderate risk
Community protection	No protection	Low risk	Low risk
Environmental protection	No protection	No increase	High risk
Time between implementation and completion	Not applicable	6 months	1 year
Reduction of toxicity, mobility, and volume through treatment			
Toxicity, mobility, and volume	None	None	None

Table 10.3. (continued)

Assessment criteria	Alternative 1: No Action	Alternative 2: Institutional Controls and Advisories	Alternative 3: Containment
		Implementability	
Technical	Easy	Easy	Moderate
Administrative	Easy	Moderate	Difficult
Material availability	Not applicable	Readily available	Readily available
		Cost ($)	
Capital	0	1.5 million	16.9 million
Present worth	0	6.1 million	17.1 million

ARAR = applicable or relevant and appropriate requirement

are dredged and used for agricultural purposes, and if excess fish consumption occurs. If alternative risk assumptions are used, then there would be no unacceptable risks to humans from shallow sediments. Unregulated sediment-disturbing activities of deep sediments would also cause concern as most of the contaminants released during the peak release years are within these sediments. Exposure to deep sediments either by direct ingestion, ingestion of crops grown on contaminated sediment, or consumption of beef or beef products raised on these crops is of concern. Environmental exposure to disturbed deep sediments are also a concern as most of the deep sediment contamination is typically unavailable to all but a few benthic organisms. Disturbance would probably increase availability of contaminants to a broad range of biota. Loss of existing public advisories could increase health risks to humans because ingestion of fish above advised levels may cause certain health problems.

Alternative 2 would protect humans from exposure to the deep sediments by regulating dredging activities thus maintaining the existing cover than Alternative 1. If properties are released by DOE, the restrictions placed on deeds would prohibit land usages that could elevate risk levels. Alternative 2 would be more protective of the environment than Alternative 1 due to permit programs limiting the types of sediment-disturbing activities that may occur. Monitoring of site conditions would enable faster responses to contaminant movement should it occur and risks to the environment or humans increase.

Alternative 3 would be most protective to human health and the environment by containing of shallow sediment contaminants with a geomembrane cap in addition to institutional controls and advisories. Physical separation of receptor from contaminants provides an increased level of protection by ensuring no pathway of concern is complete. Initially, capping would destroy the benthos and their habitat on the capped area. Benthic habitat similar to the existing habitat may never return to the capped area.

During remediation, Alternatives 2 and 3 would protect the community and workers through the use of engineered and institutional controls. Short-term risks to the community (not including transportation) and to nonremediation workers would be approximately equal and within acceptable limits for all action alternatives.

10.3.2 Compliance with ARARs

No ARARs are triggered for the no action alternative. There are no ARARs governing institutional controls and advisories; however the NCP [40 CFR 300.430(e)(3)(ii)] and DOE Order 5400.5(IV)(6)(c) recommend certain controls which may be used in Alternative 2. All ARARs for Alternative 3 would be met without waivers. TBCs for Alternative 3 institutional controls are the same as for Alternative 2. Consultations will be held with TVA, COE, and

TDEC to ensure substantive requirements are met for the TVA Act, the COE Nationwide Permit Program, and the TDEC Aquatic Resource Alteration Permit Program. If Alternative 3 is chosen as the preferred alternative, a wetland and/or floodplain analyses would be required before the initiating of actions for containment activities as well as potential mitigation for the tall larkspur (*Delphinium exaltatum*), wetland mitigation (if required), and a Phase I archaeological resource survey.

10.3.3 Long-Term Effectiveness and Permanence

Alternative 1 (no action) would have no effect in the long term. The risk assessment indicates that the current site conditions, with no waste management may not be protective of human health or the environment. Sediment-disturbing activities could occur, resuspending contaminated sediment and increasing risk levels without forewarning. No remedial activities would be conducted on any areas of Clinch River or Poplar Creek under this alternative.

Alternatives 2 and 3 would be effective in the long term at minimizing risks to potential human receptors. Institutional controls provided in Alternative 2 would be protective to human receptors under current land uses whereas Alternative 3 would provide on-site containment and institutional controls to reduce the residual risks to potential future human receptors and current ecological receptors. Alternative 3 would use containment to prevent access and exposure to the contaminated shallow sediments; however, the waste would remain in place. The cap in Alternative 3 could degrade with time, especially without proper inspections and maintenance. Proper maintenance would keep the cap in good repair for many years.

10.3.4 Reduction of Toxicity, Mobility, or Volume

None of the proposed alternatives reduce toxicity, mobility, or volume because no treatment options are used.

10.3.5 Short-Term Effectiveness

Alternative 1 would not involve any action; therefore, there would be no increase in short-term risks and no short-term environmental effects.

Alternatives 2 and 3 approximately equally protect the local community during implementation. Through the use of engineering and institutional controls, access to the work site would be controlled. Air or dust emissions from the installation of the geomembrane cap is not expected to have an effect off DOE property.

The risks to workers are expected to be similar in implementing Alternatives 2 and the institutional controls portion of Alternative 3. By planning activities in accordance with as low as reasonably achievable principles, industry and Occupational Safety and Health Administration codes and requirements, and DOE Orders, worker risks due to contaminant exposure would be controlled to acceptable levels during construction of a cap.

The short-term environmental effects would vary for the alternatives. Alternative 2 would have little or no short-term impacts. Alternative 3 would likely increase some sediment disturbance, although the use of erosion controls during capping activities would minimize the impact. Disruption of habitat would occur along the inland areas used to haul construction equipment and materials into the site, but would be temporary. Permanent impact on habitat would occur on capped areas, but full recovery of most species is anticipated, except aquatic plants and shallow sediment benthic organisms.

The duration of the activities varies significantly between alternatives. Alternative 1 would have no implementation time because there are no activities. Alternative 2 would take approximately 6 months to implement, depending on the area to be covered. Alternative 3 could be completed within 1–2 years if the summer pool season is used to gather all the materials and set the stage for accelerated construction during winter pool.

10.3.6 Implementability

There would be no insurmountable technical implementability issues for any of the alternatives. The materials for caps and the technical experience are available locally. Alternative 3 would be more difficult to implement because of the health and safety considerations and the need to control migration of sediments and contaminants. However, all of the technologies and experience are available. No difficulty in sampling and analyzing for contaminants in sediments, water, or biota would occur because all of them have been conducted many times in the past.

Administrative implementability would arise from meetings and information exchanges among TVA, COE, TDEC, and DOE concerning the substantive requirements of permit programs, monitoring results (and reports), and record keeping.

10.3.7 Cost

Cost estimates are used in the CERCLA FS process to eliminate remediation alternatives that are significantly more expensive than competing alternatives unless they offer commensurate increases in performance or overall protection of human health and the environment. The cost estimates developed are order-of-magnitude estimates with an intended accuracy range of −30

to +50 percent. Final costs would depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final scope, final schedule, final engineering design, and other variables.

Costs developed were direct capital cost (including fixed-price remedial construction), indirect capital cost (engineering and project management during remediation), and long-term maintenance and monitoring (post-remediation). Overall, 30-year present value costs were developed for each alternative assuming the following: a discount rate of 7 percent, variable escalation per the ORER0294.VAL standard file for the Automated Estimating System cost estimating program, and a 25–40 percent contingency. Additional cost estimate detail and backup is provided in Appendix H. In summary, Alternative 3 would be noticeably more expensive than Alternatives 1 or 2, due to greater numbers of needed laborers and an extended construction calendar, heavy equipment, and materials.

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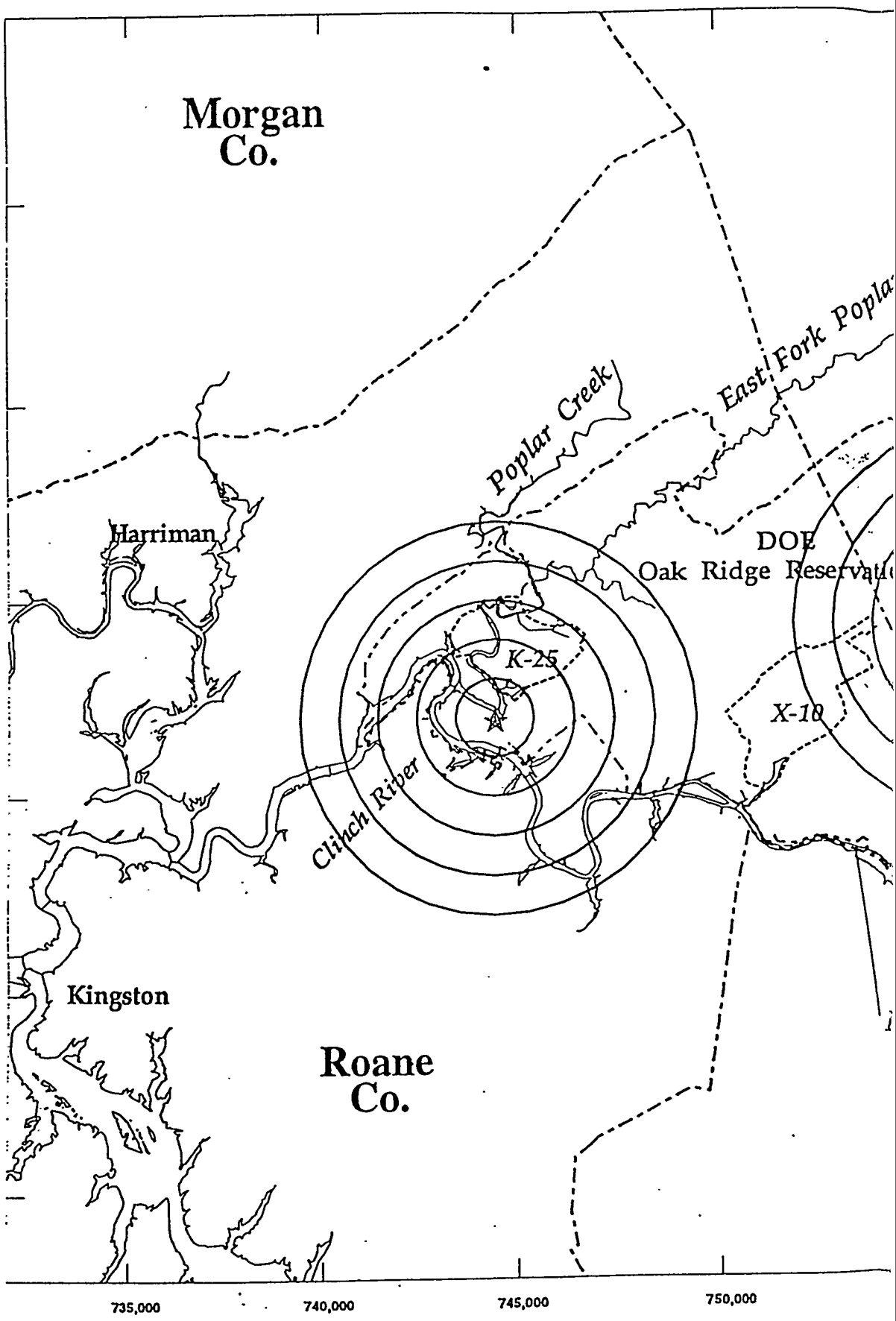
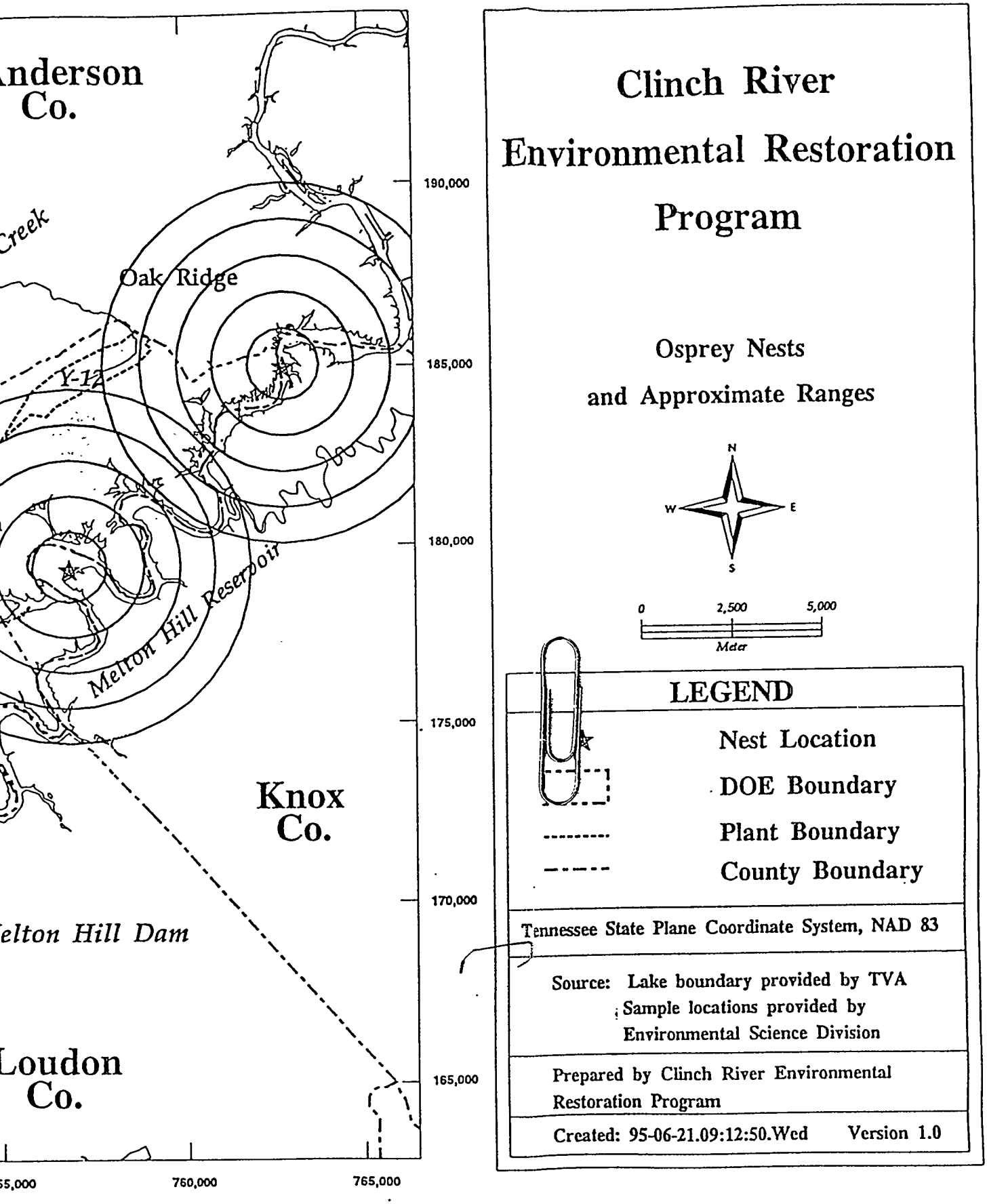


Fig. 6.30. Location of active osprey nesting locations adjacent to the Oak Ridge Rese



ation. Circles represent 1 km radii from nest.

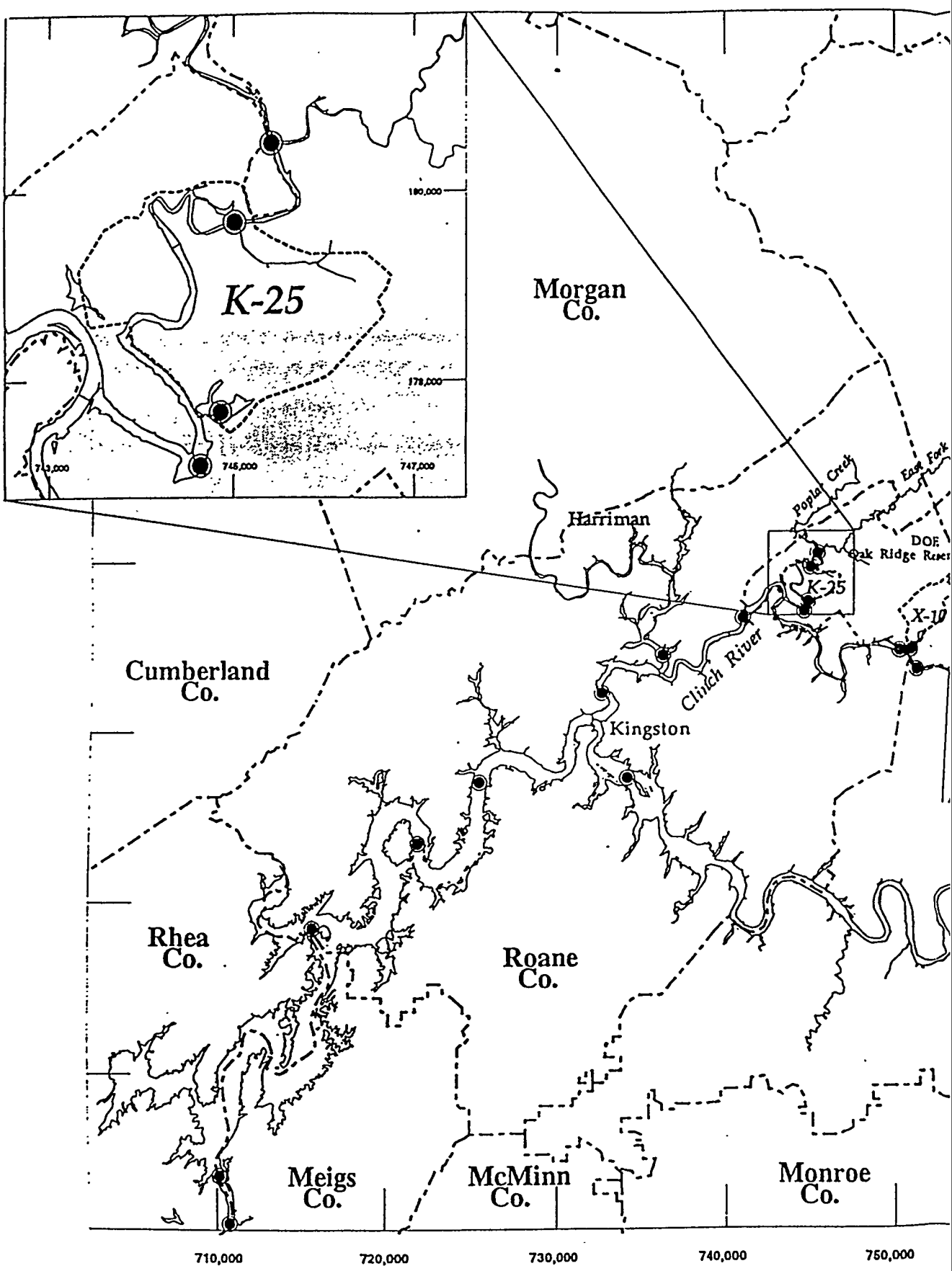
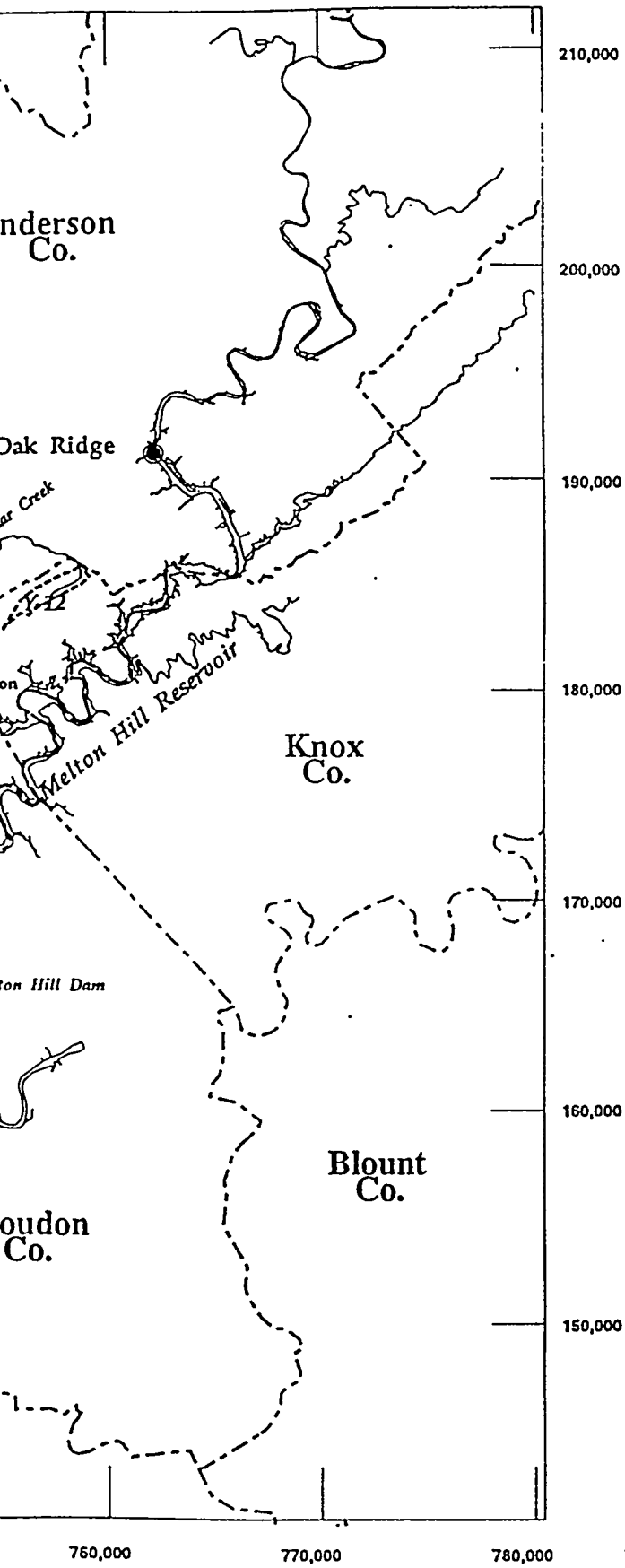
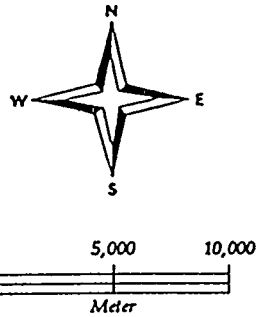


Fig. 3.50. Sampling locations for characterization of biota.



Clinch River Environmental Restoration Program

Fish Sampling Locations for Phase 2



LEGEND

- Sample Location
- DOE Boundary
- Plant Boundary
- County Boundary

Tennessee State Plane Coordinate System, NAD 83

Source: Lake boundary provided by TVA
Sample locations provided by
Environmental Science Division

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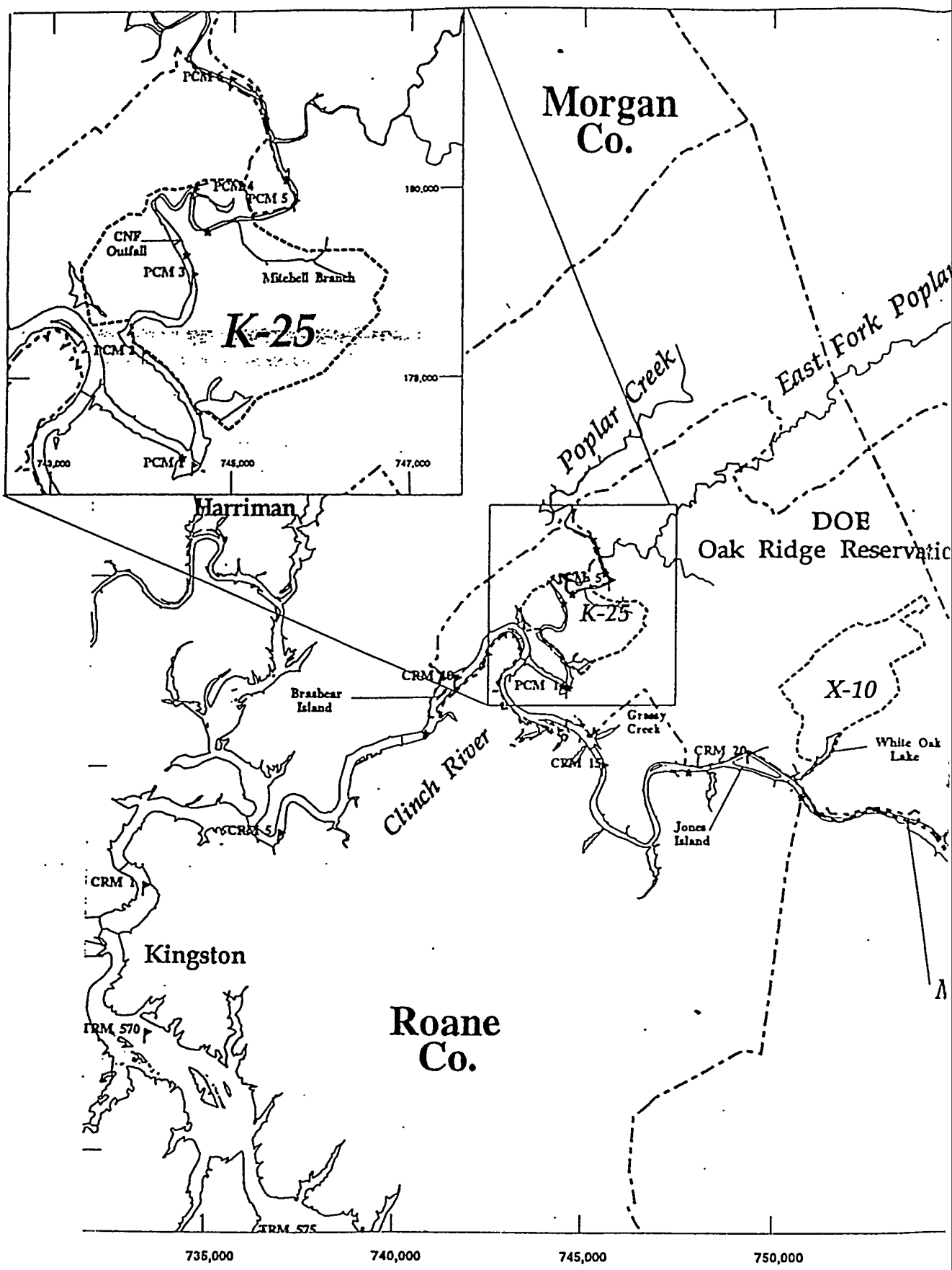
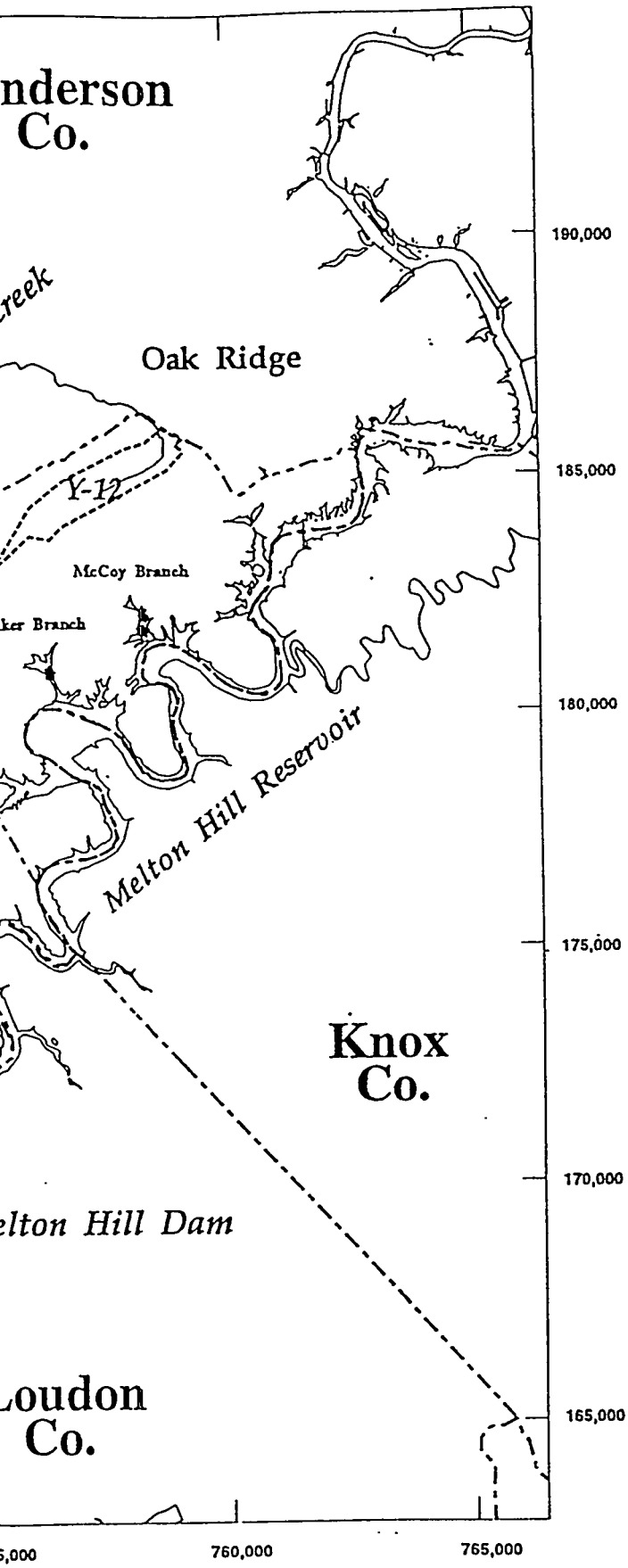


Fig. 3.16. Sample locations for aqueous toxicity testing.



Clinch River Environmental Restoration Program

Sampling Locations for Water Toxicity Task

N
W E
S

0 2,500 5,000
Meter

LEGEND

- Sample Location
- River Mile Marker
- DOE Boundary
- Plant Boundary
- County Boundary

Tennessee State Plane Coordinate System, NAD 83

Source: Lake boundary provided by TVA
Sample locations provided by
Environmental Science Division

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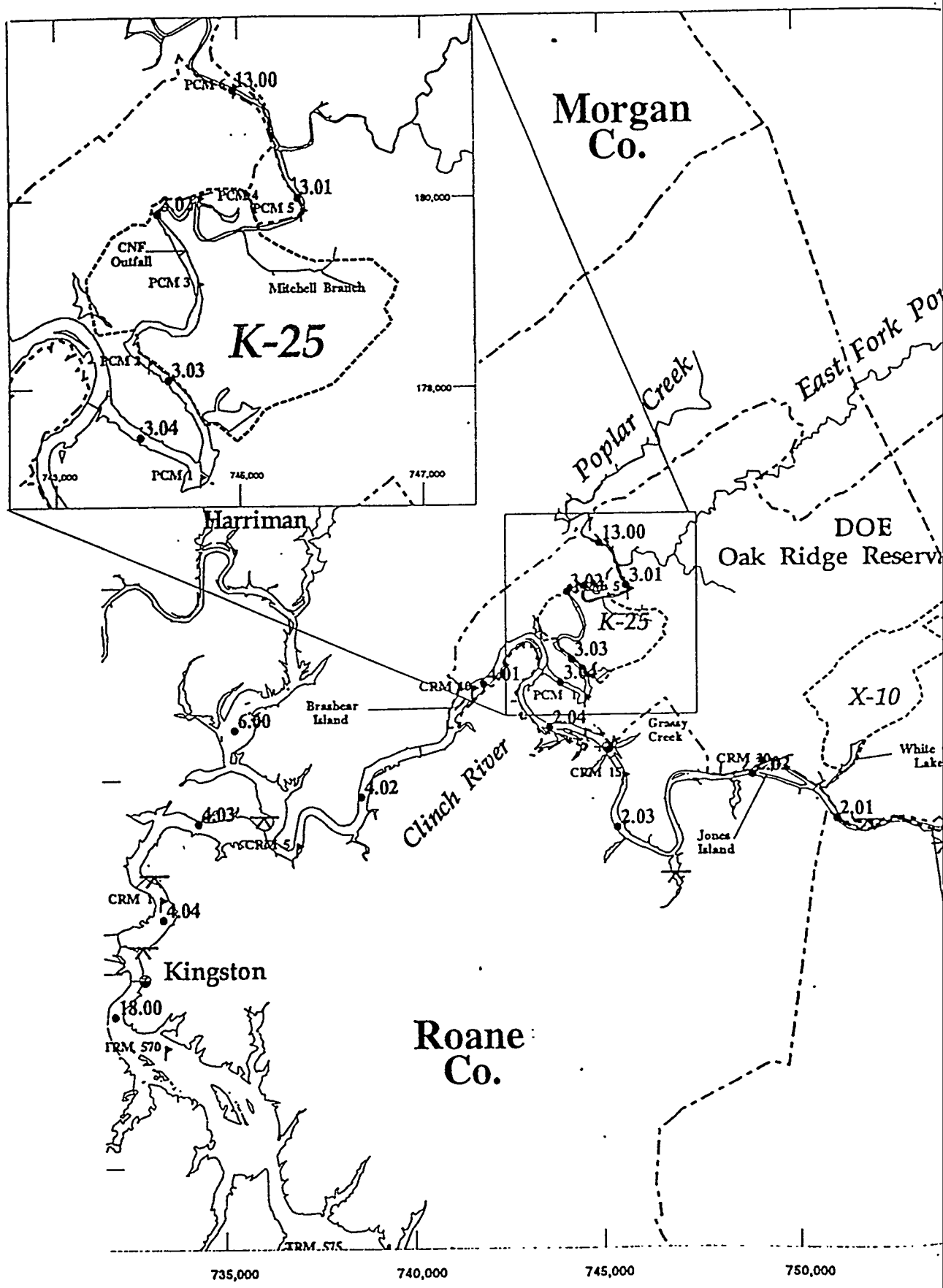
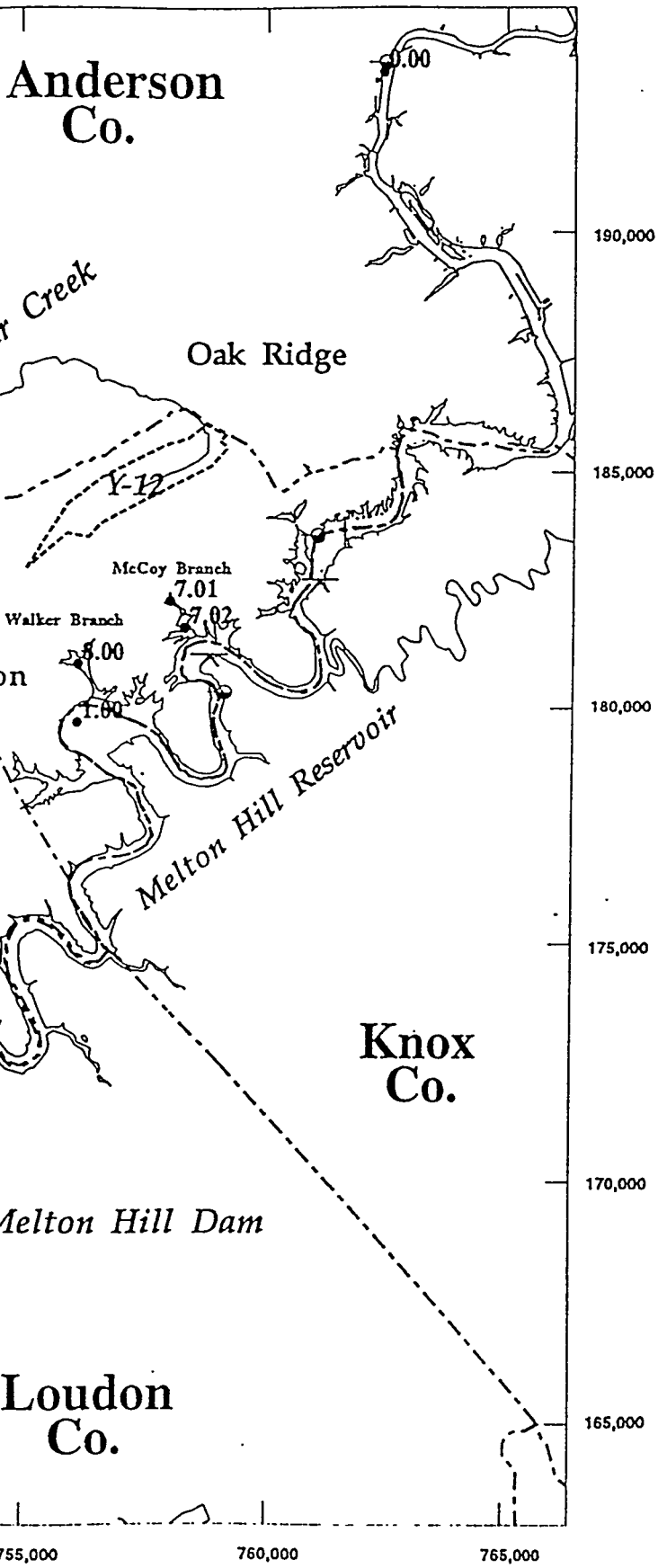


Fig. 3.1. Reaches and subreaches studied as part of the Clinch River/Poplar Creek Remedial Investi



Clinch River Environmental Restoration Program

Study Sites

N
W E
S

0 2,500 5,000
Meter

LEGEND

- Subreaches
- River Mile Marker
- Water Intake
- Recreation Area
- DOE Boundary
- Plant Boundary
- County Boundary

Tennessee State Plane Coordinate System, NAD 83

Source: Lake boundary provided by TVA
Sample locations provided by
Environmental Science Division

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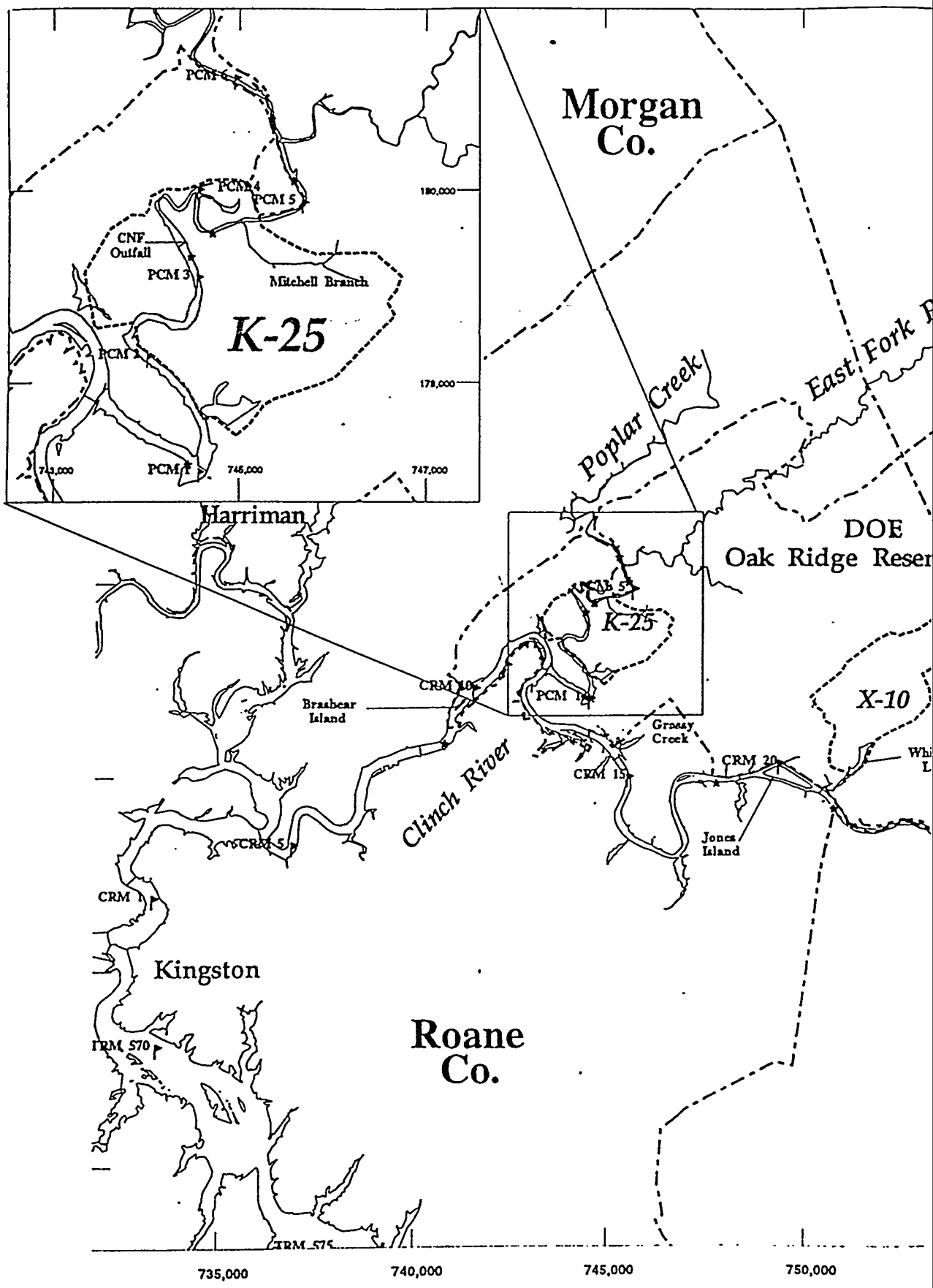
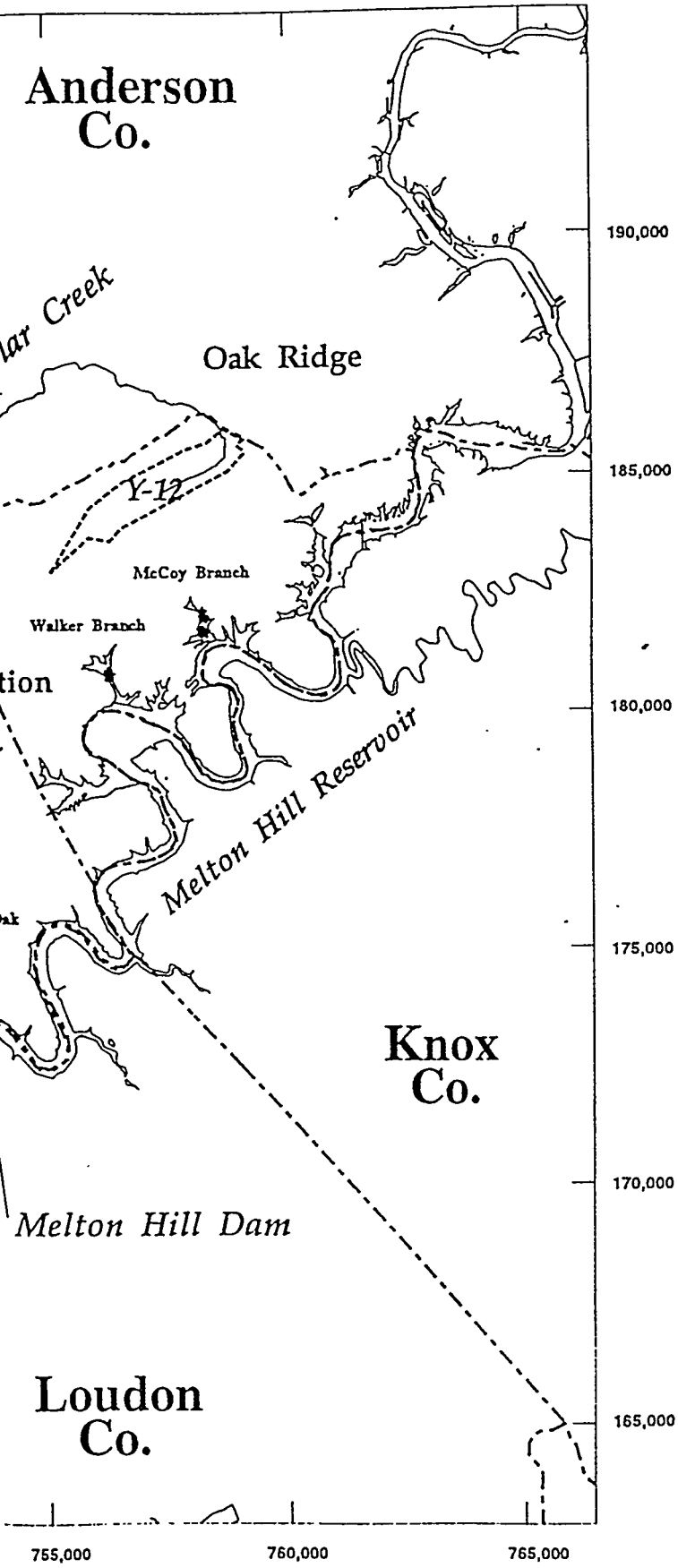


Fig. 3.46. Sampling locations for sediment and pore water toxicity samples.



Clinch River Environmental Restoration Program

Sampling Locations for Sediment Toxicity Task

N
W E
S

0 2,500 5,000
Meter

LEGEND

*	Sample Location
	River Mile Marker
	DOE Boundary
	Plant Boundary
	County Boundary

Tennessee State Plane Coordinate System, NAD 83

Source: Lake boundary provided by TVA
Sample locations provided by Environmental Science Division

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DOE/OR/01-1393V2&D1

Remedial Investigation/Feasibility Study for the Clinch River/Poplar Creek Operable Unit

Volume 2, Appendixes A, B, C, D

ChemRisk Document 2462
(Vol. 2)

DOE/OR/01-1393/V2&D1
ORNL/ER-315/V2&D1

Energy Systems Environmental Restoration Program
ORNL Environmental Restoration Program

Remedial Investigation/Feasibility Study for the Clinch River/Poplar Creek Operable Unit

Volume 2. Appendixes A, B, C, D

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Oak Ridge National Laboratory

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Appendix A

WATER CHARACTERIZATION

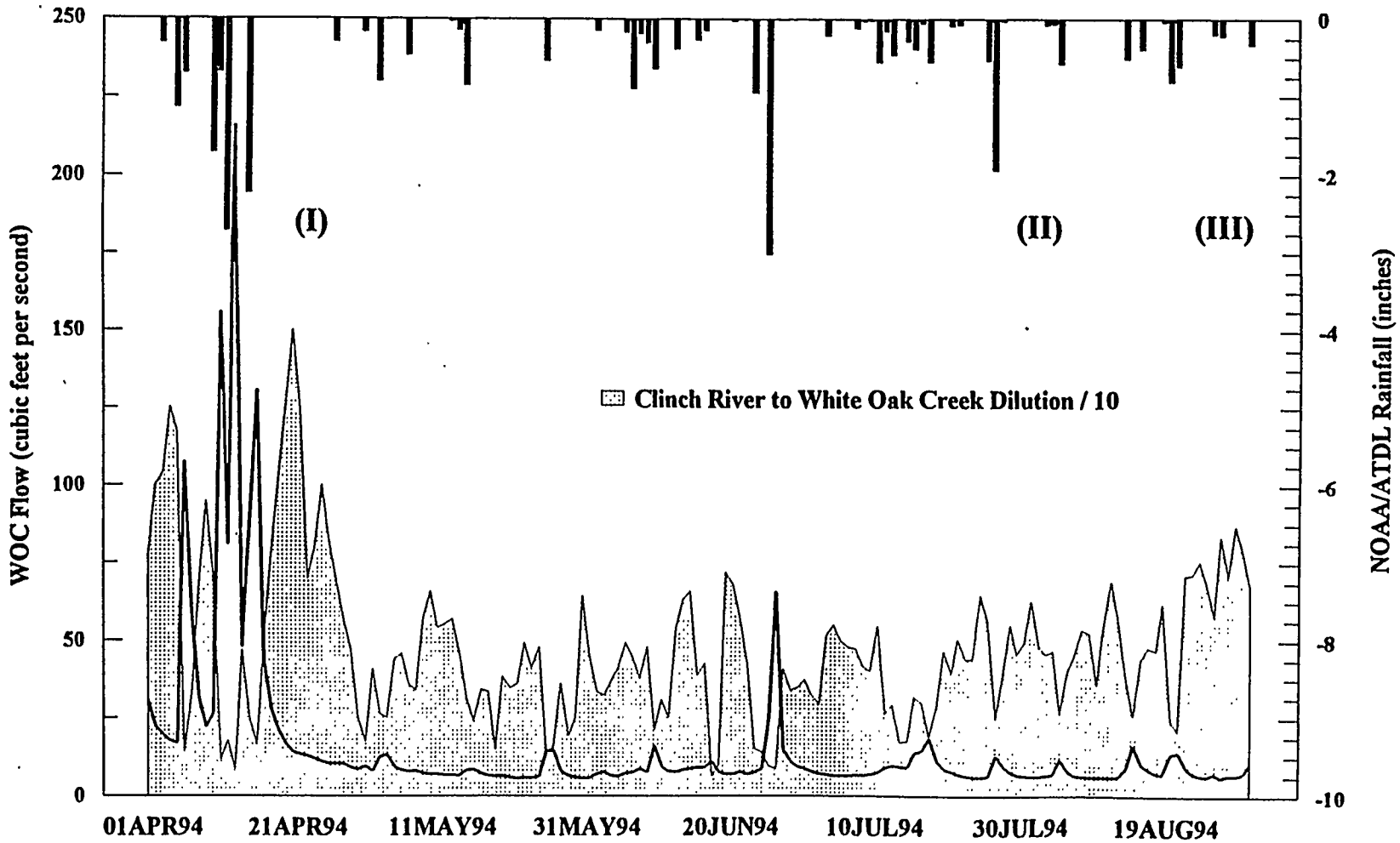

Fig. A1. Rainfall at NOAA/ATDL (top), flow rates at White Oak Dam (solid line), dilution of WOC water by the Clinch River (shading), and sampling events (roman numerals) April through August, 1994

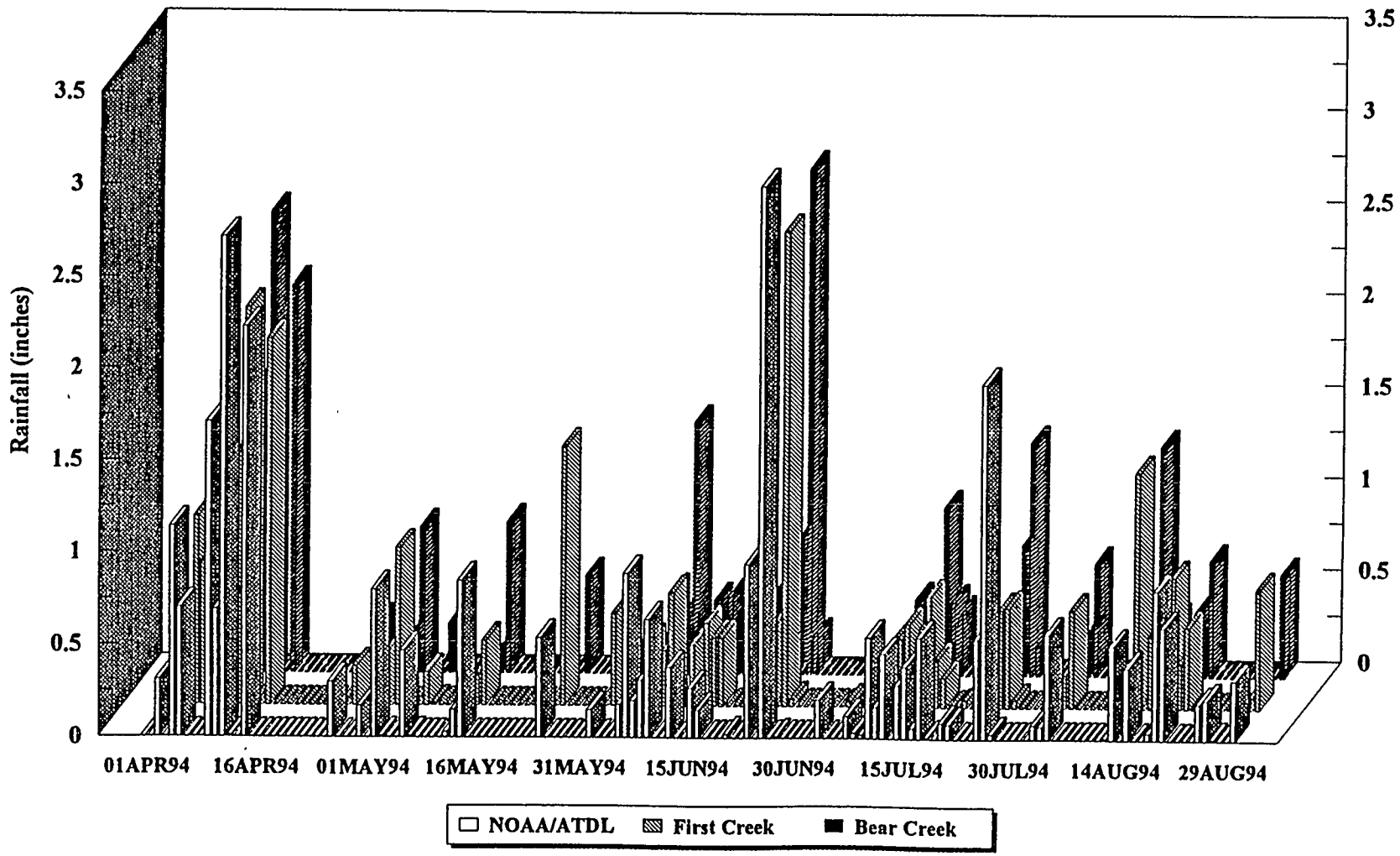

Fig. A2. Plots of rainfall, April through August 1994, at three gauge stations (see legend) located on the Oak Ridge Reservation

Table A1. Analytical results for the study of the distribution of contaminants downstream from the CNF (PCM 3.4)

Distance downstream (m)	Media	Analyte	Qtr full	Half full	Full Channel	units
			LOW FLOW PCM 3.4			
1	WHOL	Alkalinity as C	1.30E+00	1.40E+00	1.30E+00	MEQ/L
1	WHOL	Gross Alpha act	2.53E+00	1.24E+00	2.23E+00	PCI/L
10	WHOL	Gross Alpha act	1.34E+00	.	1.24E+00	PCI/L
100	WHOL	Gross Alpha act	1.62E+00	1.41E+00	1.19E+00	PCI/L
1000	WHOL	Gross Alpha act	1.90E+00	.	1.73E+00	PCI/L
1	WHOL	Gross Beta acti	3.99E+00	1.98E+00	1.70E+00	PCI/L
10	WHOL	Gross Beta acti	1.76E+00	.	2.24E+00	PCI/L
100	WHOL	Gross Beta acti	3.48E+00	2.85E+00	1.74E+00	PCI/L
1000	WHOL	Gross Beta acti	2.79E+00	.	1.98E+00	PCI/L
1	WHOL	pH	7.80E+00	7.60E+00	7.60E+00	
1	RE	Suspend particl	3.40E+00	8.00E-01	8.00E-01	MG/L
10	RE	Suspend particl	2.20E+00	.	6.00E-01	MG/L
100	RE	Suspend particl	2.20E+00	2.00E+00	1.00E+00	MG/L
1000	RE	Suspend particl	1.20E+00	.	1.60E+00	MG/L
1	WHOL	Turbidity	9.00E+00	3.90E+00	3.40E+00	NTU
10	WHOL	Turbidity	3.90E+00	.	3.50E+00	NTU
100	WHOL	Turbidity	3.60E+00	3.50E+00	3.30E+00	NTU
1000	WHOL	Turbidity	3.60E+00	.	3.80E+00	NTU
			HIGH FLOW PCM 3.4			
1	WHOL	Gross Alpha act	2.51E+00	1.99E+00	2.00E+00	PCI/L
10	WHOL	Gross Alpha act	1.60E+00	.	1.29E+00	PCI/L
100	WHOL	Gross Alpha act	1.85E+00	2.25E+00	1.82E+00	PCI/L
1000	WHOL	Gross Alpha act	1.80E+00	.	1.58E+00	PCI/L
1	WHOL	Gross Beta acti	3.57E+00	4.94E+00	1.74E+00	PCI/L
10	WHOL	Gross Beta acti	2.69E+00	.	2.25E+00	PCI/L
100	WHOL	Gross Beta acti	2.50E+00	2.84E+00	6.99E+00	PCI/L
1000	WHOL	Gross Beta acti	2.17E+00	.	2.37E+00	PCI/L
1	RE	Suspend particl	2.60E+01	1.92E+01	1.96E+01	MG/L
10	RE	Suspend particl	2.08E+01	.	2.08E+01	MG/L
100	RE	Suspend particl	2.28E+01	2.08E+01	2.04E+01	MG/L
1000	RE	Suspend particl	1.96E+01	.	3.20E+01	MG/L
1	WHOL	Turbidity	.	2.10E+01	2.20E+01	NTU
10	WHOL	Turbidity	2.30E+01	.	2.00E+01	NTU
100	WHOL	Turbidity	2.10E+01	2.40E+01	2.20E+01	NTU
1000	WHOL	Turbidity	2.20E+01	.	.	NTU

Table A2. Analytical results for the study of the distribution of contaminants downstream from the mouth of Mitchell Branch (PCM 4.6)

Distance downstream (m)	media	Analyte	Qtr full	Half full	Full Channel	units
LOW FLOW						
1	WHOL	Alkalinity as C	1.80E+00	1.50E+00	1.50E+00	MEQ/L
1	WHOL	Gross Alpha act	2.82E+00	2.65E+00	9.81E-01	PCI/L
10	WHOL	Gross Alpha act	2.03E+00	.	1.74E+00	PCI/L
100	WHOL	Gross Alpha act	2.72E+00	1.98E+00	1.92E+00	PCI/L
1000	WHOL	Gross Alpha act	1.62E+00	.	2.22E+00	PCI/L
1	WHOL	Gross Beta acti	4.34E+00	4.00E+00	2.10E+00	PCI/L
10	WHOL	Gross Beta acti	6.13E+00	.	3.72E+00	PCI/L
100	WHOL	Gross Beta acti	3.42E+00	5.92E+00	4.46E+00	PCI/L
1000	WHOL	Gross Beta acti	2.10E+00	.	9.39E+00	PCI/L
1	WHOL	pH	7.60E+00	7.60E+00	7.60E+00	
10	WHOL	pH	7.30E+00	.	7.32E+00	
100	WHOL	pH	7.39E+00	7.41E+00	7.46E+00	
1000	WHOL	pH	7.49E+00	.	7.50E+00	
1	RE	Suspend particl	4.20E+00	4.20E+00	4.00E+00	MG/L
10	RE	Suspend particl	4.80E+00	.	4.80E+00	MG/L
100	RE	Suspend particl	4.00E+00	4.80E+00	5.20E+00	MG/L
1000	RE	Suspend particl	5.20E+00	.	5.80E+00	MG/L
1	WHOL	Turbidity	4.10E+00	4.00E+00	4.40E+00	NTU
10	WHOL	Turbidity	4.10E+00	.	4.00E+00	NTU
100	WHOL	Turbidity	4.10E+00	4.50E+00	4.40E+00	NTU
1000	WHOL	Turbidity	4.20E+00	.	4.60E+00	NTU

Table A3. Analytical results for the study of the distribution of contaminants downstream from the mouth of East Fork Poplar Creek (PCM 5.5)

Distance downstream (m)	media	Analyte	Qtr full	Half full	Full Channel	units
			LOW FLOW, PCM 5.5			
1	WHOL	Alkalinity as C	2.40E+00	1.80E+00	1.20E+00	MEQ/L
1	WHOL	Aluminum	5.05E-02	1.44E-01	1.60E-01	MG/L
10	WHOL	Aluminum	1.32E-01	.	2.06E-01	MG/L
100	WHOL	Aluminum	1.43E-01	1.91E-01	1.86E-01	MG/L
1000	WHOL	Aluminum	1.83E-01	.	1.40E-01	MG/L
1	WHOL	Antimony	1.00E-03	1.00E-03	1.00E-03	MG/L
1	WHOL	Barium	3.34E-02	3.39E-02	3.45E-02	MG/L
10	WHOL	Barium	3.33E-02	.	3.45E-02	MG/L
100	WHOL	Barium	3.35E-02	3.40E-02	3.43E-02	MG/L
1000	WHOL	Barium	3.33E-02	.	3.35E-02	MG/L
1	WHOL	Boron	4.11E-02	2.01E-02	1.69E-02	MG/L
10	WHOL	Boron	1.99E-02	.	3.00E-03	MG/L
100	WHOL	Boron	5.20E-03	3.01E-02	2.32E-02	MG/L
1000	WHOL	Boron	1.65E-02	.	7.00E-03	MG/L
1	WHOL	Calcium	4.45E+01	2.83E+01	2.31E+01	MG/L
10	WHOL	Calcium	3.17E+01	.	2.52E+01	MG/L
100	WHOL	Calcium	3.05E+01	2.94E+01	2.82E+01	MG/L
1000	WHOL	Calcium	3.07E+01	.	2.84E+01	MG/L
1	WHOL	Chromium	1.79E-03	1.70E-03	1.60E-03	MG/L
10	WHOL	Chromium	1.60E-03	.	1.50E-03	MG/L
100	WHOL	Chromium	1.30E-03	2.10E-03	1.40E-03	MG/L
1000	WHOL	Chromium	1.70E-03	.	1.30E-03	MG/L
1	WHOL	Copper	1.86E-03	2.00E-03	2.20E-03	MG/L
10	WHOL	Copper	1.40E-03	.	1.40E-03	MG/L
100	WHOL	Copper	1.60E-03	1.50E-03	1.70E-03	MG/L
1000	WHOL	Copper	1.60E-03	.	1.40E-03	MG/L
1	WHOL	Iron	4.41E-01	4.24E-01	4.44E-01	MG/L
10	WHOL	Iron	4.49E-01	.	4.55E-01	MG/L
100	WHOL	Iron	4.55E-01	4.52E-01	4.47E-01	MG/L
1000	WHOL	Iron	4.68E-01	.	4.51E-01	MG/L
1	WHOL	Magnesium	7.66E+00	6.89E+00	6.88E+00	MG/L
10	WHOL	Magnesium	7.25E+00	.	7.06E+00	MG/L
100	WHOL	Magnesium	7.13E+00	7.30E+00	7.28E+00	MG/L
1000	WHOL	Magnesium	7.24E+00	.	7.28E+00	MG/L
1	WHOL	Manganese	2.43E-02	7.53E-02	9.35E-02	MG/L
10	WHOL	Manganese	6.71E-02	.	9.03E-02	MG/L
100	WHOL	Manganese	6.88E-02	7.57E-02	7.99E-02	MG/L
1000	WHOL	Manganese	6.98E-02	.	7.82E-02	MG/L
1	WHOL	Mercury	6.89E-05	5.33E-05	4.69E-06	MG/L

Table A3 (continued)

Distance downstream (m)	media	Analyte	Qtr full	Half full	Full Channel	units
10	WHOL	Mercury	4.56E-05	.	1.61E-05	MG/L
100	WHOL	Mercury	3.50E-05	2.42E-05	2.10E-05	MG/L
1000	WHOL	Mercury	3.23E-05	.	2.71E-05	MG/L
1	WHOL	Methyl Mercury	1.54E-07	1.09E-07	5.00E-08	MG/L
10	WHOL	Methyl Mercury	1.04E-07	.	6.50E-08	MG/L
100	WHOL	Methyl Mercury	1.01E-07	8.20E-08	7.70E-08	MG/L
1000	WHOL	Methyl Mercury	1.08E-07	.	9.40E-08	MG/L
1	WHOL	Nickel	3.53E-03	4.40E-03	4.10E-03	MG/L
10	WHOL	Nickel	3.90E-03	.	4.30E-03	MG/L
100	WHOL	Nickel	4.40E-03	4.30E-03	4.30E-03	MG/L
1000	WHOL	Nickel	4.20E-03	.	4.20E-03	MG/L
1	WHOL	pH	7.75E+00	7.66E+00	7.47E+00	
10	WHOL	pH	7.37E+00	.	7.19E+00	
100	WHOL	pH	7.50E+00	7.47E+00	7.50E+00	
1000	WHOL	pH	7.53E+00	.	7.59E+00	
1	WHOL	Potassium	1.76E+00	1.24E+00	1.06E+00	MG/L
10	WHOL	Potassium	1.32E+00	.	1.14E+00	MG/L
100	WHOL	Potassium	1.32E+00	1.31E+00	1.28E+00	MG/L
1000	WHOL	Potassium	1.32E+00	.	1.24E+00	MG/L
1	WHOL	Sodium	1.02E+01	4.98E+00	3.27E+00	MG/L
10	WHOL	Sodium	6.03E+00	.	3.76E+00	MG/L
100	WHOL	Sodium	5.62E+00	5.13E+00	4.79E+00	MG/L
1000	WHOL	Sodium	5.53E+00	.	4.84E+00	MG/L
1	RE	Suspend particl	8.00E-01	2.20E+00	3.00E+00	MG/L
10	RE	Suspend particl	2.20E+00	.	3.40E+00	MG/L
100	RE	Suspend particl	3.20E+00	2.80E+00	2.80E+00	MG/L
1000	RE	Suspend particl	3.20E+00	.	2.80E+00	MG/L
1	WHOL	Uranium	1.03E-02	2.70E-03	1.00E-03	MG/L
10	WHOL	Uranium	4.00E-03	.	1.00E-03	MG/L
100	WHOL	Uranium	3.50E-03	2.70E-03	2.10E-03	MG/L
1000	WHOL	Uranium	3.50E-03	.	2.30E-03	MG/L
1	WHOL	Zinc	9.69E-03	6.60E-03	7.00E-03	MG/L
10	WHOL	Zinc	5.40E-03	.	5.90E-03	MG/L
100	WHOL	Zinc	6.20E-03	5.90E-03	6.10E-03	MG/L
1000	WHOL	Zinc	6.10E-03	.	6.00E-03	MG/L
HIGH FLOW						
1	WHOL	Alkalinity as C	1.30E+00	1.20E+00	6.00E-01	MEQ/L
10	WHOL	Alkalinity as C	1.00E+00	.	8.00E-01	MEQ/L
100	WHOL	Alkalinity as C	8.00E-01	8.00E-01	7.00E-01	MEQ/L
1000	WHOL	Alkalinity as C	1.30E+00	.	6.00E-01	MEQ/L
1	WHOL	Aluminum	6.97E-01	6.34E-01	1.00E+00	MG/L

Table A3 (continued)

Distance downstream (m)	media	Analyte	Qtr full	Half full	Full Channel	units
10	WHOL	Aluminum	6.15E-01	.	7.19E-01	MG/L
100	WHOL	Aluminum	8.20E-01	7.39E-01	8.73E-01	MG/L
1000	WHOL	Aluminum	9.14E-01	.	1.18E+00	MG/L
1	WHOL	Barium	3.06E-02	2.82E-02	3.25E-02	MG/L
10	WHOL	Barium	3.04E-02	.	3.10E-02	MG/L
100	WHOL	Barium	3.17E-02	3.18E-02	3.30E-02	MG/L
1000	WHOL	Barium	3.19E-02	.	3.37E-02	MG/L
1	WHOL	Boron	7.00E-03	7.00E-03	7.00E-03	MG/L
10	WHOL	Boron	7.00E-03	.	7.00E-03	MG/L
100	WHOL	Boron	7.00E-03	8.50E-03	7.00E-03	MG/L
1000	WHOL	Boron	7.00E-03	.	7.00E-03	MG/L
1	WHOL	Calcium	2.30E+01	1.98E+01	1.13E+01	MG/L
10	WHOL	Calcium	2.01E+01	.	1.46E+01	MG/L
100	WHOL	Calcium	1.49E+01	1.53E+01	1.29E+01	MG/L
1000	WHOL	Calcium	1.54E+01	.	1.27E+01	MG/L
1	WHOL	Chromium	1.90E-03	2.00E-03	2.90E-03	MG/L
10	WHOL	Chromium	1.80E-03	.	2.10E-03	MG/L
100	WHOL	Chromium	1.90E-03	2.30E-03	1.90E-03	MG/L
1000	WHOL	Chromium	2.00E-03	.	2.40E-03	MG/L
1	WHOL	Cobalt	1.00E-03	1.00E-03	1.70E-03	MG/L
10	WHOL	Cobalt	1.00E-03	.	1.20E-03	MG/L
100	WHOL	Cobalt	1.20E-03	1.20E-03	1.30E-03	MG/L
1000	WHOL	Cobalt	1.00E-03	.	1.30E-03	MG/L
1	WHOL	Copper	5.72E-03	4.00E-03	4.50E-03	MG/L
10	WHOL	Copper	5.00E-03	.	4.80E-03	MG/L
100	WHOL	Copper	3.90E-03	4.70E-03	4.60E-03	MG/L
1000	WHOL	Copper	4.40E-03	.	4.80E-03	MG/L
1	WHOL	Iron	9.37E-01	1.04E+00	1.68E+00	MG/L
10	WHOL	Iron	9.69E-01	.	1.23E+00	MG/L
100	WHOL	Iron	1.33E+00	1.34E+00	1.47E+00	MG/L
1000	WHOL	Iron	1.33E+00	.	1.62E+00	MG/L
1	WHOL	Lead	2.70E-03	2.20E-03	2.50E-03	MG/L
10	WHOL	Lead	2.00E-03	.	2.30E-03	MG/L
100	WHOL	Lead	2.40E-03	2.20E-03	1.90E-03	MG/L
1000	WHOL	Lead	1.80E-03	.	2.10E-03	MG/L
1	WHOL	Magnesium	4.26E+00	4.08E+00	4.41E+00	MG/L
10	WHOL	Magnesium	4.25E+00	.	4.19E+00	MG/L
100	WHOL	Magnesium	4.38E+00	4.24E+00	4.48E+00	MG/L
1000	WHOL	Magnesium	4.41E+00	.	4.59E+00	MG/L
1	WHOL	Manganese	4.86E-02	5.94E-02	1.24E-01	MG/L
10	WHOL	Manganese	6.63E-02	.	9.52E-02	MG/L
100	WHOL	Manganese	9.80E-02	9.57E-02	1.12E-01	MG/L

Table A3 (continued)

Distance downstream (m)	media	Analyte	Qtr full	fu		
1000	WHOL	Manganese	9.43E-02	.		
1	WHOL	Mercury	5.52E-04	3.74E-04		
10	WHOL	Mercury	2.26E-04	.		
100	WHOL	Mercury	1.09E-04	1.39E-04	5.	
1000	WHOL	Mercury	1.30E-04	.	3.84	
1	WHOL	Methyl Mercury	2.39E-07	2.27E-07	6.70E-	
10	WHOL	Methyl Mercury	4.94E-07	.	1.27E-07	
100	WHOL	Methyl Mercury	2.21E-07	2.52E-07	1.23E-07	
1000	WHOL	Methyl Mercury	3.13E-07	.	8.70E-08	
1	WHOL	Nickel	4.33E-03	4.40E-03	6.70E-03	
10	WHOL	Nickel	5.30E-03	.	4.90E-03	M
100	WHOL	Nickel	5.60E-03	5.10E-03	5.80E-03	MG
1000	WHOL	Nickel	5.00E-03	.	5.60E-03	MG/L
1	WHOL	pH	7.60E+00	7.60E+00	7.30E+00	
10	WHOL	pH	7.20E+00	.	7.90E+00	
100	WHOL	pH	7.80E+00	7.80E+00	7.60E+00	
1000	WHOL	pH	7.50E+00	.	7.80E+00	
1	WHOL	Potassium	1.46E+00	1.37E+00	1.49E+00	MG/L
10	WHOL	Potassium	1.42E+00	.	1.40E+00	MG/L
100	WHOL	Potassium	1.41E+00	1.40E+00	1.49E+00	MG/L
1000	WHOL	Potassium	1.43E+00	.	1.51E+00	MG/L
1	WHOL	Sodium	3.96E+00	3.49E+00	2.91E+00	MG/L
10	WHOL	Sodium	3.87E+00	.	3.24E+00	MG/L
100	WHOL	Sodium	3.01E+00	3.69E+00	3.11E+00	MG/L
1000	WHOL	Sodium	3.22E+00	.	3.15E+00	MG/L
1	RE	Suspend particl	2.12E+01	1.80E+01	1.52E+01	MG/L
10	RE	Suspend particl	1.92E+01	.	3.24E+01	MG/L
100	RE	Suspend particl	3.40E+01	3.52E+01	3.56E+01	MG/L
1000	RE	Suspend particl	3.20E+01	.	3.80E+01	MG/L
1	WHOL	Thallium	1.00E-03	1.00E-03	1.00E-03	MG/L
10	WHOL	Thallium	1.00E-03	.	1.00E-03	MG/L
100	WHOL	Thallium	1.00E-03	1.00E-03	1.00E-03	MG/L
1000	WHOL	Thallium	1.00E-03	.	1.00E-03	MG/L
1	WHOL	Turbidity	1.60E+01	1.90E+01	2.10E+01	NTU
10	WHOL	Turbidity	1.80E+01	.	2.20E+01	NTU
100	WHOL	Turbidity	1.70E+01	2.20E+01	2.60E+01	NTU
1000	WHOL	Turbidity	1.80E+01	.	1.80E+01	NTU
1	WHOL	Uranium	7.45E-03	5.60E-03	1.00E-03	MG/L
10	WHOL	Uranium	4.90E-03	.	2.30E-03	MG/L
100	WHOL	Uranium	2.40E-03	2.40E-03	1.00E-03	MG/L
1000	WHOL	Uranium	2.30E-03	.	1.00E-03	MG/L
1	WHOL	Vanadium	1.18E-03	1.50E-03	2.40E-03	MG/L

Table A3 (continued)

Distance downstream (m)	media	Analyte	Qtr full	Half full	Full Channel	units
10	WHOL	Vanadium	1.40E-03	.	2.00E-03	MG/L
100	WHOL	Vanadium	1.20E-03	1.70E-03	1.30E-03	MG/L
1000	WHOL	Vanadium	1.90E-03	.	2.30E-03	MG/L
1	WHOL	Zinc	1.63E-02	1.36E-02	2.24E-02	MG/L
10	WHOL	Zinc	2.13E-02	.	1.86E-02	MG/L
100	WHOL	Zinc	2.05E-02	2.34E-02	2.40E-02	MG/L
1000	WHOL	Zinc	1.96E-02	.	2.45E-02	MG/L

Table A4. Analytes that were below detection limits (mg/L), with exceptions, for surface water analyses from Oak Ridge Reservation Environmental Monitoring data from 14 locations collected bimonthly from March 1993 through September 1994 (BCM=Bear Creek Mile, EFM=East Fork Poplar Creek Mile, CRM=Clinch River Mile, MIM=Mitchell Branch Mile, PCM=Poplar Creek Mile, WCM=White Oak Creek Mile)

ANALYTE	EXCEPTIONS	DETECTION LIMIT (MG/L)
INORGANICS		
Antimony		0.05
Arsenic	CRM 52.2 (11/11/93, 0.05 mg/l) PCM 13.7 (8/10/93, 0.0531 mg/l) EFM 3.4 (8/10/93, 0.0545 mg/l)	0.05
Beryllium	CRM 49.7 (5/3/94, 0.0014 mg/l) CRM 52.2 (5/3/94, 0.0012 mg/l) BCM 0.4 (5/4/94, 0.001 mg/l)	0.001
Cadmium		0.005
Chromium	CRM 41.0 (12/8/93, 0.0053 mg/l; 4/12/94, 0.0042 mg/l) CRM 49.7 (5/11/93, 0.012 mg/l; 11/11/93, 0.0089 mg/l; 3/8/94, 0.0076 mg/l) CRM 52.2 (5/11/93, 0.012 mg/l; 11/11/93, 0.0093 mg/l; 3/8/94, 0.0079 mg/l) CRM 19.9 (12/8/93, 0.032 mg/l) PCM 1.4 (12/6/93, 0.0046mg/l; 4/12/94, 0.0046 mg/l) PCM 13.7 (12/8/93, 0.001 mg/l) BCM 0.4 (5/13/93, 0.014 mg/l; 11/10/93, 0.013 mg/l; 3/8/94, 0.0098 mg/l) MIM 0.1 (6 of 9 observations above detection limit) MIM 0.9 (8/10/93, 0.0194 mg/l; 12/7/93, 0.0047 mg/l; 4/12/94, 0.013 mg/l) WCM 0.6 (all 10 observation above the detection limit)	0.004
Table 1. (cont.)		
Cobalt	CRM 41.0 (4/12/94, 0.0045 mg/l) CRM 19.9 (4/5/94, 0.0045 mg/l) PCM 1.4 (4/12/94, 0.0052 mg/l) MIM 0.9 (8/10/93, 0.0153 mg/l; 4/12/94, 0.0042 mg/l) WCM 0.6 (11/16/93, 0.0077 mg/l)	0.004

Table A4 (continued)

ANALYTE	EXCEPTIONS	DETECTION LIMIT (MG/L)
Copper	MIM 0.1 (4/5/93, 0.0125 mg/l; 6/15/94, 0.012 mg/l) MIM 0.9 (4/5/93, 0.013 mg/l; 8/10/93, 0.0201 mg/l)	0.007
Cyanide		0.002
Lead		0.05
Mercury	CRM 36.0 (8/8/94, 0.000064 mg/l) CRM 41.0 (12/8/93, 0.000083 mg/l; 6/15/94, 0.000058 mg/l) CRM 49.7 (7/18/94, 0.000074 mg/l; 9/12/94, 0.000068 mg/l) CRM 52.2 (3/8/94, 0.000055 mg/l) CRM 14.3 (8/8/94, 0.000054 mg/l) CRM 19.9 (8/8/94, 0.000069 mg/l) CRM 9.9 (8/4/94, 0.000088 mg/l) PCM 1.4 (10/13/93, 0.000051 mg/l; 8/3/94, 0.000097 mg/l) PCM 13.7 (8/3/94; 0.000057 mg/l) BCM 0.4 (3/8/94, 0.000095 mg/l; 9/7/94, 0.000098 mg/l) EFM 3.4 (5 of 9 observations above detection limit) MIM 0.1 (12/6/93, 0.000065 mg/l; 8/3/94, 0.000087 mg/l) MIM 0.9 (8/8/94, 0.000076 mg/l) WCM 0.6 (9/9/93, 0.000095 mg/l; 9/8/94, 0.00021 mg/l)	0.00005
Nickel	CRM 49.7 (5/3/94, 0.01 mg/l) CRM 19.9 (12/8/93, 0.014 mg/l) MIM 0.1 (4 out of 9 observations above detection limit) MIM 0.9 (8/10/93, 0.064 mg/l)	0.01
Selenium		0.05
Silver	MIM 0.9 (8/8/94, 0.011 mg/l)	0.005
Thallium	CRM 36.0 (6/15/94, 1.1 mg/l) PCM 1.4 (10/13/93, 0.007 mg/l) BCM 0.4 (3/8/94, 0.0056 mg/l)	0.005
ORGANICS		

Table A4 (continued)

ANALYTE	EXCEPTIONS	DETECTION LIMIT (MG/L)
1,1,1-Trichloroethane		0.005
1,1,2,2-Tetrachloroethane		0.005
1,1,2-Trichloroethane		0.005
1,1-Dichloroethane	MIM 0.1 (8/10/93, 0.0012 mg/l; 10/12/93, 0.0012 mg/l)	0.005
1,1-Dichloroethene		0.005
1,2-Dichloroethane		0.005
1,2-Dichloroethene	MIM 0.1 (above detection limits 8 out of 9 times)	0.005
1,2-Dichloropropane		0.005
2-Butanone	CRM 36.0 (8/8/94, 0.002 mg/l) CRM 41.0 (8/8/94, 0.001 mg/l) CRM 49.7 (7/18/94, 0.011 mg/l; 9/12/94, 0.0062 mg/l) CRM 52.2 (7/18/94, 0.012 mg/l; 9/12/94, 0.0065 mg/l) CRM 19.9 (8/8/94, 0.002 mg/l) PCM 1.4 (8/3/94,0.002 mg/l) CRM 9.9 (8/4/94, 0.003 mg/l) BCM 0.4 (7/14/94, 0.0096 mg/l; 9/7/94, 0.003 mg/l) EFM 3.4 (8/3/94, 0.002 mg/l) MIM 0.9 (8/8/94, 0.001 mg/l)	0.01
2-Hexanone		0.01
4-Methyl-2-pentanone		0.01

Table A4 (continued)

ANALYTE	EXCEPTIONS	DETECTION LIMIT (MG/L)
Acetone	CRM 49.7 (9/12/94, 0.007 mg/l) CRM 52.2 (9/12/94, 0.0097 mg/l) CRM 19.9 (8/11/93, 0.014 mg/l) PCM 1.4 (2/1/94, 0.013 mg/l) PCM 13.7 (4/5/93, 0.045 mg/l) BCM 0.4 (9/7/94, 0.003 mg/l) WCM 0.6 (9/9/93, 0.0078 mg/l)	0.01
Benzene		0.005
Bromodichloromethane		0.005
Bromoform		0.005
Bromoethane		0.01
Carbon disulfide	CRM 14.3 (4/5/93, 0.01 mg/l) PCM 1.4 (4/5/93, 0.004 mg/l; 2/1/94, 0.02 mg/l) PCM 13.7 (4/5/93, 0.024 mg/l)	0.005
Carbon tetrachloride		0.005
Chlorobenzene		0.005
Chloroethane		0.01
Chloroform	PCM 1.4 (2/1/94, 0.004 mg/l) MIM 0.1 (6 of 9 observations above detection limit)	0.005
Chloromethane		0.01
cis-1,3-Dichloropropene	MIM 0.1 (12/6/93, 0.025 mg/l)	0.005
Dibromochloromethane		0.005
Dimethylbenzene	CRM 49.7 (9/12/94, 0.0014 mg/l)	0.005

Table A4 (continued)

ANALYTE	EXCEPTIONS	DETECTION LIMIT (MG/L)
Ethylbenzene		0.005
Methylene chloride	BCM 0.4 (9/14/93, 0.0026 mg/l)	0.005
Styrene		0.005
Tetrachloroethene	MIM 0.1 (8/10/93, 0.0012 mg/l; 10/12/93, 0.0013 mg/l)	0.005
Toluene	CRM 14.3 (8/8/94, 0.001 mg/l)	0.005
trans-1,3-Dichloropropene		0.005
Trichloroethene	CRM 19.9 (8/11/93, 0.003 mg/l) MIM 0.1 (8 of 9 observations above detection limit)	0.005
Vinyl chloride	MIM 0.1 (4 of 9 observations above detection limit)	0.01
PHYSICAL		
Biological Oxygen Demand	PCM 1.4 (6/15/94, 7.1 mg/l; 8/3/94, 13 mg/l) EFM 3.4 (4/5/93, 8 mg/l) WCM 0.6 (4 of 9 observations above detection limit)	5

Table A5. Summary data for the ORREM project, 1993 and 1994

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Summary statistics for CRM 52.2							
INORGANICS (mg/L)							
Alkalinity as CaCO3	10	10	90, 113	101.1	2.62657	105.915	99
Aluminum	10	10	0.067, 1.1	0.372	0.08859	0.535	0.3
Ammonium Nitrogen	10	10	0.035, 0.08	0.05	0.00519	0.06	0.044
Barium	10	10	0.026, 0.187	0.05	0.01582	0.079	0.032
Chloride	10	10	2.4, 3.8	3.23	0.149	3.503	3.35
Chromium	10	3	<0.004, 0.012	0.008	0.00049	0.009	0.008
Iron	10	10	0.12, 1.4	0.419	0.11488	0.629	0.299
Manganese	10	10	0.031, 0.16	0.082	0.01395	0.107	0.074
Nitrate	10	10	1.3, 3.8	2.43	0.225	2.843	2.4
Phosphorus	10	7	<0.2, 0.51	0.286	0.03342	0.347	0.268
Sulfate	10	10	14, 25	19.93	1.117	21.977	21
Total Hardness	10	10	100, 131	116.5	3.12072	122.221	114
Uranium	9	6	0, 0.001	0	0.00005	0	0
Vanadium	10	3	<0.002, 0.024	0.005	0.00248	0.009	0.003
Zinc	10	3	<0.005, 0.038	0.01	0.0036	0.016	0.006
PHYSICAL							
Chemical Oxygen Demand (mg/l)	10	2	<5, 16	6.1	1.47580	8.805	5
Total dissolved solids (mg/l)	10	10	129, 182	149.9	6.60547	162.009	144
Total suspended particles (mg/l)	10	7	<5, 29	9.2	2.43352	13.661	6
RADIONUCLIDES (PCI/L)							
Cesium-137	10	10	-27.03, 2.162	-2.1624	2.779	2.933	0.4055
Cobalt-60	10	10	-2.703, 3.784	1.3623	0.711	2.666	1.4056
Gross Alpha activity	10	10	0, 2.703	1.1488	0.304	1.707	0.9055

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Gross Beta activity	10	10	1.433, 4.055	2.717	0.28307	3.235	2.595
Strontium-90	10	10	-0.27, 3.244	1.122	0.36754	1.795	0.865
Technetium-99	10	10	-2.703, 6.487	1.8759	1.156	3.995	1.757
Tritium	10	10	-486.54, 351.39	-32.436	102.318	155.125	40.545
Radioactive Uranium	10	10	0.027, 2.973	0.851	0.28261	1.37	0.541
Summary statistics for CRM 49.7							
INORGANICS (mg/L)							
Alkalinity as CaCO3	10	10	75, 110	97.2	4.02437	104.577	99
Aluminum	10	9	<0.05, 0.62	0.265	0.06025	0.375	0.215
Ammonium Nitrogen	10	10	0.03, 0.09	0.052	0.00733	0.066	0.042
Barium	10	10	0.023, 0.092	0.036	0.00637	0.048	0.031
Chloride	10	10	2.4, 3.8	3.16	0.1514	3.438	3.3
Chromium	10	3	<0.004, 0.012	0.008	0.00052	0.009	0.008
Iron	10	10	0.073, 0.69	0.287	0.06942	0.414	0.233
Manganese	10	10	0.022, 0.12	0.062	0.01059	0.081	0.057
Nitrate	10	10	1.6, 25	4.65	2.2682	8.808	2.75
Phosphorus	10	6	<0.2, 0.52	0.286	0.03588	0.352	0.25
Sulfate	10	10	16.4, 24	19.84	0.8737	21.442	19.5
Total Hardness	10	10	89, 150	120.2	5.07674	129.506	121
Uranium	9	6	0, 0.002	0	0.00016	0.001	0
Vanadium	10	4	<0.002, 0.023	0.004	0.00228	0.008	0.002
Zinc	10	4	<0.005, 0.02	0.007	0.00157	0.01	0.006
PHYSICAL							
Chemical Oxygen Demand (mg/l)	10	3	<5, 22	8.6	1.73378	11.778	7
Total dissolved solids (mg/L)	10	10	114, 180	146.5	7.52514	160.294	142.5
Total suspended particles	10	7	<5, 15	8.3	0.92978	10.004	7.5

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
RADIONUCLIDES (PCI/L)							
Cesium-137	10	10	-1.081, 2.703	1.081	0.4049	1.824	1.216
Cobalt-60	10	10	-1.352, 5.676	2.438	0.7304	3.777	2.973
Gross Alpha activity	10	10	-0.649, 2.649	0.97	0.278	1.48	1.054
Gross Beta activity	10	10	0.811, 7.568	3.706	0.72427	5.033	4.325
Strontium-90	10	10	-0.811, 3.244	1.308	0.41007	2.06	1.122
Technetium-99	10	10	-3.784, 5.406	1.892	0.9993	3.724	2.703
Tritium	10	10	-324.36, 540.6	170.289	99.3595	352.426	216.24
Radioactive Uranium	10	10	-0.622, 3.514	0.851	0.32904	1.455	0.649
Summary statistics for CRM 41.0							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	83, 115	97.111	3.97368	104.5	95
Aluminum	9	9	0.073, 1.8	0.406	0.18937	0.758	0.19
Ammonium Nitrogen	9	9	0.03, 0.08	0.04	0.00525	0.05	0.036
Barium	9	9	0.026, 0.04	0.032	0.00149	0.035	0.031
Chloride	9	9	2.7, 5	3.567	0.246	4.02	3.3
Iron	9	6	<0.05, 2.3	0.48	0.24894	0.943	0.122
Manganese	9	8	<0.001, 0.08	0.04	0.00715	0.054	0.034
Nitrate	9	9	1.6, 3.9	2.378	0.253	2.85	2.1
Phosphorus	9	6	<0.17, 0.49	0.293	0.04402	0.375	0.3
Sulfate	9	9	15, 26	21.111	1.252	23.44	22
Total Hardness	9	9	100, 130	117.889	3.42152	124.251	117
Uranium	8	6	0, 0.001	0	0.00012	0.001	0
Vanadium	9	3	<0.002, 0.005	0.003	0.0003	0.004	0.003
Zinc	9	2	<0.005, 0.014	0.007	0.0012	0.009	0.006
PHYSICAL							

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Chemical Oxygen Demand (mg/l)	9	3	<5, 9	6.642	0.39021	7.170	6
Total dissolved solids (mg/l)	9	9	120, 185	151.778	7.96307	166.585	154
Total suspended particles (mg/l)	9	4	<5, 36	10.556	3.59749	17.245	6
RADIONUCLIDES (PCI/L)							
Cesium-137	9	9	-4.055, 2.97	0.03	0.693	1.32	0.5406
Cobalt-60	9	9	-0.811, 6.49	1.351	0.822	2.88	0.5406
Gross Alpha activity	9	9	0.081, 1.65	0.7	0.181	1.04	0.5947
Gross Beta activity	9	9	1.703, 5.136	3.445	0.48046	4.338	3.514
Strontium-90	9	9	-0.405, 2.676	0.985	0.26993	1.487	0.946
Technetium-99	9	9	-0.27, 23.25	5.007	2.459	9.58	1.8921
Tritium	9	9	-432.48, 2973.3	393.437	353.007	1049.87	0
Radioactive Uranium	9	9	0.081, 2.054	0.916	0.23917	1.361	1.027
Summary statistics for CRM 36.0							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	73, 116	98	4.84195	107.004	100
Aluminum	9	9	0.071, 1.6	0.355	0.16525	0.663	0.115
Ammonium Nitrogen	9	8	<0.03, 0.06	0.039	0.00335	0.045	0.039
Barium	9	9	0.024, 0.041	0.032	0.00177	0.035	0.031
Chloride	9	9	2.8, 5.3	3.5	0.253	3.97	3.3
Iron	9	8	<0.05, 1.4	0.337	0.15516	0.626	0.087
Manganese	9	9	0.019, 0.069	0.043	0.00638	0.054	0.042
Nitrate	9	9	0.82, 13	3.269	1.245	5.583	2.3
Phosphorus	9	6	<0.13, 0.48	0.256	0.04635	0.342	0.28
Sulfate	9	9	14, 30	21.444	1.625	24.467	21
Total Hardness	9	9	91, 130	114.333	4.6398	122.961	118

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Uranium	8	5	0, 0.001	0	0.00012	0	0
Vanadium	9	3	<0.002, 0.004	0.003	0.00009	0.003	0.003
Zinc	9	2	<0.005, 0.017	0.015	0.0003	0.015	0.015
PHYSICAL							
Chemical Oxygen Demand (mg/l)	9	3	<5, 12	8.89	0.679	10.15	8
Total dissolved solids (mg/l)	9	9	105, 160	140.111	6.3562	151.931	148
Total suspended particles (mg/l)	9	5	<5, 30	10	2.9866	15.554	5
RADIONUCLIDES (PCI/L)							
Cesium-137	9	9	-4.055, 2.973	0.06	0.874	1.686	0.2703
Cobalt-60	9	9	-1.352, 14.867	2.55	1.599	5.523	1.6218
Gross Alpha activity	9	9	0.27, 2.973	1.063	0.291	1.605	0.7298
Gross Beta activity	9	9	1.703, 8.65	3.64	0.71269	4.965	2.703
Strontium-90	9	9	0.027, 1.622	0.76	0.21214	1.154	0.649
Technetium-99	9	9	-1.081, 7.568	2.006	0.979	3.826	0.8109
Tritium	9	9	-459.51, 648.72	111.123	119.908	334.098	81.09
Radioactive Uranium	9	9	0.159, 3.514	0.835	0.34858	1.483	0.432
Summary statistics for WCM 0.6							
INORGANICS (mg/L)							
Alkalinity as CaCO3	10	10	63, 130	104.2	5.6663	114.587	104
Aluminum	10	10	0.067, 2.15	1.023	0.2119	1.411	1
Ammonium Nitrogen	10	10	0.045, 0.11	0.062	0.0065	0.074	0.056
Barium	10	10	0.028, 0.173	0.054	0.0135	0.079	0.045
Chloride	10	10	2.5, 22	9.39	1.71	12.52	9.75
Chromium	10	10	0.007, 0.023	0.014	0.0019	0.018	0.013
Iron	10	10	0.17, 1.8	0.925	0.1559	1.21	0.91

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Manganese	10	10	0.038, 0.22	0.118	0.0179	0.151	0.125
Nitrate	10	9	<0.56, 2.6	1.57	0.25	2.04	1.25
Phosphorus	10	8	<0.2, 0.5	0.361	0.0262	0.409	0.35
Sulfate	10	10	14, 64	44.1	5.31	53.83	41.5
Total Hardness	10	10	74, 170	134.9	8.2965	150.108	137
Uranium	9	9	0, 0.01	0.003	0.0009	0.005	0.002
Vanadium	10	9	<0.002, 0.004	0.003	0.0002	0.003	0.003
Zinc	10	9	<0.005, 0.004	0.023	0.0022	0.027	0.023
PHYSICAL							
Chemical Oxygen Demand (mg/l)	10	6	<5, 24	9.9	1.7213	13.055	7.5
Total dissolved solids (mg/l)	10	10	92, 265	198.5	15.9215	227.686	199.5
Total suspended particles (mg/ll)	10	10	5, 49	23.1	5.1	32.449	17
RADIONUCLIDES (PCI/L)							
Cesium-137	10	10	11.08, 137.85	57.06	12.31	79.63	44.6
Cobalt-60	10	10	0.81, 5.95	4.05	0.59	5.14	4.46
Gross alpha activity	10	10	1.73, 12.43	5.44	0.89	7.08	5.27
Gross Beta activity	10	10	324.36, 540.6	421.668	23.9062	465.491	391.935
Plutonium-238	2	2	0.27, 0.35	0.31	0.04	0.57	0.31
Plutonium-239	2	2	0.14, 0.27	0.2	0.07	0.63	0.2
Strontium-90	10	10	108.12, 210.834	178.398	9.5268	195.862	186.507
Technetium-99	10	10	4.32, 35.14	16.92	2.82	22.08	16.62
Tritium	10	10	37842, 240567	135960.9	21393.96	175178.44	136501.5
Radioactive Uranium	10	10	2.189, 6.217	4.652	0.4087	5.401	4.865
Uranium-234	8	8	2.46, 5.41	3.82	0.36	4.51	3.51
Uranium-235	8	8	-0.01, 0.32	0.18	0.04	0.25	0.18

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Uranium-238	8	8	0.541, 1.406	0.878	0.1057	1.079	0.811
Summary statistics for CRM 19.9							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	83, 118	101.333	3.55512	107.944	100
Aluminum	9	9	0.114, 1.2	0.27	0.11829	0.49	0.13
Ammonium Nitrogen	9	9	0.03, 0.16	0.059	0.01374	0.084	0.04
Barium	9	9	0.025, 0.046	0.032	0.00202	0.036	0.03
Chloride	9	9	3, 5.3	3.811	0.237	4.25	3.6
Iron	9	7	<0.05, 1.1	0.275	0.11073	0.481	0.15
Manganese	9	9	0.01, 0.091	0.043	0.00782	0.057	0.04
Nitrate	9	9	1, 5.6	2.822	0.472	3.7	2.3
Phosphorus	9	7	<0.18, 0.47	0.267	0.03202	0.326	0.25
Sulfate	9	9	17, 27	20.556	0.973	22.37	21
Total Hardness	9	9	100, 130	115.556	4.0487	123.084	118
Uranium	8	4	0, 0.003	0.001	0.00043	0.002	0
Vanadium	9	4	<0.002, 0.003	0.002	0.00016	0.003	0.002
Zinc	9	3	<0.005, 0.029	0.009	0.00297	0.014	0.006
PHYSICAL							
Chemical Oxygen Demand (mg/l)	9	4	<5, 11	5.778	0.72072	7.118	5
Total dissolved solids (mg/l)	9	9	108, 174	139.111	6.5605	151.311	146
Total suspended particles (mg/l)	9	6	<5, 25	9.556	2.40439	14.027	6
RADIONUCLIDES (PCI/L)							
Cesium-137	9	9	-2.703, 2.97	-0.06	0.569	1	0.27
Cobalt-60	9	9	-2.973, 5.41	0.631	0.813	2.14	0.27
Gross Beta activity	9	9	2.162, 12.704	6.187	1.27057	8.55	4.325

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Gross Alpha activity	9	9	-0.162, 2.97	0.988	0.321	1.58	0.757
Strontium-90	9	9	-0.189, 4.865	1.946	0.50289	2.881	2.162
Technetium-99	9	9	-1.622, 8.92	3.652	1.178	5.84	3.784
Tritium	9	9	189.21, 2973.3	985.093	311.338	1564.04	567.63
Radioactive Uranium	9	9	0.216, 1.379	0.592	0.13013	0.834	0.405
Summary Statistics for CRM 14.3							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	83, 115	100.333	4.2947	108.32	105
Aluminum	9	9	0.1, 0.47	0.256	0.03871	0.328	0.23
Ammonium Nitrogen	9	8	<0.02, 0.09	0.048	0.00756	0.062	0.05
Barium	9	8	<0.001. 0.041	0.027	0.00166	0.033	0.029
Chloride	9	9	3, 5.1	3.689	0.2189	4.096	3.5
Iron	9	8	<0.05, 0.68	0.329	0.06622	0.452	0.263
Manganese	9	9	0.02, 0,38	0.085	0.0378	0.155	0.047
Nitrate	9	9	1, 5.3	2.778	0.4515	3.617	2.4
Phosphorus	9	7	<0.2, 0.48	0.3	0.03256	0.361	0.26
Sulfate	9	9	16, 26	19.778	0.9969	21.632	20
Total Hardness	9	9	100, 128	116.278	3.58538	122.945	118
Uranium	8	5	0, 0.001	0	0.00009	0	0
Vanadium	9	2	<0.002, 0.002	0.002	0	0.002	0.002
Zinc	9	3	<0.005, 0.008	0.006	0.00037	0.007	0.006
PHYSICAL							
Chemical Oxygen Demand (mg/l)	9	4	<5, 6	5.22	0.160	5.52	5
Total dissolved solids (mg/l)	9	9	118, 165	143.111	4.50137	151.482	143
Total suspended particles (mg/l)	9	8	<5, 40	13.667	3.77498	20.686	9
RADIONUCLIDES (PCI/L)							

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Cesium-137	9	9	-0.5406, 5.676	1.952	0.7372	3.323	1.892
Cobalt-60	9	9	-2.703, 5.406	0.12	0.8772	1.751	0
Gross Beta activity	9	9	2.352, 6.217	3.655	0.4117	4.421	3.514
Gross Alpha activity	9	9	-0.027, 2.703	0.829	0.272	1.335	0.541
Strontium-90	9	9	-0.757, 2.973	1.12	0.4151	1.892	1
Technetium-99	9	9	-1.8651, 13.245	3.307	1.4087	5.926	2.162
Tritium	9	9	-54.06, 783.87	336.373	87.019	498.189	324.36
Radioacive Uranium	9	9	0.135, 1.595	0.64	0.14146	0.903	0.64
Summary Statistics for CRM 14.3							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	83, 115	100.333	4.2947	108.32	105
Aluminum	9	9	0.1, 0.47	0.256	0.03871	0.328	0.23
Ammonium Nitrogen	9	8	<0.02, 0.09	0.048	0.00756	0.062	0.05
Barium	9	8	<0.001. 0.041	0.027	0.00166	0.033	0.029
Chloride	9	9	3, 5.1	3.689	0.2189	4.096	3.5
Iron	9	8	<0.05, 0.68	0.329	0.06622	0.452	0.263
Manganese	9	9	0.02, 0,38	0.085	0.0378	0.155	0.047
Nitrate	9	9	1, 5.3	2.778	0.4515	3.617	2.4
Phosphorus	9	7	<0.2, 0.48	0.3	0.03256	0.361	0.26
Sulfate	9	9	16, 26	19.778	0.9969	21.632	20
Total Hardness	9	9	100, 128	116.278	3.58538	122.945	118
Uranium	8	5	0, 0.001	0	0.00009	0	0
Vanadium	9	2	<0.002, 0.002	0.002	0	0.002	0.002
Zinc	9	3	<0.005, 0.008	0.006	0.00037	0.007	0.006
PHYSICAL							
Chemical Oxygen Demand (mg/l)	9	4	<5, 6	5.22	0.160	5.52	5

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Total dissolved solids (mg/l)	9	9	118, 165	143.111	4.50137	151.482	143
Total suspended particles (mg/l)	9	8	<5, 40	13.667	3.77498	20.686	9
RADIONUCLIDES (PCI/L)							
Cesium-137	9	9	-0.5406, 5.676	1.952	0.7372	3.323	1.892
Cobalt-60	9	9	-2.703, 5.406	0.12	0.8772	1.751	0
Gross Beta activity	9	9	2.352, 6.217	3.655	0.4117	4.421	3.514
Gross Alpha activity	9	9	-0.027, 2.703	0.829	0.272	1.335	0.541
Strontium-90	9	9	-0.757, 2.973	1.12	0.4151	1.892	1
Technetium-99	9	9	-1.8651, 13.245	3.307	1.4087	5.926	2.162
Tritium	9	9	-54.06, 783.87	336.373	87.019	498.189	324.36
Radioacive Uranium	9	9	0.135, 1.595	0.64	0.14146	0.903	0.64
Summary Statistics for BCM 0.4							
INORGANICS (mg/L)							
Alkalinity as CaCO3	10	10	85, 160	126.7	9.5348	144.178	131.5
Aluminum	10	10	0.061, 0.48	0.216	0.048	0.304	0.191
Ammonium Nitrogen	10	9	<0.03, 0.084	0.049	0.0067	0.061	0.039
Barium	10	10	0.044, 0.138	0.074	0.0088	0.09	0.067
Chloride	10	10	4.5, 29	8.33	2.344	12.627	5.65
Chromium	10	3	<0.004, 0.014	0.011	0.0006	0.012	0.01
Iron	10	10	0.082, 0.49	0.207	0.0416	0.283	0.145
Manganese	10	9	<0.001, 0.054	0.025	0.0044	0.033	0.026
Nitrate	10	10	3.4, 23	11	2.155	14.95	9.25
Phosphorus	10	4	<0.2, 0.5	0.263	0.0393	0.335	0.2
Sulfate	10	10	15, 51	26.64	3.792	33.591	20.5
Total Hardness	10	10	105, 213	161.8	12.5537	184.812	168
Uranium	9	8	0, 0.038	0.022	0.0024	0.027	0.022

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Vanadium	10	2	<0.002, 0.023	0.005	0.0028	0.01	0.003
Zinc	10	3	<0.005, 0.06	0.018	0.0061	0.03	0.011
PHYSICAL							
Chemical Oxygen Demand (mg/l)	10	2	<5, 19	6.4	1.8783	9.843	5
Total dissolved solids (mg/l)	10	10	105, 285	213.5	17.2493	245.12	226
Total suspended particles (mg/l)	10	2	<5, 10	5.5	0.6708	6.73	5
RADIONUCLIDES (PCI/L)							
Cesium-137	10	10	-4.325, 2.43	-0.054	0.628	1.097	0.27
Cobalt-60	10	10	-1.081, 5.14	1.811	0.596	2.904	1.487
Gross Alpha activity	10	10	5.406, 12.16	9.515	0.627	10.663	9.866
Gross Beta activity	10	10	6.217, 20.543	13.326	1.4849	16.048	12.028
Plutonium-238	2	2	-0.108, 0.54	0.216	0.324	2.264	0.27
Plutonium-239	2	2	-0.122, 0.14	0.007	0.128	0.817	0.068
Strontium-90	10	10	-0.676, 3.514	1.619	0.4399	2.425	1.649
Technetium-99	10	10	0.541, 25.41	11.839	2.395	16.23	10.407
Tritium	10	10	-594.66, 1270.41	302.736	165.539	606.188	202.725
Radioactive Uranium	10	10	7.839, 22.705	10.812	1.4132	13.402	9.055
Uranium-234	9	9	2.271, 8.38	3.946	0.604	5.069	3.244
Uranium-235	9	9	-0.27, 0.68	0.245	0.095	0.421	0.216
Uranium-238	9	9	4.595, 14.326	6.788	0.9997	8.647	5.947
Summary statistics for EFM 3.4							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	98, 125	113.778	3.3615	120.029	120
Aluminum	9	7	<0.05, 0.707	0.213	0.0723	0.347	0.11
Ammonium Nitrogen	9	9	0.04, 0.24	0.073	0.0215	0.113	0.047

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Barium	9	8	<0.001, 0.039	0.032	0.0015	0.034	0.032
Chloride	9	9	8.2, 23	15.011	1.651	18.081	14
Iron	9	7	<0.05, 0.605	0.19	0.0575	0.297	0.12
Manganese	9	8	<0.001, 0.065	0.021	0.0058	0.032	0.016
Nitrate	9	9	7, 37	18.1	3.149	23.956	17
Phosphorus	9	8	<0.2, 0.92	0.489	0.0796	0.637	0.48
Sulfate	9	9	20, 41	31.889	2.771	37.042	32
Total Hardness	9	9	114.5, 172	148.167	5.9055	159.148	154
Uranium	8	7	0, 0.015	0.008	0.0011	0.01	0.007
Zinc	9	6	<0.005, 0.021	0.011	0.0021	0.015	0.012
PHYSICAL							
Chemical Oxygen Demand (mg/l)	9	4	<5, 12	6.444	0.962	8.233	5
Total suspended particles (mg/l)	9	5	<5, 33	9.222	3.1367	15.055	6
Total dissolved solids (mg/l)	9	9	146, 284	219.667	15.268	248.058	226
RADIONUCLIDES (PCI/L)							
Cesium-137	9	9	1.081, 7.84	2.493	0.776	3.936	1.6218
Cobalt-60	9	9	-1.081, 2.43	0.841	0.412	1.606	0.8109
Gross Alpha activity	9	9	1.973, 10.81	4.634	0.868	6.249	4.3248
Gross Beta activity	9	9	0.811, 8.65	6.307	0.9342	8.044	7.839
Strontium-90	9	9	0.541, 2.216	1.484	0.2017	1.859	1.243
Technetium-99	9	9	0.541, 10.27	5.106	1.165	7.272	5.406
Tritium	9	9	-432.48, 2973.3	228.253	361.612	900.688	0
Radioactive Uranium	9	9	0.001, 5.406	3.724	0.5326	4.715	4.055
Uranium-234	7	7	1.324, 2.16	1.714	0.124	1.956	1.6218
Uranium-235	7	7	0.003, 0.43	0.177	0.055	0.284	0.1676
Uranium-238	7	7	1.649, 3.784	2.483	0.256	2.98	2.514

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Summary statistics for MIM 0.9							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	33, 100	67.111	8.1857	82.333	68
Aluminum	9	9	0.093, 11.2	1.714	1.1931	3.932	0.43
Ammonium Nitrogen	9	7	<0.03, 0.07	0.044	0.0056	0.055	0.039
Barium	9	8	<0.001, 0.176	0.058	0.0153	0.086	0.046
Chloride	9	9	1.2, 2.5	1.8444	0.129	2.085	1.9
Chromium	9	3	<0.004, 0.019	0.007	0.002	0.011	0.005
Iron	9	9	0.11, 16.8	2.668	1.7803	5.978	0.77
Manganese	9	9	0.047, 1.7	0.342	0.1781	0.673	0.101
Nitrate	9	6	<0.1, 9.5	1.813	1.0234	3.716	0.45
Phosphorus	9	6	<0.2, 0.43	0.327	0.0161	0.357	0.3
Sulfate	9	9	13, 40	22.1111	3.155	27.979	19
Total Hardness	9	9	41, 181	89.611	14.0579	115.752	79
Vanadium	9	3	<0.002, 0.019	0.005	0.002	0.009	0.003
Zinc	9	4	<0.005, 0.14	0.027	0.016	0.057	0.008
PHYSICAL							
Chemical Oxygen Demand (mg/l)	9	6	<5, 15	8.444	1.1561	10.594	7
Total dissolved solids (mg/l)	9	9	51, 183	116.667	14.7902	144.17	115
Total suspended particles (mg/l)	9	4	<5, 415	66	48.1975	155.626	12
RADIONUCLIDES (PCI/L)							
Cesium-137	9	9	-2.162, 8.92	2.4327	1.169	4.606	3.2436
Cobalt-60	9	9	-1.622, 3.514	0.9611	0.591	2.06	0.2703
Gross Alpha activity	9	9	-0.081, 2.514	1.0992	0.312	1.68	0.919
Gross Beta activity	9	9	2.1894, 12.704	5.499	1.1042	7.552	4.055
Strontium-90	9	9	-0.5947, 1.784	0.613	0.2688	1.112	0.514

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Technetium-99	9	9	0.27, 10.001	4.0755	1.157	6.226	2.9733
Tritium	9	9	-810.9, 675.75	-51.6573	147.808	223.199	0
Radioactive Uranium	9	9	0.2703, 6.758	1.445	0.6931	2.733	0.487
Summary statistics for MIM 0.1							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	48, 153	119.778	11.263	140.722	128
Aluminum	9	8	<0.05, 1.17	0.395	0.1349	0.646	0.163
Ammonium Nitrogen	9	9	0.05, 0.086	0.068	0.0042	0.076	0.07
Barium	9	8	<0.001, 0.044	0.038	0.0016	0.041	0.038
Chloride	9	9	3.1, 26	12.311	2.5083	16.975	12
Chromium	9	6	<0.004, 0.01	0.006	0.0006	0.007	0.005
Iron	9	8	<0.021, 1.66	0.585	0.1886	0.936	0.357
Manganese	9	9	0.11, 0.2	0.149	0.0106	0.169	0.147
Nickel	9	4	<0.01, 0.016	0.014	0.0004	0.015	0.014
Nitrate	9	8	<1, 2.6	1.622	0.172	1.942	1.6
Phosphorus	9	7	<0.2, 0.46	0.306	0.0361	0.373	0.26
Sulfate	9	9	16, 46	29.378	3.1453	35.227	29
Total Hardness	9	9	88.5, 192	151.278	11.947	173.494	164
Uranium	8	8	0.005, 0.018	0.012	0.0017	0.015	0.013
Vanadium	9	3	<0.002, 0.003	0.003	0.0001	0.003	0.003
Zinc	9	6	<0.005, 0.032	0.011	0.0031	0.016	0.007
ORGANICS (MG/L)							
1,2-Dichloroethene	9	8	<0.005, 0.04	0.023	0.0044	0.031	0.02
Chloroform	9	6	<0.001, 0.005	0.002	0.0004	0.003	0.002
Trichloroethene	9	8	<0.005, 0.05	0.028	0.0053	0.038	0.027
Vinyl chloride	9	4	<0.002, 0.01	0.004	0.0008	0.005	0.004

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
PHYSICAL							
Chemical Oxygen Demand(mg/l)	9	4	<5, 10	7.778	0.4361	8.589	7
Total dissolved solids (mg/l)	9	9	135, 301	203.889	17.4017	236.248	199
Total suspended particles (mg/l)	9	5	<5, 39	10.667	3.9047	17.928	5
RADIONUCLIDES (PCI/L)							
Cesium-137	9	9	-1.892, 2.703	0.541	0.5368	1.539	0.27
Cobalt-60	9	9	-6.487, 4.055	0.631	1.0362	2.557	0.27
Gross Alpha activity	9	9	9.19, 15.137	12.133	0.6986	13.432	12.434
Gross Beta activity	9	9	12.434, 40.545	21.774	3.4566	28.202	21.354
Strontium-90	9	9	-0.108, 2.325	1.072	0.2292	1.498	1.027
Technetium-99	9	9	13.785, 32.436	20.032	2.1099	23.956	18.651
Tritium	9	9	-243.27, 540.6	111.123	85.5291	270.169	135.15
Radioactive Uranium	9	9	4.055, 14.326	10.542	1.173	12.723	10.812
Uranium-234	8	8	4.325, 10.542	7.67	0.7695	9.128	7.568
Uranium-235	8	8	0.119, 0.649	0.345	0.0638	0.465	0.297
Uranium-238	8	8	2.243, 4.595	3.321	0.258	3.81	3.108
Summary statistics for PCM 1.4							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	35, 113	78.444	8.8633	94.926	85
Aluminum	9	9	0.18, 1.45	0.706	0.1619	1.007	0.53
Ammonium Nitrogen	9	9	0.03, 0.069	0.047	0.0042	0.055	0.05
Barium	9	8	<0.001, 0.047	0.035	0.0018	0.039	0.035
Chloride	9	9	1.6, 11	5.956	1.041	7.89	6.1
Iron	9	9	0.27, 1.6	0.823	0.1645	1.129	0.68
Manganese	9	9	0.058, 0.12	0.085	0.0068	0.098	0.082
Nitrate	9	9	1.2, 9.6	3.589	0.799	5.07	3

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Phosphorus	9	6	<0.2, 0.48	0.298	0.0369	0.366	0.23
Sulfate	9	9	17, 35	25.889	2.044	29.69	29
Total Hardness	9	9	49, 150	104.389	10.6744	124.238	110
Uranium	8	7	<0.0001, 0.003	0.002	0.0003	0.003	0.003
Vanadium	9	4	<0.002, 0.004	0.003	0.0002	0.003	0.002
Zinc	9	6	<0.005, 0.014	0.009	0.001	0.011	0.008
PHYSICAL							
Chemical Oxygen Demand (mg/l)	9	5	<5, 16	9.667	0.9623	11.456	8
Total dissolved solids (mg/l)	9	9	66, 201	136	14.091	162.203	132
Total suspended particles (mg/l)	9	9	7, 23	17.222	1.4979	20.008	18
RADIONUCLIDES (PCI/L)							
Cesium-137	9	9	-1.081, 4.87	2.042	0.533	3.03	1.8921
Cobalt-60	9	9	-2.162, 4.05	1.502	0.451	2.34	1.0812
Gross Alpha activity	9	9	0.919, 5.68	2.147	0.505	3.09	1.8651
Gross Beta activity	9	9	0.2973, 12.434	5.226	1.2291	7.511	5.136
Strontium-90	9	9	-0.8109, 2.216	0.94	0.2166	1.343	0.892
Technetium-99	9	9	-4.055, 8.38	3.634	1.145	5.76	3.2436
Tritium	9	9	-540.6, 2973.3	423.47	324.36	1026.63	54.06
Radioactive Uranium	9	9	0.0002, 2.216	1.364	0.254	1.836	1.243
Uranium-234	2	2	1.135, 1.87	1.5	0.365	3.8	1.5002
Uranium-235	2	2	0.035, 0.07	0.054	0.019	0.17	0.0541
Uranium-238	2	2	1, 1.62	1.311	0.311	3.27	1.311
Summary statistics for CRM 9.9							
INORGANICS (mg/L)							
Alkalinity as CaCO3	9	9	58, 108	91.111	5.20268	100.786	95
Aluminum	9	9	0.093, 1.3	0.445	0.13862	0.703	0.24

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A5 (continued)

ANALYTE	N	DETECTS[1]	RANGE	MEAN	SE[2]	95% UCB[3]	MEDIAN
Ammonium Nitrogen	9	8	<0.03, 0.09	0.052	0.00613	0.063	0.05
Barium	9	8	<0.001, 0.044	0.032	0.00209	0.036	0.031
Chloride	9	9	2.2, 5.3	3.5778	0.287	4.111	3.5
Iron	9	8	<0.05, 1.5	0.486	0.16792	0.798	0.27
Manganese	9	9	0.0031, 0.13	0.051	0.01168	0.072	0.05
Nitrate	9	9	1.5, 10	2.6556	0.92	4.366	1.8
Phosphorus	9	6	<0.16, 0.49	0.278	0.04316	0.358	0.3
Sulfate	9	9	11, 27	18.4444	1.51	21.253	18
Total Hardness	9	9	67, 150	111.444	7.66506	125.698	108
Uranium	8	7	<0.0001, 0.001	0	0.0001	0.001	0
Vanadium	9	2	<0.002, 0.004	0.002	0.00027	0.003	0.002
Zinc	9	2	<0.005, 0.012	0.008	0.00061	0.009	0.008
PHYSICAL							
Chemical Oxygen Demand (mg/l)	9	3	<5, 21	9.556	2.010	13.29	7
Total dissolved solids (mg/l)	9	9	77, 169	138.333	9.04771	155.158	147
Total suspend particles (mg/l)	9	6	<5, 45	15.111	4.62664	23.715	7
RADIONUCLIDES (PCI/L)							
Cesium-137	9	9	-2.433, 4.325	0.6607	0.903	2.341	0.2703
Cobalt-60	9	9	-6.758, 5.406	0.8109	1.302	3.232	1.8921
Gross Alpha activity	9	9	-0.135, 1.649	0.88	0.186	1.226	0.8379
Gross Beta activity	9	9	1.5407, 6.758	4.226	0.53102	5.213	3.784
Strontium-90	9	9	-1.0542, 2.541	0.76	0.36915	1.446	0.676
Technetium-99	9	9	-2.703, 5.947	1.9221	0.909	3.613	2.9733
Tritium	9	9	-567.63, 540.6	48.0533	116.677	265.019	81.09
Radioactive Uranium	9	9	0.3514, 5.406	1.117	0.5394	2.12	0.541

[1] Number of observations above the detection limit
[2] Standard error
[3] Upper confidence bound

Table A6. Description of subtasks, listing of requested analyses, locations and sample collection frequency during the Phase 2 RI on the Clinch River and Poplar Creek Operable Units

Description	Analytical Classes[A]	Locations (reach)	Number of sites sampled
Water contaminant concentrations and water quality in Poplar Creek	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH,	PCM 1 (3.04)	n=12[C] (includes 3 W1.1T for TOX)
		PCM 2.9 (3.03)	n=14[C] (includes 3 W1.1T for TOX)
		PCM 4.3 (3.02)	n=14[C] (includes 3 W1.1T for TOX)
		PCM 5.1 (3.01)	n=13[C] (includes 3 W1.1T for TOX)
		PCM 6 (13)	n=14[C] (includes 3 W1.1T for TOX)
		PCM 6.5 (13)	n=12[C]
		PCM 7 (13)	n=12[C]
		PCM 7.5 (13)	n=11[C]
Water contaminant concentrations and ambient toxicity testing	W1.1T: Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH W2: *C. dubia*, Fathead minnow, Japanese medaka, chromotest[D]	CRM 22 (2.01)	W1.1T n=3, W2, n=6
		CRM 19 (2.03)	W1.1T n=3, W2 n= 6
		PCM 5.1 (3.01)	W1.1T see above, W2 n=6
		PCM 4.3 (3.02)	W1.1T see above, W2 n=6
		PCM 2.9 (3.03)	W1.1T see above, W2 n=6
		PCM 1 (3.04)	W1.1T see above, W2 n= 6
		CRM 9 (4.01)	W1.1T n=3, W2 n= 6
		PCM 6 (13)	W1.1T see above, W2 n= 6
		PCM 11.3 (13)	W2 n=6

Table A6 (continued)

Description	Analytical Classes[A]	Locations (reach)	Number of sites sampled
		MBM 0.2 (7.02)	W1.1T n=2, W2 n=2[F]
		MBM 0.4 (7.01)	W1.1Tn=2, W2 n=2[F]
		Walker Branch (WBM) 0.4 (8)	W1.1T n=2, W2 n=2[F]
Mixing of contaminants with distance from EFPC (PCM 5.5)	Total ICP-MS metals, Hg-spec, TSP, Alkalinity, NTU, pH	PCM 5.5: 10 sites (transects at 0, 10, 100 and 1000 m)	n=20 (1 set during winter low flow and 1 during winter high flow)
Mixing of contaminants with distance from Mitchell Branch (PCM 4.6)	Gross Alpha- Beta, TSP, Alkalinity, NTU, pH	PCM 4.6: 10 sites (transects at 0, 10, 100 and 1000 m)	n=10 (1 set during winter low flow)
Mixing of contaminants with distance from CNF outfall (PCM 3.4)	Gross Alpha- Beta, TSP, Alkalinity, NTU, pH	PCM 3.4:10 sites, (transects at 0, 10, 100 and 1000 m)	n=20 (1 set during winter low flow and 1 during winter high flow)
Biased Event Sampling, McCoy Branch	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH	CRM 36.9B[E] (1)	n=3, April 19, July 28, August 29
		MBM 0.2A (7.02)	n=3, April 19, July 28, August 29
		MBM 0.2B (7.02)	n=3, April 19, July 28, August 29
		MBM 0.2C (7.02)	n=3, April 19, July 28, August 29
		MBM 0.4B (7.01)	n=3, April 19, July 28, August 29
Biased Event Sampling, White Oak Creek	Total + Filtered (SVOA, PPCB, ICP-MS metals, Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH Note: no mercury speciation data were collected at this source.	CRM 19B (2.03)	n=3, April 19, July 28, August 29
		CRM 20.2A (2.02)	n=3, April 19, July 28, August 29
		CRM 20.2B (2.02)	n=3, April 19, July 28, August 29

Table A6 (continued)

Description	Analytical Classes[A]	Locations (reach)	Number of sites sampled
		CRM 20.2C (2.02)	n=3, April 19, July 28, August 29
		WOCM 0B (2.02)	n=3, April 19, July 28, August 29
Biased Event Sampling, Poplar Creek	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH	CRM 9B (4.01)	n=3, April 20, July 29, August 30
		CRM 11.8A (4.01)	n=3, April 20, July 29, August 30
		CRM 11.8B (4.01)	n=3, April 20, July 29, August 30
		CRM 11.8C (4.01)	n=3, April 20, July 29, August 30
		PCM 0.25B (3.04)	n=3, April 20, July 29, August 30

Table A6 (continued)

Description	Analytical Classes[A]	Locations (reach)	Number of sites sampled
Biased Event Sampling, Reference area	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH	CRM 41.5B (1)	n=3, April 20, July 29, August 30
		CRM 43B (1)	n=3, April 20, July 29, August 30
		CRM 46B (1)	n=3, April 20, July 29, August 30
		CRM 1B (4.04)	n=3, April 20, July 29, August 30
Contaminant remobilization from sediments (samples collected from 1m above sediment surface)	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH	CRM 41.5 (1)	n=6, 3 samples per season[F]
		MBM 0.2 (7.02)	n=6, 3 samples per season[F]
		CRM 6 (4.02)	n=6, 3 samples per season[F]
		CRM 1 (4.04)	n=6, 3 samples per season[F]
Oak Ridge Reservation Environmental Monitoring Program	General water quality, total metals, radionuclides, including ^{241}Am, ^{244}Cm, ^{238}Pu, ^{239}Pu, ^{99}Tc, ^{234}U, ^{235}U, ^{238}U and total U activity, volatile organic analytes.	see DOE/OR-1066	see DOE/OR-1066
TVA Collection of water samples from source areas to Melton Hill and Watts Bar Reservoir (Task 4.2 of DE-A105-91OR22007)	Total + Filtered (ICP metals, AA metals, CVAA - Hg, Cyanide), ^{3}H, TSP	see Task 4.2 of DE-A105-91OR22007	once per site

A See Appendix B in ORNL/ER-218 for analytical methods. Applicable to all listed subtasks except for non-CR-ERP and Historic data.

C Winter, spring and summer seasons sampled.

D See DOE/OR/01-1111&D3 for toxicity testing information.

E Letter designation following location indicates lateral position in the stream channel relative to the outfall position: "A"= one-quarter distance from outfall shore to mid-channel, "B" = mid-channel, "C"= three-quarters distance from outfall shore to opposite shore.

F Spring and summer seasons sampled.

Table A7. Unfiltered and filtered metal concentrations (mg/L) for biased sampling events (April 18-19, 1994, July 28-29, 1994, and August 29-30, 1994). One sample per site per event. Analytes at a given site that were below detection for all events were omitted from this table.

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
McCoy	MBM 0.4B	Unfiltered	Arsenic	3.300E-03	5.400E-03	2.400E-03
McCoy	MBM 0.4B	Unfiltered	Barium	3.440E-02	3.240E-02	3.110E-02
McCoy	MBM 0.4B	Unfiltered	Boron	8.520E-02	6.130E-02	3.000E-02
McCoy	MBM 0.4B	Unfiltered	Chromium	<0.002	<0.001	1.900E-03
McCoy	MBM 0.4B	Unfiltered	Copper	5.300E-03	1.700E-03	2.360E-02
McCoy	MBM 0.4B	Unfiltered	Iron	2.910E-01	2.000E-01	1.440E-01
McCoy	MBM 0.4B	Unfiltered	Lead	1.200E-03	<0.001	1.300E-03
McCoy	MBM 0.4B	Unfiltered	Manganese	4.240E-02	5.100E-02	6.040E-02
McCoy	MBM 0.4B	Unfiltered	Molybdenum	1.500E-03	<0.005	<0.005
McCoy	MBM 0.4B	Unfiltered	Nickel	3.000E-03	<0.001	5.500E-03
McCoy	MBM 0.4B	Unfiltered	Vanadium	1.300E-03	1.600E-03	<0.001
McCoy	MBM 0.4B	Unfiltered	Zinc	1.550E-02	7.200E-03	1.750E-02
McCoy	MBM 0.4B	Filtered	Aluminum	<0.0010	<0.006	1.140E-02
McCoy	MBM 0.4B	Filtered	Antimony	5.600E-03	4.400E-03	6.900E-03
McCoy	MBM 0.4B	Filtered	Arsenic	3.400E-03	5.100E-03	1.700E-03
McCoy	MBM 0.4B	Filtered	Barium	2.910E-02	2.730E-02	2.630E-02
McCoy	MBM 0.4B	Filtered	Boron	6.630E-02	5.160E-02	3.350E-02
McCoy	MBM 0.4B	Filtered	Chromium	<0.002	<0.001	1.400E-03
McCoy	MBM 0.4B	Filtered	Copper	2.100E-03	2.700E-03	4.000E-03
McCoy	MBM 0.4B	Filtered	Iron	2.140E-02	<0.0018	<0.0018
McCoy	MBM 0.4B	Filtered	Manganese	2.080E-02	<0.001	2.500E-03
McCoy	MBM 0.4B	Filtered	Molybdenum	1.600E-03	<0.005	<0.005
McCoy	MBM 0.4B	Filtered	Nickel	2.900E-03	1.000E-02	1.200E-03
McCoy	MBM 0.4B	Filtered	Vanadium	<0.001	1.300E-03	<0.001
McCoy	MBM 0.4B	Filtered	Zinc	4.200E-03	5.500E-03	3.800E-03
McCoy	MBM 0.2A	Unfiltered	Aluminum	2.590E-01	3.350E-02	1.010E-01
McCoy	MBM 0.2A	Unfiltered	Arsenic	1.300E-03	1.000E-03	<0.001
McCoy	MBM 0.2A	Unfiltered	Barium	2.640E-02	2.850E-02	3.240E-02
McCoy	MBM 0.2A	Unfiltered	Boron	4.190E-02	1.130E-01	5.200E-02
McCoy	MBM 0.2A	Unfiltered	Chromium	<0.002	<0.001	1.900E-03
McCoy	MBM 0.2A	Unfiltered	Copper	5.600E-03	1.400E-03	2.270E-02
McCoy	MBM 0.2A	Unfiltered	Iron	4.340E-01	3.230E-02	1.460E-01
McCoy	MBM 0.2A	Unfiltered	Lead	1.500E-03	<0.001	1.300E-03
McCoy	MBM 0.2A	Unfiltered	Manganese	4.560E-02	3.120E-02	6.540E-02
McCoy	MBM 0.2A	Unfiltered	Nickel	2.800E-03	<0.001	5.500E-03
McCoy	MBM 0.2A	Unfiltered	Vanadium	1.100E-03	<0.001	<0.001
McCoy	MBM 0.2A	Unfiltered	Zinc	1.180E-02	6.200E-03	2.250E-02
McCoy	MBM 0.2A	Filtered	Aluminum	1.420E-02	1.020E-02	8.800E-03
McCoy	MBM 0.2A	Filtered	Antimony	1.900E-03	1.300E-03	3.000E-03

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
McCoy	MBM 0.2A	Filtered	Arsenic	<0.001	1.500E-03	1.000E-03
McCoy	MBM 0.2A	Filtered	Barium	2.070E-02	3.210E-02	2.520E-02
McCoy	MBM 0.2A	Filtered	Boron	5.350E-02	1.100E-01	3.380E-02
McCoy	MBM 0.2A	Filtered	Chromium	<0.002	<0.001	1.700E-03
McCoy	MBM 0.2A	Filtered	Copper	9.500E-03	2.500E-03	3.700E-03
McCoy	MBM 0.2A	Filtered	Iron	3.300E-02	1.800E-02	<0.0018
McCoy	MBM 0.2A	Filtered	Manganese	5.900E-03	<0.001	1.500E-03
McCoy	MBM 0.2A	Filtered	Nickel	1.800E-03	1.400E-03	1.400E-03
McCoy	MBM 0.2A	Filtered	Zinc	8.600E-03	2.700E-03	3.800E-03
McCoy	MBM 0.2B	Unfiltered	Aluminum	2.870E-01	4.810E-02	6.580E-02
McCoy	MBM 0.2B	Unfiltered	Barium	2.340E-02	2.830E-02	2.810E-02
McCoy	MBM 0.2B	Unfiltered	Boron	4.120E-02	9.250E-02	4.100E-02
McCoy	MBM 0.2B	Unfiltered	Chromium	<0.002	<0.001	1.900E-03
McCoy	MBM 0.2B	Unfiltered	Copper	5.100E-03	1.300E-03	3.220E-02
McCoy	MBM 0.2B	Unfiltered	Iron	4.640E-01	4.860E-02	1.080E-01
McCoy	MBM 0.2B	Unfiltered	Lead	<0.001	<0.001	1.300E-03
McCoy	MBM 0.2B	Unfiltered	Manganese	4.050E-02	2.870E-02	4.130E-02
McCoy	MBM 0.2B	Unfiltered	Nickel	1.500E-03	<0.001	8.700E-03
McCoy	MBM 0.2B	Unfiltered	Zinc	8.200E-03	3.000E-03	2.340E-02
McCoy	MBM 0.2B	Filtered	Aluminum	1.200E-02	<0.006	1.350E-02
McCoy	MBM 0.2B	Filtered	Antimony	2.800E-03	<0.001	3.800E-03
McCoy	MBM 0.2B	Filtered	Arsenic	1.100E-03	<0.001	<0.001
McCoy	MBM 0.2B	Filtered	Barium	2.070E-02	2.800E-02	2.520E-02
McCoy	MBM 0.2B	Filtered	Boron	3.340E-02	1.160E-01	4.780E-02
McCoy	MBM 0.2B	Filtered	Chromium	<0.002	<0.001	1.800E-03
McCoy	MBM 0.2B	Filtered	Copper	2.900E-03	3.000E-03	4.200E-03
McCoy	MBM 0.2B	Filtered	Iron	2.690E-02	<0.0018	<0.0018
McCoy	MBM 0.2B	Filtered	Manganese	4.800E-03	<0.001	1.500E-03
McCoy	MBM 0.2B	Filtered	Nickel	1.400E-03	4.200E-03	1.100E-03
McCoy	MBM 0.2B	Filtered	Selenium	3.200E-03	<0.001	<0.001
McCoy	MBM 0.2B	Filtered	Zinc	5.100E-03	2.000E-03	3.900E-03
McCoy	MBM 0.2C	Unfiltered	Aluminum	5.330E-01	5.370E-02	6.940E-02
McCoy	MBM 0.2C	Unfiltered	Barium	2.890E-02	2.890E-02	3.010E-02
McCoy	MBM 0.2C	Unfiltered	Boron	4.508E-02	1.120E-01	4.320E-02
McCoy	MBM 0.2C	Unfiltered	Chromium	<0.002	2.500E-03	2.100E-03
McCoy	MBM 0.2C	Unfiltered	Copper	5.260E-03	1.800E-03	3.680E-02
McCoy	MBM 0.2C	Unfiltered	Iron	4.400E-01	5.670E-02	1.040E-01
McCoy	MBM 0.2C	Unfiltered	Lead	1.440E-03	<0.001	1.700E-03
McCoy	MBM 0.2C	Unfiltered	Manganese	3.829E-02	2.890E-02	3.840E-02
McCoy	MBM 0.2C	Unfiltered	Nickel	3.620E-03	<0.001	1.000E-02

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
McCoy	MBM 0.2C	Unfiltered	Selenium	<0.003	<0.001	1.100E-03
McCoy	MBM 0.2C	Unfiltered	Zinc	1.683E-02	3.900E-03	1.590E-02
McCoy	MBM 0.2C	Filtered	Aluminum	<0.0010	<0.006	6.000E-03
McCoy	MBM 0.2C	Filtered	Antimony	5.300E-03	<0.001	2.400E-03
McCoy	MBM 0.2C	Filtered	Arsenic	1.300E-03	<0.001	<0.001
McCoy	MBM 0.2C	Filtered	Barium	2.170E-02	2.790E-02	2.300E-02
McCoy	MBM 0.2C	Filtered	Boron	2.610E-02	6.820E-02	4.040E-02
McCoy	MBM 0.2C	Filtered	Chromium	<0.002	<0.001	1.500E-03
McCoy	MBM 0.2C	Filtered	Copper	3.000E-03	2.000E-03	3.200E-03
McCoy	MBM 0.2C	Filtered	Iron	3.460E-02	<0.0018	<0.0018
McCoy	MBM 0.2C	Filtered	Manganese	3.700E-03	1.200E-03	<0.001
McCoy	MBM 0.2C	Filtered	Nickel	1.300E-03	4.300E-03	1.100E-03
McCoy	MBM 0.2C	Filtered	Zinc	2.000E-03	<0.002	3.700E-03
McCoy	CRM 39.6B	Unfiltered	Aluminum	2.070E-01	6.730E-02	7.140E-02
McCoy	CRM 39.6B	Unfiltered	Barium	2.690E-02	2.790E-02	2.420E-02
McCoy	CRM 39.6B	Unfiltered	Boron	4.310E-02	9.980E-02	6.430E-02
McCoy	CRM 39.6B	Unfiltered	Chromium	<0.002	1.100E-03	2.400E-03
McCoy	CRM 39.6B	Unfiltered	Copper	6.500E-03	2.100E-03	2.900E-03
McCoy	CRM 39.6B	Unfiltered	Iron	3.770E-01	7.560E-02	7.400E-02
McCoy	CRM 39.6B	Unfiltered	Lead	1.400E-03	<0.001	<0.001
McCoy	CRM 39.6B	Unfiltered	Manganese	8.630E-02	5.000E-02	3.690E-02
McCoy	CRM 39.6B	Unfiltered	Nickel	2.100E-03	<0.001	1.300E-03
McCoy	CRM 39.6B	Unfiltered	Zinc	1.800E-02	4.300E-03	5.400E-03
McCoy	CRM 39.6B	Filtered	Aluminum	<0.0010	3.371E-02	3.188E-02
McCoy	CRM 39.6B	Filtered	Antimony	4.600E-03	<0.001	3.520E-03
McCoy	CRM 39.6B	Filtered	Barium	2.320E-02	2.505E-02	2.215E-02
McCoy	CRM 39.6B	Filtered	Boron	3.690E-02	7.463E-02	8.393E-02
McCoy	CRM 39.6B	Filtered	Chromium	<0.002	1.360E-03	2.260E-03
McCoy	CRM 39.6B	Filtered	Copper	7.400E-03	2.520E-03	5.080E-03
McCoy	CRM 39.6B	Filtered	Iron	3.910E-02	<0.0018	<0.0018
McCoy	CRM 39.6B	Filtered	Manganese	1.200E-02	<0.001	1.650E-03
McCoy	CRM 39.6B	Filtered	Nickel	1.800E-03	1.660E-03	1.860E-03
McCoy	CRM 39.6B	Filtered	Zinc	1.490E-02	4.790E-03	8.260E-03
Poplar Cr.	PCM 0.1 B	Unfiltered	Aluminum	1.320E-01	2.260E-01	1.480E-01
Poplar Cr.	PCM 0.1 B	Unfiltered	Antimony	1.900E-03	<0.001	<0.001
Poplar Cr.	PCM 0.1 B	Unfiltered	Arsenic	1.400E-03	<0.001	<0.001
Poplar Cr.	PCM 0.1 B	Unfiltered	Barium	3.050E-02	2.990E-02	2.440E-02
Poplar Cr.	PCM 0.1 B	Unfiltered	Boron	2.250E-02	9.260E-02	1.080E-01
Poplar Cr.	PCM 0.1 B	Unfiltered	Chromium	<0.002	1.300E-03	1.600E-03

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Poplar Cr.	PCM 0.1 B	Unfiltered	Copper	2.100E-03	3.300E-03	1.900E-03
Poplar Cr.	PCM 0.1 B	Unfiltered	Iron	3.220E-01	3.060E-01	1.670E-01
Poplar Cr.	PCM 0.1 B	Unfiltered	Lead	<0.001	1.300E-03	<0.001
Poplar Cr.	PCM 0.1 B	Unfiltered	Manganese	6.230E-02	5.250E-02	4.530E-02
Poplar Cr.	PCM 0.1 B	Unfiltered	Nickel	3.700E-03	1.900E-03	1.400E-03
Poplar Cr.	PCM 0.1 B	Unfiltered	Uranium	1.600E-03	<0.001	<0.001
Poplar Cr.	PCM 0.1 B	Unfiltered	Zinc	1.410E-02	1.980E-02	2.700E-03
Poplar Cr.	PCM 0.1 B	Filtered	Aluminum	2.190E-02	3.060E-02	1.450E-02
Poplar Cr.	PCM 0.1 B	Filtered	Antimony	1.300E-03	2.600E-03	8.400E-03
Poplar Cr.	PCM 0.1 B	Filtered	Arsenic	1.100E-03	<0.001	1.100E-03
Poplar Cr.	PCM 0.1 B	Filtered	Barium	2.820E-02	2.620E-02	2.310E-02
Poplar Cr.	PCM 0.1 B	Filtered	Boron	3.550E-02	1.300E-02	6.120E-02
Poplar Cr.	PCM 0.1 B	Filtered	Chromium	<0.002	<0.001	1.100E-03
Poplar Cr.	PCM 0.1 B	Filtered	Copper	1.200E-03	6.120E-02	7.900E-03
Poplar Cr.	PCM 0.1 B	Filtered	Iron	1.710E-01	<0.0018	<0.0018
Poplar Cr.	PCM 0.1 B	Filtered	Manganese	4.930E-02	6.300E-03	2.000E-03
Poplar Cr.	PCM 0.1 B	Filtered	Nickel	3.400E-03	1.600E-03	2.200E-03
Poplar Cr.	PCM 0.1 B	Filtered	Uranium	1.600E-03	<0.001	<0.001
Poplar Cr.	PCM 0.1 B	Filtered	Zinc	3.700E-03	1.280E-01	3.600E-03
Poplar Cr.	CRM 11.8 A	Unfiltered	Aluminum	9.870E-02	3.560E-01	1.120E-01
Poplar Cr.	CRM 11.8 A	Unfiltered	Barium	2.610E-02	3.080E-02	2.440E-02
Poplar Cr.	CRM 11.8 A	Unfiltered	Boron	1.800E-02	6.030E-02	5.390E-02
Poplar Cr.	CRM 11.8 A	Unfiltered	Chromium	<0.002	1.300E-03	1.500E-03
Poplar Cr.	CRM 11.8 A	Unfiltered	Copper	1.200E-03	8.140E-02	1.700E-03
Poplar Cr.	CRM 11.8 A	Unfiltered	Iron	3.200E-01	4.390E-01	1.320E-01
Poplar Cr.	CRM 11.8 A	Unfiltered	Lead	<0.001	2.400E-03	<0.001
Poplar Cr.	CRM 11.8 A	Unfiltered	Manganese	5.080E-02	5.380E-02	4.080E-02
Poplar Cr.	CRM 11.8 A	Unfiltered	Nickel	3.200E-03	2.500E-03	1.100E-03
Poplar Cr.	CRM 11.8 A	Unfiltered	Zinc	4.100E-03	1.860E-01	3.000E-03
Poplar Cr.	CRM 11.8 A	Filtered	Aluminum	2.350E-02	3.800E-02	9.000E-03
Poplar Cr.	CRM 11.8 A	Filtered	Antimony	<0.001	3.400E-03	7.300E-03
Poplar Cr.	CRM 11.8 A	Filtered	Barium	2.220E-02	2.640E-02	2.390E-02
Poplar Cr.	CRM 11.8 A	Filtered	Boron	2.780E-02	2.090E-02	5.130E-02
Poplar Cr.	CRM 11.8 A	Filtered	Chromium	3.000E-03	<0.001	1.300E-03
Poplar Cr.	CRM 11.8 A	Filtered	Copper	2.200E-03	6.570E-02	3.200E-03
Poplar Cr.	CRM 11.8 A	Filtered	Iron	2.350E-01	<0.0018	1.800E-02
Poplar Cr.	CRM 11.8 A	Filtered	Manganese	9.400E-03	3.500E-03	2.100E-03
Poplar Cr.	CRM 11.8 A	Filtered	Nickel	3.000E-03	1.700E-03	1.800E-03
Poplar Cr.	CRM 11.8 A	Filtered	Zinc	4.300E-03	1.280E-01	2.800E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Aluminum	9.310E-02	5.230E-01	9.430E-02

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Poplar Cr.	CRM 11.8 B	Unfiltered	Antimony	<0.001	<0.001	1.700E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Arsenic	<0.001	<0.001	1.000E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Barium	2.390E-02	3.390E-01	2.500E-02
Poplar Cr.	CRM 11.8 B	Unfiltered	Boron	<0.0018	7.590E-02	5.880E-02
Poplar Cr.	CRM 11.8 B	Unfiltered	Chromium	<0.002	2.200E-03	1.700E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Copper	1.100E-03	5.100E-03	2.000E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Iron	2.960E-01	6.990E-01	1.170E-01
Poplar Cr.	CRM 11.8 B	Unfiltered	Lead	<0.001	2.100E-03	<0.001
Poplar Cr.	CRM 11.8 B	Unfiltered	Manganese	4.560E-02	6.460E-02	4.130E-02
Poplar Cr.	CRM 11.8 B	Unfiltered	Nickel	2.800E-03	2.900E-03	1.200E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Uranium	<0.001	1.500E-03	<0.001
Poplar Cr.	CRM 11.8 B	Unfiltered	Vanadium	<0.001	1.400E-03	<0.001
Poplar Cr.	CRM 11.8 B	Unfiltered	Zinc	2.800E-03	3.290E-02	4.200E-03
Poplar Cr.	CRM 11.8 B	Filtered	Aluminum	1.570E-02	2.970E-02	1.100E-02
Poplar Cr.	CRM 11.8 B	Filtered	Antimony	<0.001	4.600E-03	6.300E-03
Poplar Cr.	CRM 11.8 B	Filtered	Arsenic	1.100E-03	<0.001	<0.001
Poplar Cr.	CRM 11.8 B	Filtered	Barium	2.090E-02	2.740E-02	2.320E-02
Poplar Cr.	CRM 11.8 B	Filtered	Boron	1.800E-02	8.150E-02	7.130E-02
Poplar Cr.	CRM 11.8 B	Filtered	Chromium	<0.002	1.600E-03	<0.001
Poplar Cr.	CRM 11.8 B	Filtered	Copper	1.200E-03	1.030E-02	3.400E-03
Poplar Cr.	CRM 11.8 B	Filtered	Iron	2.130E-01	2.280E-02	<0.0018
Poplar Cr.	CRM 11.8 B	Filtered	Manganese	3.600E-03	1.000E-02	1.900E-03
Poplar Cr.	CRM 11.8 B	Filtered	Nickel	2.900E-03	3.700E-03	2.600E-03
Poplar Cr.	CRM 11.8 B	Filtered	Selenium	<0.005	1.100E-03	1.200E-03
Poplar Cr.	CRM 11.8 B	Filtered	Uranium	<0.001	1.500E-03	<0.001
Poplar Cr.	CRM 11.8 B	Filtered	Zinc	4.800E-03	7.400E-03	3.800E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Aluminum	9.310E-02	8.610E-01	2.840E-01
Poplar Cr.	CRM 11.8 C	Unfiltered	Arsenic	<0.001	<0.001	1.300E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Barium	2.480E-02	3.630E-02	2.920E-02
Poplar Cr.	CRM 11.8 C	Unfiltered	Boron	4.450E-02	8.620E-02	6.830E-02
Poplar Cr.	CRM 11.8 C	Unfiltered	Chromium	<0.002	2.300E-03	2.000E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Copper	1.700E-03	8.320E-02	1.800E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Iron	3.060E-01	9.710E-01	3.230E-01
Poplar Cr.	CRM 11.8 C	Unfiltered	Lead	<0.001	3.200E-03	<0.001
Poplar Cr.	CRM 11.8 C	Unfiltered	Manganese	4.500E-02	7.340E-02	6.540E-02
Poplar Cr.	CRM 11.8 C	Unfiltered	Nickel	2.800E-03	4.300E-03	1.700E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Uranium	<0.001	2.000E-03	1.300E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Vanadium	<0.001	1.900E-03	<0.001
Poplar Cr.	CRM 11.8 C	Unfiltered	Zinc	7.900E-03	2.000E-01	4.700E-03
Poplar Cr.	CRM 11.8 C	Filtered	Aluminum	1.750E-02	2.770E-02	1.090E-02
Poplar Cr.	CRM 11.8 C	Filtered	Antimony	<0.001	4.100E-03	7.100E-03

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Poplar Cr.	CRM 11.8 C	Filtered	Arsenic	1.200E-03	<0.001	1.200E-03
Poplar Cr.	CRM 11.8 C	Filtered	Barium	2.290E-02	2.910E-02	2.600E-02
Poplar Cr.	CRM 11.8 C	Filtered	Boron	<0.0018	6.050E-02	8.030E-02
Poplar Cr.	CRM 11.8 C	Filtered	Chromium	<0.002	4.900E-03	1.200E-03
Poplar Cr.	CRM 11.8 C	Filtered	Copper	1.000E-03	9.700E-03	4.000E-03
Poplar Cr.	CRM 11.8 C	Filtered	Iron	2.260E-01	5.340E-02	1.800E-02
Poplar Cr.	CRM 11.8 C	Filtered	Lead	1.400E-03	1.300E-03	<0.001
Poplar Cr.	CRM 11.8 C	Filtered	Manganese	3.800E-03	1.500E-02	2.900E-03
Poplar Cr.	CRM 11.8 C	Filtered	Nickel	4.000E-03	5.200E-03	1.700E-03
Poplar Cr.	CRM 11.8 C	Filtered	Selenium	<0.005	<0.001	1.100E-03
Poplar Cr.	CRM 11.8 C	Filtered	Uranium	<0.001	1.700E-03	1.100E-03
Poplar Cr.	CRM 11.8 C	Filtered	Zinc	3.800E-03	1.740E-02	4.100E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Aluminum	1.120E-01	1.050E-01	9.500E-02
Poplar Cr.	CRM 9.0 B	Unfiltered	Antimony	<0.001	<0.001	2.000E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Arsenic	<0.001	<0.001	1.100E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Barium	2.660E-02	2.820E-02	2.470E-02
Poplar Cr.	CRM 9.0 B	Unfiltered	Boron	<0.0018	4.130E-02	1.270E-01
Poplar Cr.	CRM 9.0 B	Unfiltered	Chromium	<0.002	1.400E-03	1.700E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Copper	1.300E-03	2.840E-02	2.300E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Iron	3.590E-01	1.190E-01	9.120E-02
Poplar Cr.	CRM 9.0 B	Unfiltered	Lead	<0.001	1.800E-03	<0.001
Poplar Cr.	CRM 9.0 B	Unfiltered	Manganese	5.160E-02	3.530E-02	3.640E-02
Poplar Cr.	CRM 9.0 B	Unfiltered	Molybdenum	1.800E-03	<0.005	<0.005
Poplar Cr.	CRM 9.0 B	Unfiltered	Nickel	2.900E-03	2.500E-03	1.200E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Zinc	3.800E-03	6.390E-02	3.400E-03
Poplar Cr.	CRM 9.0 B	Filtered	Aluminum	1.560E-02	3.280E-02	1.631E-02
Poplar Cr.	CRM 9.0 B	Filtered	Antimony	<0.001	4.720E-03	7.730E-03
Poplar Cr.	CRM 9.0 B	Filtered	Arsenic	1.200E-03	<0.001	<0.001
Poplar Cr.	CRM 9.0 B	Filtered	Barium	2.130E-02	2.518E-02	2.421E-02
Poplar Cr.	CRM 9.0 B	Filtered	Boron	2.040E-02	2.145E-02	6.587E-02
Poplar Cr.	CRM 9.0 B	Filtered	Chromium	<0.002	<0.001	1.450E-03
Poplar Cr.	CRM 9.0 B	Filtered	Copper	1.400E-03	5.605E-02	3.730E-03
Poplar Cr.	CRM 9.0 B	Filtered	Iron	2.570E-01	1.800E-02	3.219E-02
Poplar Cr.	CRM 9.0 B	Filtered	Manganese	5.200E-03	<0.001	2.520E-03
Poplar Cr.	CRM 9.0 B	Filtered	Nickel	3.300E-03	1.610E-03	1.950E-03
Poplar Cr.	CRM 9.0 B	Filtered	Zinc	3.300E-03	1.116E-01	4.820E-03
Reference	CRM 46.0 B	Unfiltered	Aluminum	6.470E-02	9.370E-02	8.900E-02
Reference	CRM 46.0 B	Unfiltered	Arsenic	<0.001	<0.001	1.100E-03
Reference	CRM 46.0 B	Unfiltered	Barium	2.440E-02	2.620E-02	2.940E-02

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Reference	CRM 46.0 B	Unfiltered	Boron	<0.0018	1.160E-02	7.780E-02
Reference	CRM 46.0 B	Unfiltered	Chromium	<0.002	1.600E-03	5.100E-03
Reference	CRM 46.0 B	Unfiltered	Copper	1.500E-03	6.900E-03	8.800E-03
Reference	CRM 46.0 B	Unfiltered	Iron	3.410E-01	1.320E-01	1.200E-01
Reference	CRM 46.0 B	Unfiltered	Lead	<0.001	1.400E-03	2.500E-03
Reference	CRM 46.0 B	Unfiltered	Manganese	5.010E-02	5.780E-02	6.050E-02
Reference	CRM 46.0 B	Unfiltered	Nickel	3.000E-03	2.600E-03	4.700E-03
Reference	CRM 46.0 B	Unfiltered	Zinc	3.900E-03	2.640E-02	2.550E-02
Reference	CRM 46.0 B	Filtered	Aluminum	1.910E-02	3.200E-02	5.670E-02
Reference	CRM 46.0 B	Filtered	Antimony	<0.001	4.700E-03	8.400E-03
Reference	CRM 46.0 B	Filtered	Arsenic	<0.001	<0.001	1.700E-03
Reference	CRM 46.0 B	Filtered	Barium	2.250E-02	2.300E-02	2.810E-02
Reference	CRM 46.0 B	Filtered	Boron	2.180E-02	2.570E-02	6.720E-02
Reference	CRM 46.0 B	Filtered	Chromium	<0.002	1.500E-03	5.500E-03
Reference	CRM 46.0 B	Filtered	Copper	1.100E-03	3.600E-03	2.040E-02
Reference	CRM 46.0 B	Filtered	Iron	2.560E-01	<0.0018	5.100E-02
Reference	CRM 46.0 B	Filtered	Lead	<0.001	<0.001	3.000E-03
Reference	CRM 46.0 B	Filtered	Manganese	1.090E-02	6.200E-03	2.380E-02
Reference	CRM 46.0 B	Filtered	Molybdenum	2.200E-03	<0.005	<0.005
Reference	CRM 46.0 B	Filtered	Nickel	3.200E-03	2.000E-03	8.000E-03
Reference	CRM 46.0 B	Filtered	Zinc	4.200E-03	5.500E-03	3.450E-02
Reference	CRM 43.0 B	Unfiltered	Aluminum	8.720E-02	1.250E-01	8.750E-02
Reference	CRM 43.0 B	Unfiltered	Arsenic	<0.001	<0.001	1.100E-03
Reference	CRM 43.0 B	Unfiltered	Barium	4.710E-02	2.680E-02	2.770E-02
Reference	CRM 43.0 B	Unfiltered	Boron	2.880E-02	5.000E-02	7.330E-02
Reference	CRM 43.0 B	Unfiltered	Chromium	<0.002	1.300E-03	4.300E-03
Reference	CRM 43.0 B	Unfiltered	Copper	1.700E-03	8.290E-02	1.380E-02
Reference	CRM 43.0 B	Unfiltered	Iron	3.390E-01	1.370E-01	1.250E-01
Reference	CRM 43.0 B	Unfiltered	Lead	<0.001	2.600E-03	1.700E-03
Reference	CRM 43.0 B	Unfiltered	Manganese	7.670E-02	6.620E-02	5.260E-02
Reference	CRM 43.0 B	Unfiltered	Nickel	3.500E-03	2.800E-03	4.000E-03
Reference	CRM 43.0 B	Unfiltered	Zinc	4.000E-03	1.910E-01	2.350E-02
Reference	CRM 43.0 B	Filtered	Aluminum	1.640E-02	8.400E-03	2.770E-02
Reference	CRM 43.0 B	Filtered	Antimony	<0.001	2.200E-03	6.100E-03
Reference	CRM 43.0 B	Filtered	Arsenic	<0.001	<0.001	1.300E-03
Reference	CRM 43.0 B	Filtered	Barium	2.470E-02	2.310E-02	2.490E-02
Reference	CRM 43.0 B	Filtered	Boron	3.040E-02	3.460E-02	6.800E-02
Reference	CRM 43.0 B	Filtered	Chromium	<0.002	1.200E-03	3.000E-03
Reference	CRM 43.0 B	Filtered	Copper	2.200E-03	2.400E-03	1.440E-02
Reference	CRM 43.0 B	Filtered	Iron	2.530E-01	1.800E-02	3.430E-02
Reference	CRM 43.0 B	Filtered	Lead	<0.001	<0.001	1.200E-03

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Reference	CRM 43.0 B	Filtered	Manganese	1.080E-02	<0.001	1.730E-02
Reference	CRM 43.0 B	Filtered	Nickel	3.400E-03	1.100E-03	3.600E-03
Reference	CRM 43.0 B	Filtered	Zinc	7.300E-03	2.100E-03	1.900E-02
Reference	CRM 41.5 B	Unfiltered	Aluminum	6.660E-02	8.550E-02	9.560E-02
Reference	CRM 41.5 B	Unfiltered	Arsenic	<0.001	<0.001	1.500E-03
Reference	CRM 41.5 B	Unfiltered	Barium	5.630E-02	2.640E-02	2.860E-02
Reference	CRM 41.5 B	Unfiltered	Boron	4.160E-02	1.120E-01	1.070E-01
Reference	CRM 41.5 B	Unfiltered	Chromium	<0.002	2.600E-03	3.900E-03
Reference	CRM 41.5 B	Unfiltered	Copper	3.100E-03	6.100E-03	1.180E-02
Reference	CRM 41.5 B	Unfiltered	Iron	3.390E-01	1.000E-01	1.340E-01
Reference	CRM 41.5 B	Unfiltered	Lead	<0.001	1.300E-03	1.300E-03
Reference	CRM 41.5 B	Unfiltered	Manganese	6.490E-02	4.780E-02	5.050E-02
Reference	CRM 41.5 B	Unfiltered	Nickel	3.500E-03	2.800E-03	3.100E-03
Reference	CRM 41.5 B	Unfiltered	Zinc	6.700E-03	1.420E-02	2.050E-02
Reference	CRM 41.5 B	Filtered	Aluminum	1.524E-02	2.248E-02	1.360E-02
Reference	CRM 41.5 B	Filtered	Antimony	1.240E-03	3.820E-03	8.700E-03
Reference	CRM 41.5 B	Filtered	Arsenic	<0.001	<0.001	1.200E-03
Reference	CRM 41.5 B	Filtered	Barium	2.150E-02	2.270E-02	2.020E-02
Reference	CRM 41.5 B	Filtered	Boron	2.576E-02	7.410E-02	5.160E-02
Reference	CRM 41.5 B	Filtered	Chromium	<0.002	1.850E-03	1.700E-03
Reference	CRM 41.5 B	Filtered	Copper	<0.001	3.880E-03	1.010E-02
Reference	CRM 41.5 B	Filtered	Iron	2.352E-01	<0.0018	<0.0018
Reference	CRM 41.5 B	Filtered	Manganese	1.043E-02	<0.001	8.400E-03
Reference	CRM 41.5 B	Filtered	Nickel	2.950E-03	1.880E-03	2.100E-03
Reference	CRM 41.5 B	Filtered	Zinc	1.444E-02	3.390E-03	3.700E-03
Reference	CRM 41.5 B	Unfiltered	Aluminum	9.640E-02	1.240E-01	1.190E-01
Reference	CRM 41.5 B	Unfiltered	Arsenic	1.400E-03	1.000E-03	2.800E-03
Reference	CRM 41.5 B	Unfiltered	Barium	2.520E-02	2.700E-02	2.860E-02
Reference	CRM 41.5 B	Unfiltered	Boron	1.800E-02	3.490E-02	1.130E-01
Reference	CRM 41.5 B	Unfiltered	Chromium	<0.002	2.500E-03	8.200E-03
Reference	CRM 41.5 B	Unfiltered	Copper	1.800E-03	6.000E-03	1.200E-02
Reference	CRM 41.5 B	Unfiltered	Iron	2.920E-01	1.820E-01	1.730E-01
Reference	CRM 41.5 B	Unfiltered	Lead	<0.001	1.400E-03	1.800E-03
Reference	CRM 41.5 B	Unfiltered	Manganese	4.540E-02	4.760E-02	5.690E-02
Reference	CRM 41.5 B	Unfiltered	Nickel	3.000E-03	2.500E-03	5.600E-03
Reference	CRM 41.5 B	Unfiltered	Vanadium	<0.001	1.400E-03	1.200E-03
Reference	CRM 41.5 B	Unfiltered	Zinc	3.900E-03	2.620E-02	2.310E-02
Reference	CRM 41.5 B	Filtered	Aluminum	2.690E-02	2.770E-02	3.380E-02
Reference	CRM 41.5 B	Filtered	Antimony	<0.001	3.600E-03	4.400E-03
Reference	CRM 41.5 B	Filtered	Arsenic	1.700E-03	<0.001	2.300E-03
Reference	CRM 41.5 B	Filtered	Barium	2.330E-02	2.240E-02	2.810E-02

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Reference	CRM 41.5 B	Filtered	Boron	5.140E-02	8.040E-02	7.790E-02
Reference	CRM 41.5 B	Filtered	Chromium	<0.002	1.400E-03	4.700E-03
Reference	CRM 41.5 B	Filtered	Copper	1.800E-03	3.400E-03	1.120E-02
Reference	CRM 41.5 B	Filtered	Iron	2.120E-01	<0.0018	3.330E-02
Reference	CRM 41.5 B	Filtered	Lead	<0.001	<0.001	1.600E-03
Reference	CRM 41.5 B	Filtered	Manganese	1.800E-02	1.400E-03	4.700E-03
Reference	CRM 41.5 B	Filtered	Nickel	3.400E-03	1.600E-03	3.400E-03
Reference	CRM 41.5 B	Filtered	Selenium	<0.005	<0.001	1.600E-03
Reference	CRM 41.5 B	Filtered	Zinc	5.700E-03	4.600E-03	2.400E-02
Reference	CRM 1.0 B	Unfiltered	Aluminum	9.640E-02	1.240E-01	1.190E-01
Reference	CRM 1.0 B	Unfiltered	Arsenic	1.400E-03	1.000E-03	2.800E-03
Reference	CRM 1.0 B	Unfiltered	Barium	2.520E-02	2.700E-02	2.860E-02
Reference	CRM 1.0 B	Unfiltered	Boron	1.800E-02	3.490E-02	1.130E-01
Reference	CRM 1.0 B	Unfiltered	Chromium	<0.002	2.500E-03	8.200E-03
Reference	CRM 1.0 B	Unfiltered	Copper	1.800E-03	6.000E-03	1.200E-02
Reference	CRM 1.0 B	Unfiltered	Iron	2.920E-01	1.820E-01	1.730E-01
Reference	CRM 1.0 B	Unfiltered	Lead	<0.001	1.400E-03	1.800E-03
Reference	CRM 1.0 B	Unfiltered	Manganese	4.540E-02	4.760E-02	5.690E-02
Reference	CRM 1.0 B	Unfiltered	Nickel	3.000E-03	2.500E-03	5.600E-03
Reference	CRM 1.0 B	Unfiltered	Potassium	1.310E+00	1.420E+00	1.700E+00
Reference	CRM 1.0 B	Unfiltered	Sodium	2.630E+00	5.950E+00	6.700E+00
Reference	CRM 1.0 B	Unfiltered	Vanadium	<0.001	1.400E-03	1.200E-03
Reference	CRM 1.0 B	Unfiltered	Zinc	3.900E-03	2.620E-02	2.310E-02
Reference	CRM 1.0 B	Filtered	Aluminum	2.690E-02	2.770E-02	3.380E-02
Reference	CRM 1.0 B	Filtered	Antimony	<0.001	3.600E-03	4.400E-03
Reference	CRM 1.0 B	Filtered	Arsenic	1.700E-03	<0.001	2.300E-03
Reference	CRM 1.0 B	Filtered	Barium	2.330E-02	2.240E-02	2.810E-02
Reference	CRM 1.0 B	Filtered	Boron	5.140E-02	8.040E-02	7.790E-02
Reference	CRM 1.0 B	Filtered	Cadmium	<0.001	<0.001	<0.001
Reference	CRM 1.0 B	Filtered	Chromium	<0.002	1.400E-03	4.700E-03
Reference	CRM 1.0 B	Filtered	Copper	1.800E-03	3.400E-03	1.120E-02
Reference	CRM 1.0 B	Filtered	Iron	2.120E-01	<0.0018	3.330E-02
Reference	CRM 1.0 B	Filtered	Lead	<0.001	<0.001	1.600E-03
Reference	CRM 1.0 B	Filtered	Manganese	1.800E-02	1.400E-03	4.700E-03
Reference	CRM 1.0 B	Filtered	Nickel	3.400E-03	1.600E-03	3.400E-03
Reference	CRM 1.0 B	Filtered	Selenium	<0.005	<0.001	1.600E-03
Reference	CRM 1.0 B	Filtered	Zinc	5.700E-03	4.600E-03	2.400E-02
White Oak	WOCM 0.0B	Unfiltered	Aluminum	4.350E-01	1.360E-01	1.550E-01
White Oak	WOCM 0.0B	Unfiltered	Arsenic	<0.001	<0.001	1.100E-03

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
White Oak	WOCM 0.0B	Unfiltered	Barium	2.740E-02	2.820E-02	3.630E-02
White Oak	WOCM 0.0B	Unfiltered	Boron	2.600E-02	0.000E+00	4.080E-02
White Oak	WOCM 0.0B	Unfiltered	Chromium	<0.002	<0.001	1.700E-03
White Oak	WOCM 0.0B	Unfiltered	Copper	4.100E-03	1.400E-03	5.900E-03
White Oak	WOCM 0.0B	Unfiltered	Iron	6.080E-01	1.660E-01	1.950E-01
White Oak	WOCM 0.0B	Unfiltered	Lead	1.600E-03	<0.001	1.000E-03
White Oak	WOCM 0.0B	Unfiltered	Manganese	6.310E-02	6.210E-02	7.550E-02
White Oak	WOCM 0.0B	Unfiltered	Nickel	3.200E-03	1.300E-03	1.900E-03
White Oak	WOCM 0.0B	Unfiltered	Vanadium	1.300E-03	<0.001	<0.001
White Oak	WOCM 0.0B	Unfiltered	Zinc	1.620E-02	4.100E-03	1.810E-02
White Oak	WOCM 0.0B	Filtered	Aluminum	2.190E-02	<0.006	1.000E-02
White Oak	WOCM 0.0B	Filtered	Antimony	3.500E-03	5.300E-03	6.800E-03
White Oak	WOCM 0.0B	Filtered	Barium	2.200E-02	2.570E-02	2.740E-02
White Oak	WOCM 0.0B	Filtered	Boron	3.670E-02	0.000E+00	6.290E-02
White Oak	WOCM 0.0B	Filtered	Chromium	<0.002	<0.001	1.200E-03
White Oak	WOCM 0.0B	Filtered	Copper	2.300E-03	2.500E-03	5.900E-03
White Oak	WOCM 0.0B	Filtered	Iron	2.600E-02	<0.0018	<0.0018
White Oak	WOCM 0.0B	Filtered	Manganese	2.480E-02	7.400E-03	8.100E-03
White Oak	WOCM 0.0B	Filtered	Nickel	2.300E-03	2.200E-03	1.200E-03
White Oak	WOCM 0.0B	Filtered	Zinc	4.900E-03	4.000E-03	4.700E-03
White Oak	CRM 20.2A	Unfiltered	Aluminum	5.050E-01	9.100E-02	6.530E-02
White Oak	CRM 20.2A	Unfiltered	Barium	2.770E-02	2.850E-02	2.620E-02
White Oak	CRM 20.2A	Unfiltered	Boron	2.780E-02	0.000E+00	4.310E-02
White Oak	CRM 20.2A	Unfiltered	Chromium	<0.002	1.100E-03	1.900E-03
White Oak	CRM 20.2A	Unfiltered	Copper	5.000E-03	4.700E-03	2.700E-03
White Oak	CRM 20.2A	Unfiltered	Iron	7.050E-01	1.420E-01	8.180E-02
White Oak	CRM 20.2A	Unfiltered	Lead	1.600E-03	<0.001	<0.001
White Oak	CRM 20.2A	Unfiltered	Manganese	5.850E-02	5.850E-02	4.020E-02
White Oak	CRM 20.2A	Unfiltered	Nickel	2.600E-03	2.900E-03	<0.001
White Oak	CRM 20.2A	Unfiltered	Vanadium	1.200E-03	<0.001	<0.001
White Oak	CRM 20.2A	Unfiltered	Zinc	1.780E-02	2.640E-02	4.200E-03
White Oak	CRM 20.2A	Filtered	Aluminum	1.120E-02	<0.006	7.300E-03
White Oak	CRM 20.2A	Filtered	Antimony	1.130E-02	5.400E-03	7.400E-03
White Oak	CRM 20.2A	Filtered	Barium	2.020E-02	2.690E-02	2.380E-02
White Oak	CRM 20.2A	Filtered	Boron	2.530E-02	0.000E+00	4.220E-02
White Oak	CRM 20.2A	Filtered	Chromium	<0.002	2.200E-03	1.100E-03
White Oak	CRM 20.2A	Filtered	Copper	1.700E-03	3.600E-03	5.300E-03
White Oak	CRM 20.2A	Filtered	Iron	1.760E-02	4.080E-01	1.800E-02
White Oak	CRM 20.2A	Filtered	Manganese	4.200E-03	3.400E-03	1.800E-03
White Oak	CRM 20.2A	Filtered	Nickel	2.200E-03	5.700E-03	1.200E-03
White Oak	CRM 20.2A	Filtered	Uranium	3.100E-03	0.000E+00	<0.001

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
White Oak	CRM 20.2A	Filtered	Zinc	2.800E-03	4.800E-03	3.000E-03
White Oak	CRM 20.2B	Unfiltered	Aluminum	5.530E-01	4.620E-02	5.900E-02
White Oak	CRM 20.2B	Unfiltered	Barium	2.670E-02	2.760E-02	3.000E-02
White Oak	CRM 20.2B	Unfiltered	Boron	2.590E-02	0.000E+00	6.060E-02
White Oak	CRM 20.2B	Unfiltered	Chromium	<0.002	1.500E-03	1.700E-03
White Oak	CRM 20.2B	Unfiltered	Copper	4.500E-03	4.800E-03	2.010E-02
White Oak	CRM 20.2B	Unfiltered	Iron	6.180E-01	7.080E-02	8.580E-02
White Oak	CRM 20.2B	Unfiltered	Lead	1.700E-03	<0.001	1.000E-03
White Oak	CRM 20.2B	Unfiltered	Manganese	5.850E-02	4.470E-02	4.080E-02
White Oak	CRM 20.2B	Unfiltered	Nickel	3.000E-03	3.400E-03	4.900E-03
White Oak	CRM 20.2B	Unfiltered	Vanadium	1.200E-03	<0.001	<0.001
White Oak	CRM 20.2B	Unfiltered	Zinc	1.100E-02	1.670E-02	1.810E-02
White Oak	CRM 20.2B	Filtered	Aluminum	1.930E-02	<0.006	2.040E-02
White Oak	CRM 20.2B	Filtered	Antimony	1.190E-02	5.300E-03	6.300E-03
White Oak	CRM 20.2B	Filtered	Barium	1.980E-02	2.520E-02	2.610E-02
White Oak	CRM 20.2B	Filtered	Boron	2.480E-02	0.000E+00	1.500E-01
White Oak	CRM 20.2B	Filtered	Chromium	<0.002	<0.001	2.600E-03
White Oak	CRM 20.2B	Filtered	Copper	2.600E-03	2.500E-03	4.400E-03
White Oak	CRM 20.2B	Filtered	Iron	2.470E-02	<0.0018	<0.0018
White Oak	CRM 20.2B	Filtered	Manganese	5.300E-03	1.100E-03	2.100E-03
White Oak	CRM 20.2B	Filtered	Nickel	2.400E-03	4.900E-03	<0.001
White Oak	CRM 20.2B	Filtered	Zinc	4.000E-03	3.500E-03	<0.002
White Oak	CRM 20.2C	Unfiltered	Aluminum	4.920E-01	4.680E-02	4.550E-02
White Oak	CRM 20.2C	Unfiltered	Barium	2.630E-02	2.790E-02	2.560E-02
White Oak	CRM 20.2C	Unfiltered	Boron	3.350E-02	0.000E+00	5.280E-02
White Oak	CRM 20.2C	Unfiltered	Chromium	<0.002	<0.001	2.300E-03
White Oak	CRM 20.2C	Unfiltered	Copper	1.050E-02	5.300E-03	2.000E-03
White Oak	CRM 20.2C	Unfiltered	Iron	6.670E-01	7.980E-02	4.860E-02
White Oak	CRM 20.2C	Unfiltered	Lead	1.500E-03	1.400E-03	<0.001
White Oak	CRM 20.2C	Unfiltered	Manganese	5.990E-02	4.280E-02	3.220E-02
White Oak	CRM 20.2C	Unfiltered	Nickel	3.200E-03	5.300E-03	<0.001
White Oak	CRM 20.2C	Unfiltered	Vanadium	1.200E-03	<0.001	<0.001
White Oak	CRM 20.2C	Unfiltered	Zinc	1.500E-02	3.710E-02	4.500E-03
White Oak	CRM 20.2C	Filtered	Aluminum	1.860E-02	<0.006	1.330E-02
White Oak	CRM 20.2C	Filtered	Antimony	7.200E-03	4.200E-03	5.100E-03
White Oak	CRM 20.2C	Filtered	Arsenic	<0.001	<0.001	1.100E-03
White Oak	CRM 20.2C	Filtered	Barium	2.000E-02	2.580E-02	2.580E-02
White Oak	CRM 20.2C	Filtered	Boron	4.100E-02	0.000E+00	4.940E-02
White Oak	CRM 20.2C	Filtered	Chromium	<0.002	<0.001	1.700E-03
White Oak	CRM 20.2C	Filtered	Copper	2.500E-03	1.600E-03	3.000E-03

Table A7 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
White Oak	CRM 20.2C	Filtered	Iron	2.030E-02	<0.0018	1.800E-02
White Oak	CRM 20.2C	Filtered	Manganese	5.100E-03	<0.001	1.400E-03
White Oak	CRM 20.2C	Filtered	Nickel	2.600E-03	1.800E-03	<0.001
White Oak	CRM 20.2C	Filtered	Zinc	5.000E-03	5.200E-03	3.300E-03
White Oak	CRM 19.0 B	Unfiltered	Aluminum	5.100E-01	4.560E-02	6.420E-02
White Oak	CRM 19.0 B	Unfiltered	Barium	2.920E-02	2.840E-02	3.140E-02
White Oak	CRM 19.0 B	Unfiltered	Boron	4.190E-02	0.000E+00	5.970E-02
White Oak	CRM 19.0 B	Unfiltered	Chromium	<0.002	<0.001	2.300E-03
White Oak	CRM 19.0 B	Unfiltered	Copper	6.200E-03	3.900E-03	2.210E-02
White Oak	CRM 19.0 B	Unfiltered	Iron	7.230E-01	7.870E-02	9.700E-02
White Oak	CRM 19.0 B	Unfiltered	Lead	1.900E-03	<0.001	1.700E-03
White Oak	CRM 19.0 B	Unfiltered	Manganese	6.040E-02	4.590E-02	4.020E-02
White Oak	CRM 19.0 B	Unfiltered	Nickel	2.900E-03	3.200E-03	7.300E-03
White Oak	CRM 19.0 B	Unfiltered	Zinc	2.020E-02	2.040E-02	1.330E-02
White Oak	CRM 19.0 B	Filtered	Aluminum	1.270E-02	<0.006	6.190E-03
White Oak	CRM 19.0 B	Filtered	Antimony	8.600E-03	6.380E-03	9.670E-03
White Oak	CRM 19.0 B	Filtered	Barium	2.050E-02	2.437E-02	2.516E-02
White Oak	CRM 19.0 B	Filtered	Boron	3.480E-02	0.000E+00	4.137E-02
White Oak		Filtered	Chromium	<0.002	1.280E-03	1.510E-03
White Oak	CRM 19.0 B	Filtered	Copper	1.700E-03	1.950E-03	6.100E-03
White Oak	CRM 19.0 B	Filtered	Iron	2.270E-02	<0.0018	1.800E-02
White Oak	CRM 19.0 B	Filtered	Manganese	3.900E-03	1.120E-03	2.690E-03
White Oak	CRM 19.0 B	Filtered	Nickel	2.100E-03	4.170E-03	1.110E-03
White Oak	CRM 19.0 B	Filtered	Zinc	5.600E-03	5.460E-03	3.340E-03

Table A8. Organic analytes detected (mg/L) in association with the water biased event study

Reach	River Mile		Season	Analyte	Process	Result
1	CRM	41.5	summer	Bis(2-ethylhexyl)phthalate	Filtered	2.70E-02
4.02	CRM	6	spring	Bis(2-ethylhexyl)phthalate	Filtered	1.00E-03
4.04	CRM	1	summer	Bis(2-ethylhexyl)phthalate	Filtered	3.00E-02
7.02	MBM	0.2	summer	Bis(2-ethylhexyl)phthalate	Total	6.00E-03
1	CRM	41.5	spring	Di-n-butylphthalate	Filtered	1.00E-03
4.02	CRM	6	summer	Di-n-butylphthalate	Filtered	1.00E-03
7.02	MBM	0.2	spring	Di-n-butylphthalate	Filtered	1.00E-03
1	CRM	41.5	spring	Di-n-butylphthalate	Total	1.00E-03
7.02	MBM	0.2	summer	Di-n-butylphthalate	Total	4.00E-03
7.02	MBM	0.2	spring	alpha-BHC	Filtered	1.80E-05
7.02	MBM	0.2	spring	alpha-BHC	Total	1.30E-05

Table A9. Radionuclide concentrations for the water biased event study

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
Source: MCoy Branch										
1	CRM 36.9B	Particle associated Co-60		-5.57E+00	3.53E+01	-6.33E+01	1.60E+02	7.97E+00	2.56E+02	PCI/G
1	CRM 36.9B	Particle associated Cs-137		1.22E+01	3.77E+01	7.39E+01	1.62E+02	-4.50E+00	2.39E+02	PCI/G
1	CRM 36.9B	Cesium-137	Dissolved	1.18E+01	1.25E+01	7.30E-01	4.95E+00	-4.03E+00	5.16E+00	PCi/L
1	CRM 36.9B	Cobalt-60	Dissolved	-7.10E-01	9.05E+00	1.41E+00	4.34E+00	2.38E+00	4.69E+00	PCi/L
1	CRM 36.9B	Cesium-137	Residue	2.20E-01	6.80E-01	3.70E-01	8.10E-01	-1.00E-02	7.20E-01	PCi/L
1	CRM 36.9B	Cobalt-60	Residue	-1.00E-01	6.30E-01	-3.20E-01	8.00E-01	2.00E-02	7.70E-01	PCi/L
1	CRM 36.9B	Gross alpha activity	Total	1.15E+00	5.70E-01	-6.56E+00	2.36E+00	-4.26E+00	3.06E+00	PCi/L
1	CRM 36.9B	Gross beta activity	Total	7.12E+00	1.37E+00	5.88E+00	2.98E+00	4.32E+00	4.66E+00	PCi/L
1	CRM 36.9B	Strontium-90	Total	9.50E-01	1.93E+00	2.40E+00	1.30E+00	2.10E-01	2.31E+00	PCi/L
1	CRM 36.9B	Tritium	Total	0.00E+00	2.20E+02	4.30E+01	2.56E+02	-7.19E+01	2.43E+02	PCi/L
7.01	MBM 0.4B	Particle associated Co-60		2.44E+01	6.25E+01	-2.72E+01	9.67E+01	-2.47E+01	1.22E+02	PCI/G
7.01	MBM 0.4B	Particle associated Cs-137		1.81E+00	5.85E+01	-2.39E+01	8.64E+01	-1.57E+01	1.06E+02	PCI/G
7.01	MBM 0.4B	Cesium-137	Dissolved	-3.63E+00	1.07E+01	6.26E+00	1.12E+01	-2.00E+00	1.08E+01	PCi/L
7.01	MBM 0.4B	Cobalt-60	Dissolved	4.14E+00	1.01E+01	8.90E-01	1.00E+01	5.75E+00	1.05E+01	PCi/L
7.01	MBM 0.4B	Cesium-137	Residue	2.00E-02	6.80E-01	-1.70E-01	6.20E-01	-9.00E-02	6.30E-01	PCi/L
7.01	MBM 0.4B	Cobalt-60	Residue	2.80E-01	7.20E-01	-2.00E-01	7.00E-01	-1.50E-01	7.30E-01	PCi/L
7.01	MBM 0.4B	Gross alpha activity	Total	1.27E+00	7.40E-01	-7.34E+00	2.47E+00	-6.50E-01	3.16E+00	PCi/L
7.01	MBM 0.4B	Gross beta activity	Total	1.56E+00	1.39E+00	6.63E+00	2.86E+00	3.57E+00	4.51E+00	PCi/L
7.01	MBM 0.4B	Strontium-90	Total	6.90E-01	2.65E+00	1.42E+00	1.49E+00	1.30E+00	1.75E+00	PCi/L
7.01	MBM 0.4B	Tritium	Total	1.13E+02	2.19E+02	2.04E+02	2.56E+02	-1.53E+01	2.43E+02	PCi/L
7.02	MBM 0.2A	Particle associated Co-60		9.12E+00	2.35E+01	-6.00E+01	1.44E+02	-3.43E+01	1.91E+02	PCI/G
7.02	MBM 0.2A	Particle associated Cs-137		.	.	.	.	.	.	PCI/G
7.02	MBM 0.2A	Cesium-137	Dissolved	6.30E-01	1.03E+01	7.00E-01	5.92E+00	-1.12E+00	5.61E+00	PCi/L

Table A9 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
7.02	MBM 0.2A	Cobalt-60	Dissolved	4.19E+00	8.72E+00	2.08E+00	5.15E+00	-1.41E+00	4.94E+00	PCi/L
7.02	MBM 0.2A	Cesium-137	Residue	0.00E+00	2.90E-01	-3.10E-01	7.50E-01	1.00E-01	7.70E-01	PCi/L
7.02	MBM 0.2A	Cobalt-60	Residue	1.10E-01	3.00E-01	-2.80E-01	6.60E-01	-1.60E-01	8.80E-01	PCi/L
7.02	MBM 0.2A	Gross alpha activity	Total	3.40E-01	9.20E-01	-5.60E+00	2.46E+00	-3.29E+00	3.15E+00	PCi/L
7.02	MBM 0.2A	Gross beta activity	Total	9.90E-01	1.33E+00	1.00E+01	2.87E+00	4.54E+00	4.51E+00	PCi/L
7.02	MBM 0.2A	Strontium-90	Total	4.20E-01	2.63E+00	1.43E+00	1.32E+00	-2.11E+00	1.96E+00	PCi/L
7.02	MBM 0.2A	Tritium	Total	0.00E+00	2.19E+02	1.77E+02	2.56E+02	9.16E+01	2.43E+02	PCi/L
7.02	MBM 0.2B	Particle associated Co-60		-7.58E+00	3.97E+01	5.70E+01	8.83E+01	-1.48E+01	6.44E+01	PCI/G
7.02	MBM 0.2B	Particle associated Cs-137		-1.32E+01	3.64E+01	-4.09E+00	7.97E+01	3.04E+01	6.19E+01	PCI/G
7.02	MBM 0.2B	Cesium-137	Dissolved	-2.68E+00	5.00E+00	9.34E+00	1.16E+01	7.63E+00	1.22E+01	PCi/L
7.02	MBM 0.2B	Cobalt-60	Dissolved	-1.91E+00	4.66E+00	3.93E+00	1.07E+01	-2.60E+00	1.07E+01	PCi/L
7.02	MBM 0.2B	Cesium-137	Residue	-2.30E-01	6.30E-01	-2.00E-02	3.00E-01	1.50E-01	3.10E-01	PCi/L
7.02	MBM 0.2B	Cobalt-60	Residue	-1.30E-01	6.80E-01	2.20E-01	3.40E-01	-7.00E-02	3.20E-01	PCi/L
7.02	MBM 0.2B	Gross alpha activity	Total	4.70E-01	6.60E-01	-1.47E+01	4.65E+00	-3.42E+00	3.13E+00	PCi/L
7.02	MBM 0.2B	Gross beta activity	Total	1.45E+00	1.65E+00	7.83E+00	3.01E+00	1.70E+00	4.55E+00	PCi/L
7.02	MBM 0.2B	Strontium-90	Total	4.55E+00	2.62E+00	1.45E+00	1.19E+00	1.44E+00	1.93E+00	PCi/L
7.02	MBM 0.2B	Tritium	Total	0.00E+00	2.19E+02	1.43E+02	2.56E+02	-1.09E+02	2.43E+02	PCi/L
7.02	MBM 0.2C	Particle associated Co-60		-1.82E+00	2.15E+01	1.77E+02	2.28E+02	4.02E+01	2.23E+02	PCI/G
7.02	MBM 0.2C	Particle associated Cs-137		-1.10E+01	1.97E+01	-6.32E+01	2.15E+02	-2.18E+01	1.76E+02	PCI/G
7.02	MBM 0.2C	Cesium-137	Dissolved	1.22E+01	1.33E+01	2.36E+00	1.22E+01	8.32E+00	1.31E+01	PCi/L
7.02	MBM 0.2C	Cobalt-60	Dissolved	2.53E+00	9.48E+00	1.42E+00	9.83E+00	-2.66E+00	1.03E+01	PCi/L
7.02	MBM 0.2C	Cesium-137	Residue	-1.50E-01	2.80E-01	-2.10E-01	7.30E-01	-7.00E-02	6.00E-01	PCi/L
7.02	MBM 0.2C	Cobalt-60	Residue	-3.00E-02	3.00E-01	6.00E-01	7.80E-01	1.40E-01	7.60E-01	PCi/L
7.02	MBM 0.2C	Gross alpha activity	Total	6.60E-01	9.00E-01	-7.68E+00	2.35E+00	-4.85E+00	3.16E+00	PCi/L
7.02	MBM 0.2C	Gross beta activity	Total	1.94E+00	1.20E+00	6.10E+00	2.98E+00	2.13E+00	4.50E+00	PCi/L

Table A9 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
7.02	MBM 0.2C	Strontium-90	Total	5.57E+00	2.28E+00	1.69E+00	1.40E+00	1.46E+00	2.57E+00	PCi/L
7.02	MBM 0.2C	Tritium	Total	0.00E+00	2.15E+02	1.44E+02	2.56E+02	-2.12E+02	2.43E+02	PCi/L
Source: Poplar Creek										
3.04	PCM 0.1B	Particle associated Co-60		4.46E+00	6.68E+01	-5.15E+00	6.60E+01	2.51E+00	6.78E+01	PCI/G
3.04	PCM 0.1B	Particle associated Cs-137		3.93E+00	6.06E+01	-2.07E+01	5.97E+01	1.93E+01	6.16E+01	PCI/G
3.04	PCM 0.1B	Cesium-137	Dissolved	-2.48E+00	1.15E+01	9.42E+00	1.20E+01	1.18E+01	1.24E+01	PCi/L
3.04	PCM 0.1B	Cobalt-60	Dissolved	-3.26E+00	8.82E+00	-5.00E-02	1.13E+01	7.94E+00	1.19E+01	PCi/L
3.04	PCM 0.1B	Cesium-137	Residue	4.00E-02	5.80E-01	-2.10E-01	6.20E-01	2.10E-01	6.60E-01	PCi/L
3.04	PCM 0.1B	Cobalt-60	Residue	4.00E-02	6.40E-01	-5.00E-02	6.90E-01	3.00E-02	7.30E-01	PCi/L
3.04	PCM 0.1B	Gross alpha activity	Total	-5.60E+00	3.01E+00	-8.40E+00	2.41E+00	1.18E+00	2.93E+00	PCi/L
3.04	PCM 0.1B	Gross beta activity	Total	-1.66E+00	3.07E+00	1.26E+01	3.01E+00	-2.67E+00	4.60E+00	PCi/L
3.04	PCM 0.1B	Strontium-90	Total	8.53E+01	1.29E+00	1.31E+00	7.90E-01	8.00E-01	1.53E+00	PCi/L
3.04	PCM 0.1B	Tritium	Total	0.00E+00	2.15E+02	9.19E+02	2.56E+02	8.06E+01	2.53E+02	PCi/L
4.01	CRM 11.8A	Particle associated Co-60		3.32E+01	7.64E+01	2.13E+00	1.55E+01	-1.26E+01	5.60E+01	PCI/G
4.01	CRM 11.8A	Particle associated Cs-137		.	.	.	.	.	.	PCI/G
4.01	CRM 11.8A	Cesium-137	Dissolved	1.08E+01	1.26E+01	-1.07E+00	5.58E+00	1.47E+00	1.05E+01	PCi/L
4.01	CRM 11.8A	Cobalt-60	Dissolved	-2.49E+00	1.02E+01	-3.70E-01	4.71E+00	1.76E+00	1.09E+01	PCi/L
4.01	CRM 11.8A	Cesium-137	Residue	2.20E-01	6.50E-01	2.30E-01	3.40E-01	-1.10E-01	6.60E-01	PCi/L
4.01	CRM 11.8A	Cobalt-60	Residue	2.50E-01	5.80E-01	4.00E-02	3.20E-01	-1.70E-01	7.50E-01	PCi/L
4.01	CRM 11.8A	Gross alpha activity	Total	1.00E+00	6.70E-01	-9.47E+00	2.53E+00	1.20E-01	3.00E+00	PCi/L
4.01	CRM 11.8A	Gross beta activity	Total	-1.90E+00	1.49E+00	1.27E+01	2.89E+00	9.70E-01	4.49E+00	PCi/L
4.01	CRM 11.8A	Strontium-90	Total	8.90E-01	1.26E+00	8.90E-01	7.90E-01	2.07E+00	1.51E+00	PCi/L
4.01	CRM 11.8A	Tritium	Total	1.05E+02	2.12E+02	4.36E+02	2.56E+02	-6.76E+01	2.53E+02	PCi/L
4.01	CRM 11.8B	Particle associated Co-60		-6.40E-01	3.18E+01	6.29E+00	3.77E+01	-9.15E+01	6.32E+01	PCI/G

Table A9 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
4.01	CRM 11.8B	Particle associated Cs-137		2.81E+01	3.37E+01	-1.28E+01	3.38E+01	1.76E+01	6.41E+01	PCI/G
4.01	CRM 11.8B	Cesium-137	Dissolved	1.33E+01	1.24E+01	9.83E+00	1.28E+01	1.06E+01	1.17E+01	PCi/L
4.01	CRM 11.8B	Cobalt-60	Dissolved	5.54E+00	9.85E+00	1.00E+00	9.64E+00	5.76E+00	1.05E+01	PCi/L
4.01	CRM 11.8B	Cesium-137	Residue	2.60E-01	3.10E-01	-2.30E-01	6.10E-01	2.00E-01	7.40E-01	PCi/L
4.01	CRM 11.8B	Cobalt-60	Residue	-1.00E-02	2.90E-01	1.10E-01	6.90E-01	-1.06E+00	7.30E-01	PCi/L
4.01	CRM 11.8B	Gross alpha activity	Total	2.20E-01	9.70E-01	-1.68E+01	4.93E+00	1.20E+00	4.17E+00	PCi/L
4.01	CRM 11.8B	Gross beta activity	Total	2.95E+00	1.57E+00	1.87E+01	5.91E+00	1.63E+00	3.52E+00	PCi/L
4.01	CRM 11.8B	Strontium-90	Total	0.00E+00	1.79E+00	1.74E+00	9.20E-01	1.80E+00	1.78E+00	PCi/L
4.01	CRM 11.8B	Tritium	Total	2.36E+02	2.14E+02	3.14E+02	2.56E+02	9.81E+01	2.53E+02	PCi/L
4.01	CRM 11.8C	Particle associated Co-60		4.62E+01	9.33E+01	2.52E+01	3.08E+01	-1.33E+01	6.86E+01	PCI/G
4.01	CRM 11.8C	Particle associated Cs-137		-2.52E+01	9.08E+01	4.87E+00	2.81E+01	3.19E+01	6.50E+01	PCI/G
4.01	CRM 11.8C	Cesium-137	Dissolved	6.12E+00	1.13E+01	-8.70E-01	4.64E+00	1.04E+01	1.15E+01	PCi/L
4.01	CRM 11.8C	Cobalt-60	Dissolved	-2.43E+00	9.58E+00	2.74E+00	5.04E+00	-1.22E+00	8.34E+00	PCi/L
4.01	CRM 11.8C	Cesium-137	Residue	-2.00E-01	7.10E-01	1.10E-01	6.50E-01	4.10E-01	8.30E-01	PCi/L
4.01	CRM 11.8C	Cobalt-60	Residue	3.60E-01	7.30E-01	5.80E-01	7.10E-01	-1.70E-01	8.80E-01	PCi/L
4.01	CRM 11.8C	Gross alpha activity	Total	4.60E-01	1.30E+00	-1.03E+01	2.49E+00	2.74E+00	2.94E+00	PCi/L
4.01	CRM 11.8C	Gross beta activity	Total	4.94E+00	2.68E+00	1.86E+01	2.93E+00	-5.13E+00	4.57E+00	PCi/L
4.01	CRM 11.8C	Strontium-90	Total	0.00E+00	1.51E+00	5.60E-01	1.01E+00	1.42E+00	1.49E+00	PCi/L
4.01	CRM 11.8C	Tritium	Total	1.50E+02	2.13E+02	9.05E+01	2.56E+02	5.67E+01	2.53E+02	PCi/L
4.01	CRM 9.0B	Particle associated Co-60		-4.92E+01	6.66E+01	1.72E+01	6.95E+01	2.46E+01	1.75E+02	PCI/G
4.01	CRM 9.0B	Particle associated Cs-137		1.63E+01	6.38E+01	3.85E+00	6.63E+01	1.22E+02	1.71E+02	PCI/G
4.01	CRM 9.0B	Cesium-137	Dissolved	-2.16E+00	4.76E+00	-1.29E+00	9.78E+00	-6.80E-01	1.08E+01	PCi/L
4.01	CRM 9.0B	Cobalt-60	Dissolved	1.60E-01	4.51E+00	-5.00E-02	9.04E+00	7.94E+00	9.95E+00	PCi/L
4.01	CRM 9.0B	Cesium-137	Residue	1.70E-01	6.60E-01	2.00E-02	3.00E-01	5.40E-01	7.50E-01	PCi/L
4.01	CRM 9.0B	Cobalt-60	Residue	-5.10E-01	6.90E-01	8.00E-02	3.20E-01	1.10E-01	7.70E-01	PCi/L

Table A9 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
4.01	CRM 9.0B	Gross alpha activity	Total	7.00E-01	7.40E-01	-7.90E+00	2.35E+00	7.60E-01	2.84E+00	PCi/L
4.01	CRM 9.0B	Gross beta activity	Total	1.38E+00	1.39E+00	7.53E+00	3.09E+00	-3.28E+00	4.75E+00	PCi/L
4.01	CRM 9.0B	Strontium-90	Total	.	.	-3.70E-01	7.50E-01	1.87E+00	1.70E+00	PCi/L
4.01	CRM 9.0B	Tritium	Total	7.67E+01	2.14E+02	4.10E+02	2.56E+02	3.44E+02	2.43E+02	PCi/L
Refer+A151ence Site										
1	CRM 41.5B	Particle associated Co-60		1.75E+01	5.61E+01	9.67E+00	1.49E+02	-4.67E+01	1.69E+02	PCI/G
1	CRM 41.5B	Particle associated Cs-137		.	.	.	.	.	.	PCI/G
1	CRM 41.5B	Cesium-137	Dissolved	-1.38E+00	1.18E+01	6.23E+00	1.18E+01	8.00E-01	1.16E+01	PCi/L
1	CRM 41.5B	Cobalt-60	Dissolved	-7.60E-01	9.76E+00	-1.37E+00	8.67E+00	-1.00E+01	8.79E+00	PCi/L
1	CRM 41.5B	Cesium-137	Residue	7.00E-02	2.90E-01	1.10E-01	6.10E-01	-1.10E-01	6.70E-01	PCi/L
1	CRM 41.5B	Cobalt-60	Residue	7.00E-02	2.20E-01	5.00E-02	7.70E-01	-2.00E-01	7.10E-01	PCi/L
1	CRM 41.5B	Gross alpha activity	Total	4.20E-01	9.20E-01	-8.15E+00	2.43E+00	4.79E+00	3.08E+00	PCi/L
1	CRM 41.5B	Gross beta activity	Total	1.00E+00	1.33E+00	8.32E+00	2.99E+00	-3.60E+00	4.37E+00	PCi/L
1	CRM 41.5B	Strontium-90	Total	1.40E-01	1.09E+00	8.20E-01	8.90E-01	2.08E+00	1.70E+00	PCi/L
1	CRM 41.5B	Tritium	Total	0.00E+00	2.14E+02	1.31E+02	2.56E+02	-6.10E+01	2.53E+02	PCi/L
1	CRM 43.0B	Particle associated Co-60		5.89E+01	1.04E+02	3.91E+00	4.55E+01	3.62E+01	2.86E+02	PCI/G
1	CRM 43.0B	Particle associated Cs-137		-6.11E+00	8.64E+01	-2.03E+01	4.36E+01	1.44E+01	2.22E+02	PCI/G
1	CRM 43.0B	Cesium-137	Dissolved	2.23E+00	5.17E+00	-1.50E+00	5.24E+00	7.63E+00	1.22E+01	PCi/L
1	CRM 43.0B	Cobalt-60	Dissolved	5.82E+00	4.83E+00	-3.54E+00	4.67E+00	-1.10E-01	9.56E+00	PCi/L
1	CRM 43.0B	Cesium-137	Residue	-4.00E-02	6.20E-01	-1.50E-01	3.20E-01	4.00E-02	6.20E-01	PCi/L
1	CRM 43.0B	Cobalt-60	Residue	4.20E-01	7.50E-01	3.00E-02	3.40E-01	1.00E-01	8.00E-01	PCi/L
1	CRM 43.0B	Gross alpha activity	Total	1.23E+00	8.70E-01	-6.13E+00	2.26E+00	8.00E-02	2.95E+00	PCi/L
1	CRM 43.0B	Gross beta activity	Total	1.62E+00	1.43E+00	7.57E+00	3.20E+00	-3.83E+00	4.56E+00	PCi/L

Table A9 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
1	CRM 43.0B	Strontium-90	Total	3.29E+00	2.49E+00	6.70E-01	7.40E-01	-7.40E-01	1.50E+00	PCi/L
1	CRM 43.0B	Tritium	Total	1.30E+02	2.12E+02	-1.13E+01	2.68E+02	-3.92E+01	2.53E+02	PCi/L
1	CRM 46.0B	Particle associated Co-60		8.29E+01	1.25E+02	-2.42E+01	1.36E+02	6.58E+01	2.21E+02	PCI/G
1	CRM 46.0B	Particle associated Cs-137		5.05E+01	1.22E+02	5.63E+01	1.26E+02	2.64E+01	2.12E+02	PCI/G
1	CRM 46.0B	Cesium-137	Dissolved	-5.30E-01	5.00E+00	7.59E+00	8.78E+00	2.60E-01	1.12E+01	PCi/L
1	CRM 46.0B	Cobalt-60	Dissolved	1.61E+00	4.63E+00	6.87E+00	7.77E+00	7.00E-01	1.05E+01	PCi/L
1	CRM 46.0B	Cesium-137	Residue	2.70E-01	6.60E-01	3.00E-01	6.80E-01	9.00E-02	7.20E-01	PCi/L
1	CRM 46.0B	Cobalt-60	Residue	4.50E-01	6.80E-01	-1.30E-01	7.30E-01	2.20E-01	7.50E-01	PCi/L
1	CRM 46.0B	Gross alpha activity	Total	7.10E-01	6.60E-01	-6.01E+00	2.24E+00	0.00E+00	3.00E+00	PCi/L
1	CRM 46.0B	Gross beta activity	Total	1.89E+00	1.65E+00	1.92E+01	3.23E+00	-1.62E+00	4.54E+00	PCi/L
1	CRM 46.0B	Strontium-90	Total	2.99E+00	2.67E+00	1.18E+00	8.20E-01	1.90E+00	1.65E+00	PCi/L
1	CRM 46.0B	Tritium	Total	.	.	7.47E+01	2.68E+02	3.92E+01	2.53E+02	PCi/L
4.04	CRM 1.0B	Particle associated Co-60		4.21E+00	3.77E+01	1.99E+00	1.38E+02	3.97E+00	1.14E+02	PCI/G
4.04	CRM 1.0B	Particle associated Cs-137		1.34E+01	3.91E+01	5.07E+01	1.37E+02	2.96E+01	1.14E+02	PCI/G
4.04	CRM 1.0B	Cesium-137	Dissolved	3.43E+00	1.09E+01	5.05E+00	1.26E+01	-5.30E-01	6.06E+00	PCi/L
4.04	CRM 1.0B	Cobalt-60	Dissolved	-2.89E+00	9.94E+00	3.11E+00	1.08E+01	4.42E+00	5.08E+00	PCi/L
4.04	CRM 1.0B	Cesium-137	Residue	1.10E-01	3.10E-01	2.90E-01	7.90E-01	1.80E-01	6.80E-01	PCi/L
4.04	CRM 1.0B	Cobalt-60	Residue	3.00E-02	3.00E-01	1.00E-02	8.00E-01	2.00E-02	6.80E-01	PCi/L
4.04	CRM 1.0B	Gross alpha activity	Total	1.40E-01	8.90E-01	-7.07E+00	3.37E+00	-2.20E+00	3.08E+00	PCi/L
4.04	CRM 1.0B	Gross beta activity	Total	2.55E+00	1.20E+00	6.86E+00	4.25E+00	2.75E+00	4.38E+00	PCi/L
4.04	CRM 1.0B	Strontium-90	Total	0.00E+00	2.28E+00	1.56E+00	1.27E+00	1.75E+00	1.79E+00	PCi/L
4.04	CRM 1.0B	Tritium	Total	2.17E+02	2.13E+02	1.38E+02	2.68E+02	1.22E+02	2.53E+02	PCi/L
Source: White Oak Creek										
2.02	CRM 20.2A	Particle associated Co-60		8.16E+00	2.62E+01	-5.62E+01	2.08E+02	7.96E+00	2.15E+02	PCI/G

Table A9 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
2.02	CRM 20.2A	Particle associated Cs-137		.	.	.	.	.	.	PCI/G
2.02	CRM 20.2A	Cesium-137	Dissolved	-2.69E+00	4.69E+00	-2.05E+00	1.19E+01	-3.63E+00	9.79E+00	PCi/L
2.02	CRM 20.2A	Cobalt-60	Dissolved	4.60E-01	4.70E+00	-6.41E+00	8.22E+00	-4.15E+00	8.56E+00	PCi/L
2.02	CRM 20.2A	Cesium-137	Residue	1.10E-01	7.30E-01	4.00E-02	7.30E-01	4.00E-01	7.40E-01	PCi/L
2.02	CRM 20.2A	Cobalt-60	Residue	2.20E-01	7.00E-01	-2.00E-01	7.50E-01	3.00E-02	7.30E-01	PCi/L
2.02	CRM 20.2A	Gross alpha activity	Total	2.92E+00	6.70E-01	-8.34E+00	3.79E+00	-4.14E+00	3.18E+00	PCi/L
2.02	CRM 20.2A	Gross beta activity	Total	1.86E+00	1.49E+00	1.11E+01	3.81E+00	8.68E+00	4.48E+00	PCi/L
2.02	CRM 20.2A	Strontium-90	Total	2.87E+00	2.45E+00	5.28E+00	1.29E+00	3.29E+00	2.42E+00	PCi/L
2.02	CRM 20.2A	Tritium	Total	1.27E+03	2.17E+02	5.76E+03	2.56E+02	1.25E+03	2.43E+02	PCi/L
2.02	CRM 20.2B	Particle associated Co-60		-3.60E-01	1.18E+01	-2.26E+01	9.92E+01	-3.07E+02	2.87E+02	PCI/G
2.02	CRM 20.2B	Particle associated Cs-137		-3.87E+00	1.14E+01	6.58E+01	9.70E+01	5.50E+01	3.01E+02	PCI/G
2.02	CRM 20.2B	Cesium-137	Dissolved	7.57E+00	1.21E+01	3.56E+00	1.08E+01	-2.00E-01	1.05E+01	PCi/L
2.02	CRM 20.2B	Cobalt-60	Dissolved	-3.29E+00	9.75E+00	-3.88E+00	1.00E+01	4.52E+00	1.12E+01	PCi/L
2.02	CRM 20.2B	Cesium-137	Residue	-9.00E-02	2.80E-01	2.20E-01	3.30E-01	1.30E-01	7.20E-01	PCi/L
2.02	CRM 20.2B	Cobalt-60	Residue	-1.00E-02	2.90E-01	-8.00E-02	3.40E-01	-7.40E-01	6.90E-01	PCi/L
2.02	CRM 20.2B	Gross alpha activity	Total	2.00E-02	9.60E-01	-6.90E+00	3.23E+00	-4.97E+00	3.18E+00	PCi/L
2.02	CRM 20.2B	Gross beta activity	Total	2.36E+00	1.56E+00	8.52E+00	4.36E+00	7.15E+00	4.48E+00	PCi/L
2.02	CRM 20.2B	Strontium-90	Total	3.00E-02	2.24E+00	2.68E+00	1.36E+00	3.38E+00	1.60E+00	PCi/L
2.02	CRM 20.2B	Tritium	Total	0.00E+00	2.19E+02	1.89E+03	2.56E+02	9.81E+02	2.43E+02	PCi/L
2.02	CRM 20.2C	Particle associated Co-60		-1.45E+01	3.37E+01	2.56E+01	1.72E+02	6.25E+01	2.85E+02	PCI/G
2.02	CRM 20.2C	Particle associated Cs-137		1.90E-01	3.09E+01	-3.36E+01	1.82E+02	3.36E+01	2.92E+02	PCI/G
2.02	CRM 20.2C	Cesium-137	Dissolved	1.18E+01	1.22E+01	7.70E-01	4.76E+00	-2.58E+00	5.75E+00	PCi/L
2.02	CRM 20.2C	Cobalt-60	Dissolved	-8.10E-01	1.04E+01	3.98E+00	5.11E+00	7.40E-01	4.78E+00	PCi/L
2.02	CRM 20.2C	Cesium-137	Residue	0.00E+00	6.70E-01	-1.30E-01	6.90E-01	9.00E-02	7.60E-01	PCi/L
2.02	CRM 20.2C	Cobalt-60	Residue	-3.20E-01	7.30E-01	1.00E-01	6.50E-01	1.60E-01	7.40E-01	PCi/L

Table A9 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
2.02	CRM 20.2C	Gross alpha activity	Total	6.70E-01	8.40E-01	-5.80E+00	2.23E+00	-5.00E-01	3.25E+00	PCi/L
2.02	CRM 20.2C	Gross beta activity	Total	1.80E+00	1.42E+00	2.32E+01	6.29E+00	3.71E+00	4.37E+00	PCi/L
2.02	CRM 20.2C	Strontium-90	Total	1.93E+00	2.13E+00	3.29E+00	1.35E+00	1.52E+00	1.73E+00	PCi/L
2.02	CRM 20.2C	Tritium	Total	0.00E+00	2.18E+02	2.94E+03	2.56E+02	9.38E+01	2.43E+02	PCi/L
2.02	WOCM 0.0B	Particle associated Co-60		1.76E+01	3.69E+01	4.37E+01	1.09E+02	-2.15E+01	9.37E+01	PCI/G
2.02	WOCM 0.0B	Particle associated Cs-137		4.11E+02	3.30E+01	1.24E+02	8.94E+01	2.38E+02	6.82E+01	PCI/G
2.02	WOCM 0.0B	Cesium-137	Dissolved	6.40E-01	4.95E+00	5.60E+00	1.12E+01	-2.59E+00	5.24E+00	PCi/L
2.02	WOCM 0.0B	Cobalt-60	Dissolved	-2.70E-01	4.67E+00	4.84E+00	1.10E+01	6.25E+00	4.99E+00	PCi/L
2.02	WOCM 0.0B	Cesium-137	Residue	7.80E+00	6.30E-01	8.00E-01	5.70E-01	1.90E+00	5.50E-01	PCi/L
2.02	WOCM 0.0B	Cobalt-60	Residue	3.30E-01	7.00E-01	2.80E-01	7.00E-01	-1.70E-01	7.50E-01	PCi/L
2.02	WOCM 0.0B	Gross alpha activity	Total	2.67E+01	7.90E-01	-2.70E-01	2.39E+00	8.20E+00	3.24E+00	PCi/L
2.02	WOCM 0.0B	Gross beta activity	Total	1.72E+02	1.40E+00	1.12E+02	2.88E+00	1.44E+02	4.39E+00	PCi/L
2.02	WOCM 0.0B	Strontium-90	Total	6.56E+01	2.28E+00	2.66E+01	8.90E-01	5.10E+01	1.56E+00	PCi/L
2.02	WOCM 0.0B	Tritium	Total	5.20E+04	2.15E+02	6.27E+04	2.56E+02	3.44E+04	2.43E+02	PCi/L
2.03	CRM 19.0B	Particle associated Co-60		5.92E+00	9.03E+00	2.02E+01	6.44E+01	1.09E+02	1.28E+02	PCI/G
2.03	CRM 19.0B	Particle associated Cs-137		3.42E+00	8.68E+00	-6.64E+00	8.21E+01	-1.92E+01	1.20E+02	PCI/G
2.03	CRM 19.0B	Cesium-137	Dissolved	3.00E-02	5.35E+00	6.40E+00	1.20E+01	9.85E+00	1.28E+01	PCi/L
2.03	CRM 19.0B	Cobalt-60	Dissolved	-9.60E-01	4.49E+00	1.52E+00	8.37E+00	1.70E+00	1.03E+01	PCi/L
2.03	CRM 19.0B	Cesium-137	Residue	1.10E-01	2.80E-01	-3.00E-02	3.10E-01	-5.00E-02	3.10E-01	PCi/L
2.03	CRM 19.0B	Cobalt-60	Residue	1.90E-01	2.90E-01	8.00E-02	2.40E-01	2.80E-01	3.30E-01	PCi/L
2.03	CRM 19.0B	Gross alpha activity	Total	4.90E-01	7.40E-01	-7.42E+00	2.25E+00	-3.44E+00	3.18E+00	PCi/L
2.03	CRM 19.0B	Gross beta activity	Total	7.91E+00	1.90E+00	8.40E+00	3.11E+00	3.16E+00	4.47E+00	PCi/L
2.03	CRM 19.0B	Strontium-90	Total	3.10E-01	1.93E+00	2.48E+00	1.52E+00	2.00E+00	1.58E+00	PCi/L
2.03	CRM 19.0B	Tritium	Total	1.56E+02	2.18E+02	3.44E+02	2.56E+02	8.06E+01	2.43E+02	PCi/L

Table A10. Filtered and total methyl mercury and mercury concentrations (ng/L) of sources from biased event sampling

	Sampling Date	Filtered Methyl Mercury (ng/L)	Unfiltered Methyl Mercury (ng/L)	Filtered Inorganic Mercury (ng/L)	Unfiltered Inorganic Mercury (ng/L)
		POPLAR CREEK SOURCE			
REACH 3					
PCM 0.1B					
	20APR1994	9.00E-02	1.84E-01	2.84E+00	1.02E+02
	29JUL1994	9.00E-02	1.71E-01	1.40E+00	9.04E+01
	30AUG1994	6.00E-02	9.00E-02	1.72E+00	6.12E+01
REACH 4.01					
CRM 11.8A					
	20APR1994	3.50E-02	4.20E-02	1.79E+00	1.48E+01
	29JUL1994	1.24E-01	1.47E-01	2.71E+00	6.68E+01
	30AUG1994	4.90E-02	6.30E-02	1.72E+00	2.55E+01
CRM 11.8B					
	20APR1994	2.80E-02	3.40E-02	2.15E+00	3.80E+00
	29JUL1994	1.56E-01	2.38E-01	5.68E+00	1.82E+02
	30AUG1994	7.90E-02	8.00E-02	1.88E+00	2.59E+01
CRM 11.8C					
	20APR1994	3.50E-02	3.50E-02	4.83E+00	2.03E+00
	29JUL1994	1.84E-01	3.01E-01	9.32E+00	2.47E+02
	30AUG1994	5.40E-02	1.40E-01	4.24E+00	9.28E+01
CRM 9.0B					
	20APR1994	9.90E-02	9.90E-02	8.47E+00	2.30E+00
	29JUL1994	1.35E-01	1.15E-01	1.84E+00	1.23E+01
	30AUG1994	9.80E-02	1.48E-01	1.72E+00	3.13E+00
		MCCOY BRANCH SOURCE			
REACH 7.01					
MBM 0.4B					
	19APR1994	4.80E-02	1.00E-01	1.92E+00	6.84E+00
	28JUL1994	1.01E-01	1.04E-01	2.74E+00	4.30E+00
	29AUG1994	1.05E-01	1.16E-01	1.39E+00	2.82E+00
REACH 7.02					
MBM 0.2A					
	19APR1994	4.50E-02	3.10E-02	2.55E+00	4.32E+00
	28JUL1994	7.40E-02	8.60E-02	2.24E+00	2.25E+00
	29AUG1994	1.17E-01	1.05E-01	2.10E+00	1.21E+00
MBM 0.2B					
	19APR1994	5.10E-02	3.90E-02	2.54E+00	7.63E+00
	28JUL1994	1.33E-01	7.90E-02	1.93E+00	2.18E+00
	29AUG1994	1.16E-01	5.80E-02	7.38E-01	1.97E+00

Table A10 (continued)

	Sampling Date	Filtered Methyl Mercury (ng/L)	Unfiltered Methyl Mercury (ng/L)	Filtered Inorganic Mercury (ng/L)	Unfiltered Inorganic Mercury (ng/L)
MBM 0.2C					
	19APR1994	2.90E-02	3.50E-02	3.29E+00	7.17E+00
	28JUL1994	7.00E-02	9.10E-02	1.78E+00	2.28E+00
	29AUG1994	1.38E-01	1.04E-01	7.43E-01	2.44E+00
REACH 1					
CRM 36.9B					
	19APR1994	2.80E-02	4.70E-02	2.91E+00	4.49E+00
	28JUL1994	5.33E-01	8.50E-02	1.70E+00	1.37E+00
	29AUG1994	1.03E-01	8.10E-02	2.35E+00	2.10E+00
		REFERENCE SOURCES			
REACH 1					
CRM 46.0B					
	20APR1994	3.50E-02	4.40E-02	1.80E+00	4.45E+00
	29JUL1994	1.19E-01	9.20E-02	1.16E+00	3.03E+00
	30AUG1994	5.00E-02	6.80E-02	1.73E+00	1.49E+00
	30AUG1994	6.00E-02	6.00E-02	1.32E+00	2.17E+00
CRM 43.0B					
	20APR1994	3.70E-02	3.60E-02	2.20E+00	4.35E+00
	29JUL1994	1.82E-01	1.06E-01	1.24E+00	2.33E+00
	30AUG1994	5.90E-02	8.00E-02	1.60E+00	1.73E+00
CRM 41.5B					
	20APR1994	2.40E-02	4.30E-02	1.94E+00	2.65E+00
	29JUL1994	7.70E-02	1.07E-01	1.75E+00	2.41E+00
	30AUG1994	4.50E-02	5.40E-02	1.17E+00	1.24E+00
REACH 4.04					
CRM 1.0B					
	20APR1994	3.40E-02	4.60E-02	2.61E+00	1.35E+01
	29JUL1994	1.08E-01	1.19E-01	1.86E+00	7.47E+00
	29JUL1994	1.32E-01	1.47E-01	2.82E+00	9.17E+00
	30AUG1994	1.08E-01	4.00E-02	9.83E+00	1.67E+00

Table A11. Summary statistics for dissolved and total metal concentrations (mg/L) for the contaminant remobilization from sediments study by season

Analyte	Observations.	Detects	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
			Spring/Dissolved					
Aluminum	12	10	7.0E-03	2.9E-02	1.5E-02	1.4E-03	1.8E-02	1.5E-02
Ammonium nitrogen	12	6	5.0E-02	1.9E-01	7.5E-02	1.3E-02	9.8E-02	5.3E-02
Antimony	12	10	1.0E-03	1.2E-02	5.1E-03	1.1E-03	7.1E-03	4.5E-03
Arsenic	12	3	1.0E-03	3.0E-03	1.8E-03	8.1E-05	2.0E-03	1.7E-03
Barium	12	12	2.2E-02	2.5E-02	2.3E-02	3.1E-04	2.4E-02	2.3E-02
Boron	12	8	1.8E-02	1.1E-01	5.1E-02	5.5E-03	6.1E-02	4.5E-02
Calcium	12	12	1.8E+01	2.9E+01	2.6E+01	9.3E-01	2.8E+01	2.7E+01
Chloride	12	12	2.3E+00	1.4E+01	3.9E+00	9.3E-01	5.6E+00	2.9E+00
Chromium	12	6	1.0E-03	4.7E-03	1.8E-03	3.9E-04	2.5E-03	1.0E-03
Copper	12	12	1.2E-03	3.6E-03	2.3E-03	2.0E-04	2.7E-03	2.3E-03
Fluoride	12	4	5.0E-02	1.5E-01	7.0E-02	8.2E-03	8.5E-02	7.0E-02
Iron	12	9	1.3E-02	7.1E-02	4.4E-02	5.8E-03	5.4E-02	4.7E-02
Lead	12	3	1.0E-03	1.7E-03	1.1E-03	9.1E-05	1.3E-03	1.0E-03
Magnesium	12	12	5.4E+00	9.0E+00	7.9E+00	2.9E-01	8.4E+00	8.1E+00
Manganese	12	11	1.0E-03	1.5E-02	5.6E-03	1.2E-03	7.8E-03	4.3E-03
Mercury (BR)	12	1	1.4E-06	8.3E-06	8.3E-06	.	.	8.3E-06
Nickel	12	12	1.3E-03	1.4E-02	4.8E-03	1.2E-03	7.0E-03	3.2E-03
Nitrate/nitrite	12	12	3.6E-01	7.5E-01	5.7E-01	3.5E-02	6.3E-01	5.7E-01
Potassium	12	12	1.2E+00	1.5E+00	1.4E+00	2.5E-02	1.4E+00	1.4E+00
Sodium	12	12	2.6E+00	3.9E+00	3.5E+00	1.0E-01	3.7E+00	3.6E+00
Sulfate	12	12	1.3E+01	1.8E+01	1.7E+01	4.6E-01	1.8E+01	1.8E+01
Zinc	12	12	3.7E-03	7.2E-03	5.5E-03	3.4E-04	6.1E-03	5.5E-03
Spring/Total								
Aluminum	12	12	4.5E-02	5.8E-01	2.3E-01	4.6E-02	3.1E-01	2.3E-01

Table A11 (continued)

Analyte	Observations.	Detects	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Arsenic	12	4	1.0E-03	3.0E-03	1.5E-03	1.2E-04	1.7E-03	1.3E-03
Barium	12	12	2.4E-02	2.9E-02	2.7E-02	4.7E-04	2.8E-02	2.6E-02
Boron	12	11	1.8E-02	7.6E-02	4.5E-02	4.8E-03	5.4E-02	4.7E-02
Calcium	12	12	1.9E+01	3.5E+01	2.7E+01	1.3E+00	2.9E+01	2.8E+01
Chromium	12	7	1.0E-03	3.1E-03	1.5E-03	1.9E-04	1.9E-03	1.2E-03
Copper	12	12	1.2E-03	6.0E-03	3.1E-03	5.1E-04	4.1E-03	2.5E-03
Iron	12	12	8.2E-02	7.8E-01	3.4E-01	6.2E-02	4.6E-01	3.4E-01
Lead	12	4	1.0E-03	3.0E-03	1.8E-03	1.8E-04	2.1E-03	1.5E-03
Magnesium	12	12	5.5E+00	9.1E+00	7.9E+00	3.0E-01	8.4E+00	8.2E+00
Manganese	12	12	2.5E-02	9.2E-02	6.4E-02	5.8E-03	7.5E-02	6.4E-02
Mercury (BR)	12	8	2.0E-06	6.6E-05	1.9E-05	6.0E-06	3.0E-05	1.1E-05
Nickel	12	12	1.1E-03	4.0E-03	2.5E-03	2.8E-04	3.0E-03	2.6E-03
Potassium	12	12	1.3E+00	1.5E+00	1.4E+00	2.3E-02	1.5E+00	1.4E+00
Sodium	12	12	3.4E+00	5.8E+00	4.3E+00	2.6E-01	4.7E+00	3.9E+00
Vanadium	12	7	1.0E-03	1.6E-03	1.2E-03	4.9E-05	1.2E-03	1.1E-03
Zinc	12	12	3.0E-03	2.2E-02	9.8E-03	2.0E-03	1.3E-02	8.0E-03
Summer/Dissolved								
Aluminum	11	7	6.0E-03	1.7E-02	1.1E-02	1.0E-03	1.3E-02	9.4E-03
Ammonium nitrogen	12	2	5.0E-02	8.1E-02	5.8E-02	2.8E-03	6.3E-02	5.6E-02
Antimony	11	10	1.0E-03	1.1E-02	5.8E-03	7.1E-04	7.1E-03	5.4E-03
Barium	11	10	1.0E-03	2.8E-02	2.5E-02	6.4E-04	2.6E-02	2.5E-02
Boron	11	6	1.1E-02	7.1E-02	2.5E-02	5.3E-03	3.5E-02	1.6E-02
Calcium	11	10	2.7E-02	2.9E+01	2.7E+01	4.0E-01	2.8E+01	2.8E+01
Chloride	12	12	2.5E+00	3.2E+01	5.3E+00	2.4E+00	9.7E+00	2.9E+00
Chromium	11	8	1.0E-03	8.1E-03	2.4E-03	6.1E-04	3.5E-03	2.0E-03
Copper	11	10	1.0E-03	1.1E-02	4.3E-03	8.0E-04	5.7E-03	3.4E-03

Table A11 (continued)

Analyte	Observations.	Detects	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Fluoride	12	11	5.0E-02	1.1E-01	7.3E-02	4.7E-03	8.2E-02	6.9E-02
Iron	11	5	1.8E-02	2.7E+00	4.1E-01	2.5E-01	8.7E-01	4.0E-02
Magnesium	11	10	9.0E-03	8.1E+00	7.2E+00	2.7E-01	7.7E+00	7.6E+00
Manganese	11	10	1.0E-03	5.7E-02	1.4E-02	5.5E-03	2.4E-02	3.7E-03
Nickel	11	5	1.0E-03	1.3E-02	2.6E-03	1.1E-03	4.5E-03	1.2E-03
Nitrate/nitrite	12	12	3.0E-01	6.4E-01	4.9E-01	3.0E-02	5.4E-01	4.9E-01
Potassium	11	10	1.3E-02	1.4E+00	1.3E+00	2.6E-02	1.4E+00	1.3E+00
Selenium	11	3	1.0E-03	7.5E-03	3.6E-03	4.6E-04	4.4E-03	3.2E-03
Sodium	11	11	2.4E-02	3.4E+00	2.9E+00	2.9E-01	3.4E+00	3.2E+00
Sulfate	12	12	1.3E+01	1.7E+01	1.6E+01	3.4E-01	1.7E+01	1.7E+01
Vanadium	11	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	11	10	2.0E-03	1.1E-02	5.7E-03	1.0E-03	7.6E-03	4.2E-03
Summer/Total								
Aluminum	12	11	6.0E-03	2.2E-01	1.2E-01	2.1E-02	1.6E-01	1.1E-01
Antimony	12	3	1.0E-03	1.7E-03	1.3E-03	6.0E-05	1.4E-03	1.2E-03
Barium	12	12	2.4E-02	3.0E-02	2.7E-02	6.3E-04	2.8E-02	2.7E-02
Boron	12	4	1.1E-02	3.2E-02	2.2E-02	1.5E-03	2.5E-02	2.0E-02
Calcium	12	12	2.5E+01	3.0E+01	2.8E+01	5.0E-01	2.8E+01	2.8E+01
Chromium	12	9	1.0E-03	2.4E-03	1.7E-03	1.2E-04	1.9E-03	1.6E-03
Copper	12	12	1.4E-03	3.4E-03	2.4E-03	2.1E-04	2.8E-03	2.4E-03
Iron	12	11	1.8E-02	7.9E-01	3.4E-01	8.9E-02	5.0E-01	1.7E-01
Magnesium	12	12	6.2E+00	8.4E+00	7.5E+00	2.6E-01	8.0E+00	7.9E+00
Manganese	12	11	1.0E-03	2.2E-01	8.7E-02	1.4E-02	1.1E-01	7.9E-02
Mercury (BR)	12	5	1.9E-06	3.6E-05	1.0E-05	3.4E-06	1.6E-05	3.6E-06
Nickel	12	4	1.0E-03	1.9E-03	1.3E-03	6.8E-05	1.4E-03	1.2E-03
Potassium	12	12	1.2E+00	1.5E+00	1.3E+00	2.6E-02	1.4E+00	1.4E+00

Table A11 (continued)

Analyte	Observations.	Detects	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Sodium	12	12	2.9E+00	3.4E+00	3.2E+00	3.5E-02	3.3E+00	3.2E+00
Vanadium	12	3	1.0E-03	1.3E-03	1.0E-03	3.4E-05	1.1E-03	1.0E-03
Zinc	12	12	2.0E-03	8.7E-03	4.9E-03	6.8E-04	6.1E-03	4.7E-03

Table A 12. Summary statistics for dissolved and total metal concentrations (mg/L) for the contaminants remobilization from sediments study for each site

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
CRM 1.0/Dissolved								
Aluminum	6	4	6.0E-03	2.9E-02	1.4E-02	3.5E-03	2.1E-02	9.4E-03
Ammonium nitrogen	6	2	5.0E-02	7.5E-02	5.9E-02	4.1E-03	6.7E-02	5.6E-02
Antimony	6	6	1.1E-03	7.5E-03	4.6E-03	8.9E-04	6.4E-03	5.2E-03
Arsenic	6	1	1.0E-03	3.0E-03	2.1E-03	.	.	2.1E-03
Barium	6	6	2.2E-02	2.7E-02	2.5E-02	8.9E-04	2.6E-02	2.4E-02
Boron	6	4	1.1E-02	7.1E-02	4.3E-02	7.2E-03	5.7E-02	3.7E-02
Calcium	6	6	1.8E+01	2.8E+01	2.5E+01	1.7E+00	2.8E+01	2.7E+01
Chloride	6	6	2.3E+00	4.1E+00	3.1E+00	2.5E-01	3.6E+00	2.9E+00
Chromium	6	4	1.0E-03	4.7E-03	2.9E-03	3.8E-04	3.7E-03	2.6E-03
Copper	6	6	1.8E-03	4.5E-03	3.0E-03	3.6E-04	3.8E-03	3.1E-03
Fluoride	6	4	6.0E-02	1.5E-01	7.1E-02	4.9E-03	8.1E-02	7.0E-02
Iron	6	3	1.3E-02	5.7E-01	1.5E-01	9.3E-02	3.4E-01	6.7E-02
Magnesium	6	6	5.4E+00	8.5E+00	7.1E+00	4.6E-01	8.0E+00	7.2E+00
Manganese	6	6	1.8E-03	1.5E-02	4.7E-03	2.1E-03	8.9E-03	2.5E-03
Nickel	6	4	1.0E-03	1.4E-02	3.7E-03	2.1E-03	7.9E-03	1.5E-03
Nitrate/nitrite	6	6	3.0E-01	4.9E-01	4.1E-01	3.3E-02	4.8E-01	4.3E-01
Potassium	6	6	1.2E+00	1.4E+00	1.3E+00	2.6E-02	1.4E+00	1.4E+00
Sodium	6	6	2.6E+00	3.8E+00	3.3E+00	1.6E-01	3.6E+00	3.3E+00
Sulfate	6	6	1.3E+01	1.7E+01	1.5E+01	6.8E-01	1.6E+01	1.6E+01
Zinc	6	6	2.7E-03	1.1E-02	5.5E-03	1.3E-03	8.0E-03	4.3E-03
CRM 1.0/Total								
Aluminum	6	6	3.4E-02	5.8E-01	2.3E-01	7.9E-02	3.9E-01	2.1E-01
Arsenic	6	1	1.0E-03	3.0E-03	1.5E-03	.	.	1.5E-03
Barium	6	6	2.4E-02	2.9E-02	2.8E-02	8.2E-04	3.0E-02	2.9E-02

Table A12 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Boron	6	4	1.1E-02	5.6E-02	3.1E-02	6.9E-03	4.5E-02	2.3E-02
Calcium	6	6	1.9E+01	2.9E+01	2.5E+01	1.7E+00	2.8E+01	2.6E+01
Chromium	6	4	1.0E-03	2.4E-03	1.6E-03	2.3E-04	2.1E-03	1.4E-03
Copper	6	6	1.4E-03	5.2E-03	3.2E-03	5.0E-04	4.2E-03	3.2E-03
Iron	6	6	7.5E-02	7.9E-01	4.2E-01	1.3E-01	6.7E-01	3.7E-01
Lead	6	1	1.0E-03	1.5E-03	1.5E-03	.	.	1.5E-03
Magnesium	6	6	5.5E+00	8.3E+00	7.0E+00	4.8E-01	8.0E+00	7.1E+00
Manganese	6	6	4.2E-02	8.6E-02	6.7E-02	6.8E-03	8.1E-02	6.8E-02
Mercury (BR)	6	6	1.7E-05	3.6E-05	2.8E-05	3.7E-06	3.5E-05	2.8E-05
Nickel	6	4	1.0E-03	3.2E-03	2.1E-03	3.2E-04	2.7E-03	1.7E-03
Potassium	6	6	1.3E+00	1.5E+00	1.4E+00	2.3E-02	1.4E+00	1.4E+00
Sodium	6	6	3.2E+00	4.9E+00	3.7E+00	2.7E-01	4.2E+00	3.4E+00
Vanadium	6	4	1.0E-03	1.6E-03	1.2E-03	9.5E-05	1.4E-03	1.2E-03
Zinc	6	6	2.7E-03	2.0E-02	8.5E-03	2.5E-03	1.4E-02	7.3E-03
CRM 41.5/Dissolved								
Aluminum	5	4	7.0E-03	1.6E-02	1.5E-02	3.0E-04	1.6E-02	1.5E-02
Ammonium nitrogen	6	3	5.0E-02	1.3E-01	6.7E-02	1.4E-02	9.5E-02	5.3E-02
Antimony	5	4	1.0E-03	1.1E-02	6.9E-03	1.9E-03	1.1E-02	6.6E-03
Barium	5	5	2.1E-02	2.5E-02	2.3E-02	6.8E-04	2.5E-02	2.4E-02
Boron	5	2	1.1E-02	6.3E-02	4.6E-02	5.5E-03	5.8E-02	4.2E-02
Calcium	5	5	2.5E+01	2.8E+01	2.7E+01	5.9E-01	2.8E+01	2.7E+01
Chloride	6	6	2.7E+00	3.2E+01	9.7E+00	4.8E+00	1.9E+01	3.4E+00
Chromium	5	4	1.0E-03	3.8E-03	1.9E-03	5.6E-04	3.1E-03	1.3E-03
Copper	5	5	1.9E-03	1.1E-02	4.2E-03	1.7E-03	7.8E-03	3.0E-03
Fluoride	6	3	5.0E-02	1.5E-01	6.0E-02	7.5E-03	7.5E-02	5.5E-02
Iron	5	4	1.8E-02	5.1E-01	1.3E-01	9.8E-02	3.4E-01	5.1E-02
Lead	5	2	1.0E-03	1.7E-03	1.1E-03	1.7E-04	1.5E-03	1.0E-03

Table A12 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Magnesium	5	5	6.4E+00	8.8E+00	7.8E+00	4.2E-01	8.7E+00	8.1E+00
Manganese	5	5	7.7E-03	2.7E-02	1.4E-02	3.7E-03	2.1E-02	8.9E-03
Mercury (BR)	6	1	1.4E-06	8.3E-06	8.3E-06	.	.	8.3E-06
Nickel	5	4	1.0E-03	9.3E-03	3.5E-03	1.5E-03	6.8E-03	2.7E-03
Nitrate/nitrite	6	6	5.9E-01	7.4E-01	6.3E-01	2.4E-02	6.8E-01	6.1E-01
Potassium	5	5	1.2E+00	1.5E+00	1.3E+00	5.4E-02	1.5E+00	1.4E+00
Selenium	5	1	1.0E-03	3.2E-03	3.2E-03	.	.	3.2E-03
Sodium	5	5	3.0E+00	3.7E+00	3.4E+00	1.3E-01	3.7E+00	3.5E+00
Sulfate	6	6	1.7E+01	1.8E+01	1.7E+01	2.1E-01	1.8E+01	1.7E+01
Zinc	5	5	4.2E-03	7.2E-03	6.0E-03	6.2E-04	7.3E-03	6.6E-03
CRM 41.5/Total								
Aluminum	6	6	7.1E-02	3.3E-01	1.8E-01	4.0E-02	2.6E-01	1.6E-01
Arsenic	6	1	1.0E-03	3.0E-03	1.6E-03	.	.	1.6E-03
Barium	6	6	2.4E-02	2.7E-02	2.5E-02	4.5E-04	2.6E-02	2.6E-02
Boron	6	4	1.1E-02	7.6E-02	4.3E-02	9.8E-03	6.3E-02	3.0E-02
Calcium	6	6	2.5E+01	2.9E+01	2.7E+01	7.2E-01	2.9E+01	2.8E+01
Chromium	6	5	1.0E-03	3.1E-03	1.9E-03	3.1E-04	2.5E-03	1.6E-03
Copper	6	6	1.5E-03	6.0E-03	2.8E-03	6.7E-04	4.2E-03	2.6E-03
Iron	6	6	1.3E-01	7.4E-01	3.5E-01	9.8E-02	5.5E-01	2.9E-01
Lead	6	1	1.0E-03	3.0E-03	3.0E-03	.	.	3.0E-03
Magnesium	6	6	6.4E+00	8.5E+00	7.7E+00	3.2E-01	8.4E+00	7.9E+00
Manganese	6	6	6.4E-02	1.2E-01	8.8E-02	7.9E-03	1.0E-01	8.6E-02
Mercury (BR)	6	2	1.9E-06	3.6E-06	3.0E-06	1.5E-07	3.3E-06	2.9E-06
Nickel	6	4	1.0E-03	3.2E-03	2.0E-03	3.0E-04	2.6E-03	1.7E-03
Potassium	6	6	1.2E+00	1.5E+00	1.4E+00	5.5E-02	1.5E+00	1.3E+00
Sodium	6	6	2.9E+00	5.8E+00	3.6E+00	4.3E-01	4.5E+00	3.2E+00
Vanadium	6	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03

Table A12 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Zinc	6	6	2.2E-03	2.2E-02	8.3E-03	3.1E-03	1.4E-02	6.1E-03
CRM 6.0/Dissolved								
Aluminum	6	4	6.0E-03	1.7E-02	1.2E-02	1.5E-03	1.5E-02	1.0E-02
Antimony	6	6	3.9E-03	9.5E-03	5.7E-03	9.3E-04	7.6E-03	4.7E-03
Arsenic	6	1	1.0E-03	3.0E-03	1.7E-03	.	.	1.7E-03
Barium	6	6	2.2E-02	2.6E-02	2.4E-02	7.2E-04	2.6E-02	2.4E-02
Boron	6	5	1.6E-02	5.0E-02	2.9E-02	6.5E-03	4.2E-02	2.3E-02
Calcium	6	6	2.6E+01	2.9E+01	2.7E+01	5.4E-01	2.8E+01	2.7E+01
Chloride	6	6	2.7E+00	3.2E+00	2.9E+00	7.3E-02	3.0E+00	2.9E+00
Chromium	6	3	1.0E-03	2.6E-03	1.4E-03	2.7E-04	1.9E-03	1.1E-03
Copper	6	6	1.2E-03	3.6E-03	2.4E-03	4.0E-04	3.2E-03	2.2E-03
Fluoride	6	4	5.9E-02	1.5E-01	7.5E-02	1.2E-02	9.9E-02	6.5E-02
Iron	6	4	1.3E-02	5.3E-01	1.3E-01	8.6E-02	3.0E-01	4.0E-02
Magnesium	6	6	6.3E+00	8.6E+00	7.8E+00	3.1E-01	8.4E+00	8.0E+00
Manganese	6	6	1.6E-03	5.8E-03	3.5E-03	6.5E-04	4.8E-03	3.2E-03
Nickel	6	4	1.0E-03	4.5E-03	2.8E-03	5.8E-04	3.9E-03	2.1E-03
Nitrate/nitrite	6	6	4.0E-01	6.9E-01	5.1E-01	4.4E-02	6.0E-01	5.0E-01
Potassium	6	6	1.3E+00	1.4E+00	1.4E+00	2.0E-02	1.4E+00	1.4E+00
Selenium	6	1	1.0E-03	3.3E-03	3.3E-03	.	.	3.3E-03
Sodium	6	6	3.2E+00	3.8E+00	3.4E+00	1.1E-01	3.6E+00	3.3E+00
Sulfate	6	6	1.6E+01	1.8E+01	1.7E+01	3.7E-01	1.8E+01	1.7E+01
Zinc	6	6	2.9E-03	9.4E-03	5.1E-03	9.8E-04	7.1E-03	4.7E-03
CRM 6.0/Total								
Aluminum	6	6	4.2E-02	4.1E-01	1.5E-01	5.9E-02	2.7E-01	9.3E-02
Antimony	6	2	1.0E-03	1.7E-03	1.6E-03	2.2E-05	1.7E-03	1.6E-03
Arsenic	6	1	1.0E-03	3.0E-03	1.3E-03	.	.	1.3E-03
Barium	6	6	2.5E-02	3.0E-02	2.8E-02	6.3E-04	2.9E-02	2.8E-02

Table A12 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Boron	6	4	1.1E-02	4.7E-02	3.4E-02	3.3E-03	4.1E-02	3.0E-02
Calcium	6	6	2.6E+01	3.0E+01	2.8E+01	8.1E-01	3.0E+01	2.8E+01
Chromium	6	4	1.0E-03	2.1E-03	1.5E-03	2.0E-04	1.9E-03	1.4E-03
Copper	6	6	1.2E-03	5.4E-03	2.4E-03	6.3E-04	3.7E-03	1.9E-03
Iron	6	6	7.1E-02	6.7E-01	3.0E-01	1.1E-01	5.3E-01	1.9E-01
Lead	6	1	1.0E-03	2.8E-03	2.8E-03	.	.	2.8E-03
Magnesium	6	6	6.3E+00	8.6E+00	8.0E+00	3.5E-01	8.7E+00	8.4E+00
Manganese	6	6	2.5E-02	8.0E-02	5.4E-02	7.7E-03	6.9E-02	5.7E-02
Mercury (BR)	6	4	1.3E-05	6.6E-05	3.0E-05	8.0E-06	4.6E-05	2.0E-05
Nickel	6	4	1.0E-03	4.0E-03	1.9E-03	5.3E-04	2.9E-03	1.2E-03
Potassium	6	6	1.3E+00	1.5E+00	1.4E+00	2.6E-02	1.5E+00	1.4E+00
Sodium	6	6	3.2E+00	5.4E+00	3.9E+00	3.5E-01	4.6E+00	3.5E+00
Vanadium	6	3	1.0E-03	1.2E-03	1.2E-03	0.0E+00	1.2E-03	1.2E-03
Zinc	6	6	3.3E-03	1.2E-02	5.8E-03	1.3E-03	8.4E-03	5.0E-03
MBM 0.2/Dissolved								
Aluminum	6	5	6.0E-03	1.6E-02	1.3E-02	8.0E-04	1.5E-02	1.3E-02
Ammonium nitrogen	6	3	5.0E-02	1.9E-01	9.7E-02	2.1E-02	1.4E-01	7.8E-02
Antimony	6	4	1.0E-03	1.2E-02	5.7E-03	1.3E-03	8.4E-03	4.0E-03
Arsenic	6	1	1.0E-03	3.0E-03	2.2E-03	.	.	2.2E-03
Barium	6	5	1.0E-03	2.8E-02	2.4E-02	9.3E-04	2.6E-02	2.3E-02
Boron	6	3	1.1E-02	1.1E-01	5.0E-02	1.3E-02	7.6E-02	3.7E-02
Calcium	6	5	2.7E-02	2.9E+01	2.7E+01	4.7E-01	2.8E+01	2.7E+01
Chloride	6	6	2.5E+00	3.0E+00	2.8E+00	8.3E-02	2.9E+00	2.9E+00
Chromium	6	3	1.0E-03	8.1E-03	3.1E-03	1.1E-03	5.3E-03	2.0E-03
Copper	6	5	1.0E-03	6.8E-03	3.4E-03	9.0E-04	5.3E-03	2.8E-03
Fluoride	6	4	6.7E-02	1.5E-01	8.2E-02	5.5E-03	9.3E-02	8.5E-02
Iron	6	3	1.3E-02	2.7E+00	4.8E-01	4.9E-01	1.5E+00	4.6E-02

Table A12 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Lead	6	1	1.0E-03	1.7E-03	1.7E-03	.	.	1.7E-03
Magnesium	6	5	9.0E-03	9.0E+00	7.6E+00	4.8E-01	8.6E+00	8.0E+00
Manganese	6	4	1.0E-03	5.7E-02	1.7E-02	9.8E-03	3.7E-02	4.7E-03
Nickel	6	5	1.0E-03	1.3E-02	5.3E-03	2.1E-03	9.5E-03	2.8E-03
Nitrate/nitrite	6	6	4.2E-01	7.5E-01	5.6E-01	4.5E-02	6.5E-01	5.5E-01
Potassium	6	5	1.3E-02	1.4E+00	1.3E+00	4.2E-02	1.4E+00	1.3E+00
Selenium	6	1	1.0E-03	7.5E-03	7.5E-03	.	.	7.5E-03
Sodium	6	6	2.4E-02	3.9E+00	2.9E+00	5.9E-01	4.1E+00	3.3E+00
Sulfate	6	6	1.6E+01	1.8E+01	1.7E+01	3.1E-01	1.8E+01	1.7E+01
Vanadium	6	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	6	5	2.0E-03	1.1E-02	6.1E-03	1.1E-03	8.3E-03	5.5E-03
MBM 0.2/Total								
Aluminum	6	5	6.0E-03	2.5E-01	1.4E-01	3.8E-02	2.2E-01	1.5E-01
Antimony	6	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Arsenic	6	1	1.0E-03	3.0E-03	2.2E-03	.	.	2.2E-03
Barium	6	6	2.4E-02	3.0E-02	2.6E-02	8.3E-04	2.8E-02	2.6E-02
Boron	6	3	1.1E-02	5.3E-02	3.6E-02	4.9E-03	4.6E-02	2.9E-02
Calcium	6	6	2.6E+01	3.5E+01	3.0E+01	1.3E+00	3.2E+01	2.9E+01
Chromium	6	3	1.0E-03	2.1E-03	1.6E-03	1.1E-04	1.8E-03	1.5E-03
Copper	6	6	1.7E-03	5.0E-03	2.8E-03	5.0E-04	3.8E-03	2.3E-03
Iron	6	5	1.8E-02	7.6E-01	2.9E-01	1.1E-01	5.1E-01	2.2E-01
Lead	6	1	1.0E-03	2.2E-03	2.2E-03	.	.	2.2E-03
Magnesium	6	6	6.4E+00	9.1E+00	8.0E+00	3.7E-01	8.8E+00	8.2E+00
Manganese	6	5	1.0E-03	2.2E-01	9.4E-02	2.7E-02	1.5E-01	7.3E-02
Mercury (BR)	6	1	2.0E-06	7.1E-06	2.0E-06	.	.	2.0E-06
Nickel	6	4	1.0E-03	3.9E-03	1.9E-03	4.8E-04	2.9E-03	1.3E-03
Potassium	6	6	1.3E+00	1.5E+00	1.4E+00	3.7E-02	1.5E+00	1.4E+00

Table A12 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Sodium	6	6	3.1E+00	5.6E+00	3.8E+00	3.8E-01	4.5E+00	3.5E+00
Vanadium	6	2	1.0E-03	1.1E-03	1.0E-03	2.2E-05	1.1E-03	1.0E-03
Zinc	6	6	2.0E-03	1.7E-02	6.9E-03	2.3E-03	1.2E-02	5.0E-03

Table A13. Summary statistics for dissolved and total metal concentrations (mg/L) for the contaminant remobilization from sediments study for each site by season

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
CRM 1.0/Spring/Dissolved								
Aluminum	3	2	7.0E-03	2.9E-02	2.1E-02	4.5E-03	3.4E-02	1.7E-02
Ammonium nitrogen	3	1	5.0E-02	7.5E-02	7.5E-02	.	.	7.5E-02
Antimony	3	3	1.1E-03	5.2E-03	3.8E-03	1.4E-03	7.7E-03	5.1E-03
Arsenic	3	1	1.0E-03	3.0E-03	2.1E-03	.	.	2.1E-03
Barium	3	3	2.2E-02	2.4E-02	2.3E-02	6.3E-04	2.5E-02	2.3E-02
Boron	3	2	1.8E-02	5.2E-02	4.7E-02	2.7E-03	5.5E-02	4.5E-02
Calcium	3	3	1.8E+01	2.8E+01	2.3E+01	3.0E+00	3.1E+01	2.1E+01
Chloride	3	3	2.3E+00	4.1E+00	3.1E+00	5.3E-01	4.6E+00	2.9E+00
Chromium	3	2	1.0E-03	4.7E-03	3.4E-03	7.3E-04	5.6E-03	2.8E-03
Copper	3	3	1.8E-03	2.9E-03	2.5E-03	3.3E-04	3.4E-03	2.7E-03
Fluoride	3	1	7.0E-02	1.5E-01	7.0E-02	.	.	7.0E-02
Iron	3	2	1.3E-02	6.9E-02	6.7E-02	6.4E-04	6.9E-02	6.7E-02
Magnesium	3	3	5.4E+00	8.5E+00	6.9E+00	8.9E-01	9.5E+00	6.9E+00
Manganese	3	3	2.5E-03	1.5E-02	6.7E-03	4.2E-03	1.9E-02	2.5E-03
Nickel	3	3	1.8E-03	1.4E-02	6.1E-03	3.8E-03	1.7E-02	2.9E-03
Nitrate/nitrite	3	3	3.6E-01	4.9E-01	4.4E-01	4.2E-02	5.7E-01	4.8E-01
Potassium	3	3	1.2E+00	1.4E+00	1.3E+00	4.6E-02	1.4E+00	1.3E+00
Sodium	3	3	2.6E+00	3.8E+00	3.3E+00	3.6E-01	4.3E+00	3.4E+00
Sulfate	3	3	1.3E+01	1.6E+01	1.5E+01	8.8E-01	1.7E+01	1.5E+01
Zinc	3	3	3.7E-03	6.4E-03	4.9E-03	8.0E-04	7.2E-03	4.5E-03
CRM 1.0/Spring/Total								

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Aluminum	3	3	7.8E-02	5.8E-01	3.1E-01	1.4E-01	7.4E-01	2.9E-01
Arsenic	3	1	1.0E-03	3.0E-03	1.5E-03	.	.	1.5E-03
Barium	3	3	2.4E-02	2.9E-02	2.7E-02	1.7E-03	3.2E-02	2.9E-02
Boron	3	3	2.5E-02	5.6E-02	4.3E-02	9.1E-03	6.9E-02	4.7E-02
Calcium	3	3	1.9E+01	2.7E+01	2.2E+01	2.5E+00	2.9E+01	2.0E+01
Chromium	3	2	1.0E-03	2.4E-03	1.6E-03	4.6E-04	2.9E-03	1.2E-03
Copper	3	3	2.7E-03	5.2E-03	3.6E-03	7.9E-04	5.9E-03	3.0E-03
Iron	3	3	1.4E-01	7.8E-01	4.4E-01	1.8E-01	9.8E-01	4.1E-01
Lead	3	1	1.0E-03	1.5E-03	1.5E-03	.	.	1.5E-03
Magnesium	3	3	5.5E+00	8.3E+00	6.7E+00	8.3E-01	9.1E+00	6.3E+00
Manganese	3	3	4.2E-02	7.1E-02	5.9E-02	8.9E-03	8.5E-02	6.4E-02
Mercury	3	3	2.1E-05	3.6E-05	3.0E-05	4.9E-06	4.5E-05	3.5E-05
Nickel	3	3	1.5E-03	3.2E-03	2.5E-03	5.1E-04	4.0E-03	2.8E-03
Potassium	3	3	1.3E+00	1.4E+00	1.3E+00	2.5E-02	1.4E+00	1.4E+00
Sodium	3	3	3.5E+00	4.9E+00	4.1E+00	4.2E-01	5.3E+00	3.9E+00
Vanadium	3	3	1.1E-03	1.6E-03	1.3E-03	1.6E-04	1.8E-03	1.3E-03
Zinc	3	3	7.3E-03	2.0E-02	1.2E-02	4.1E-03	2.4E-02	8.8E-03
CRM 1.0/Summer/Dissolved								
Aluminum	3	2	6.0E-03	1.0E-02	9.1E-03	7.5E-04	1.1E-02	8.4E-03
Ammonium nitrogen	3	1	5.0E-02	5.6E-02	5.6E-02	.	.	5.6E-02
Antimony	3	3	3.2E-03	7.5E-03	5.4E-03	1.2E-03	8.9E-03	5.4E-03
Barium	3	3	2.5E-02	2.7E-02	2.6E-02	7.2E-04	2.8E-02	2.7E-02
Boron	3	2	1.1E-02	7.1E-02	4.3E-02	1.6E-02	9.0E-02	3.0E-02

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Calcium	3	3	2.6E+01	2.8E+01	2.7E+01	7.0E-01	2.9E+01	2.8E+01
Chloride	3	3	2.8E+00	3.4E+00	3.1E+00	1.8E-01	3.6E+00	3.0E+00
Chromium	3	2	1.0E-03	2.6E-03	2.5E-03	3.8E-05	2.6E-03	2.5E-03
Copper	3	3	3.2E-03	4.5E-03	3.6E-03	4.4E-04	4.9E-03	3.2E-03
Fluoride	3	3	6.0E-02	8.4E-02	7.1E-02	7.0E-03	9.2E-02	7.0E-02
Iron	3	1	1.8E-02	5.7E-01	5.7E-01	.	.	5.7E-01
Magnesium	3	3	6.3E+00	8.0E+00	7.3E+00	5.0E-01	8.8E+00	7.6E+00
Manganese	3	3	1.8E-03	3.5E-03	2.6E-03	5.0E-04	4.0E-03	2.5E-03
Nickel	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Nitrate/nitrite	3	3	3.0E-01	4.8E-01	3.8E-01	5.2E-02	5.4E-01	3.7E-01
Potassium	3	3	1.3E+00	1.4E+00	1.4E+00	1.8E-02	1.4E+00	1.4E+00
Sodium	3	3	3.3E+00	3.4E+00	3.3E+00	2.9E-02	3.4E+00	3.3E+00
Sulfate	3	3	1.3E+01	1.7E+01	1.5E+01	1.2E+00	1.9E+01	1.6E+01
Zinc	3	3	2.7E-03	1.1E-02	6.1E-03	2.7E-03	1.4E-02	4.1E-03
CRM 1.0/Summer/Total								
Aluminum	3	3	3.4E-02	2.2E-01	1.5E-01	6.0E-02	3.3E-01	2.0E-01
Barium	3	3	2.8E-02	2.9E-02	2.9E-02	2.4E-04	2.9E-02	2.8E-02
Boron	3	1	1.1E-02	2.0E-02	2.0E-02	.	.	2.0E-02
Calcium	3	3	2.5E+01	2.9E+01	2.7E+01	1.3E+00	3.1E+01	2.8E+01
Chromium	3	2	1.0E-03	2.2E-03	1.8E-03	2.3E-04	2.5E-03	1.6E-03
Copper	3	3	1.4E-03	3.4E-03	2.7E-03	6.5E-04	4.6E-03	3.3E-03
Iron	3	3	7.5E-02	7.9E-01	4.0E-01	2.1E-01	1.0E+00	3.2E-01
Magnesium	3	3	6.2E+00	8.1E+00	7.4E+00	6.0E-01	9.1E+00	7.9E+00

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Manganese	3	3	5.7E-02	8.6E-02	7.6E-02	9.2E-03	1.0E-01	8.4E-02
Mercury	3	3	1.7E-05	3.6E-05	2.5E-05	6.0E-06	4.2E-05	2.1E-05
Nickel	3	1	1.0E-03	1.9E-03	1.9E-03	.	.	1.9E-03
Potassium	3	3	1.4E+00	1.5E+00	1.4E+00	2.6E-02	1.5E+00	1.4E+00
Sodium	3	3	3.2E+00	3.3E+00	3.3E+00	2.5E-02	3.3E+00	3.3E+00
Vanadium	3	1	1.0E-03	1.3E-03	1.3E-03	.	.	1.3E-03
Zinc	3	3	2.7E-03	7.3E-03	4.9E-03	1.3E-03	8.8E-03	4.8E-03
CRM 41.5/Spring/Dissolved								
Aluminum	3	3	1.5E-02	1.6E-02	1.6E-02	2.9E-04	1.7E-02	1.6E-02
Ammonium nitrogen	3	3	5.3E-02	1.3E-01	8.0E-02	2.5E-02	1.5E-01	5.8E-02
Antimony	3	2	1.0E-03	1.1E-02	5.7E-03	3.3E-03	1.5E-02	2.9E-03
Barium	3	3	2.2E-02	2.5E-02	2.4E-02	9.3E-04	2.6E-02	2.4E-02
Boron	3	2	1.8E-02	6.3E-02	4.9E-02	8.4E-03	7.3E-02	4.2E-02
Calcium	3	3	2.6E+01	2.8E+01	2.7E+01	5.6E-01	2.9E+01	2.7E+01
Chloride	3	3	2.7E+00	1.4E+01	6.6E+00	3.7E+00	1.7E+01	3.2E+00
Chromium	3	2	1.0E-03	3.8E-03	1.9E-03	1.1E-03	5.0E-03	1.0E-03
Copper	3	3	1.9E-03	3.0E-03	2.3E-03	3.5E-04	3.3E-03	2.0E-03
Fluoride	3	1	5.0E-02	1.5E-01	5.0E-02	.	.	5.0E-02
Iron	3	3	2.0E-02	5.4E-02	4.2E-02	1.1E-02	7.3E-02	5.1E-02
Lead	3	2	1.0E-03	1.7E-03	1.2E-03	2.7E-04	2.0E-03	1.0E-03
Magnesium	3	3	7.4E+00	8.8E+00	8.1E+00	4.1E-01	9.3E+00	8.2E+00
Manganese	3	3	7.7E-03	8.9E-03	8.5E-03	3.8E-04	9.6E-03	8.8E-03
Nickel	3	3	1.3E-03	9.3E-03	4.4E-03	2.5E-03	1.2E-02	2.7E-03

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Nitrate/nitrite	3	3	5.9E-01	7.4E-01	6.5E-01	4.7E-02	7.8E-01	6.1E-01
Potassium	3	3	1.4E+00	1.5E+00	1.4E+00	3.7E-02	1.5E+00	1.4E+00
Sodium	3	3	3.5E+00	3.7E+00	3.6E+00	8.1E-02	3.8E+00	3.6E+00
Sulfate	3	3	1.7E+01	1.8E+01	1.8E+01	3.3E-01	1.9E+01	1.8E+01
Zinc	3	3	4.2E-03	7.2E-03	6.2E-03	9.8E-04	9.0E-03	7.1E-03
CRM 41.5/Spring/Total								
Aluminum	3	3	7.1E-02	3.3E-01	2.2E-01	7.7E-02	4.4E-01	2.4E-01
Arsenic	3	1	1.0E-03	3.0E-03	1.6E-03	.	.	1.6E-03
Barium	3	3	2.6E-02	2.7E-02	2.6E-02	3.2E-04	2.7E-02	2.6E-02
Boron	3	3	2.8E-02	7.6E-02	5.8E-02	1.5E-02	1.0E-01	6.9E-02
Calcium	3	3	2.5E+01	2.9E+01	2.8E+01	1.2E+00	3.1E+01	2.9E+01
Chromium	3	2	1.0E-03	3.1E-03	2.2E-03	5.4E-04	3.7E-03	1.7E-03
Copper	3	3	1.5E-03	6.0E-03	3.3E-03	1.4E-03	7.3E-03	2.3E-03
Iron	3	3	1.3E-01	5.1E-01	3.4E-01	1.1E-01	6.7E-01	3.9E-01
Lead	3	1	1.0E-03	3.0E-03	3.0E-03	.	.	3.0E-03
Magnesium	3	3	7.4E+00	8.5E+00	8.1E+00	3.5E-01	9.1E+00	8.4E+00
Manganese	3	3	6.4E-02	9.2E-02	7.9E-02	8.1E-03	1.0E-01	8.1E-02
Mercury	3	1	2.9E-06	3.4E-06	2.9E-06	.	.	2.9E-06
Nickel	3	3	1.8E-03	3.2E-03	2.5E-03	4.1E-04	3.7E-03	2.4E-03
Potassium	3	3	1.3E+00	1.5E+00	1.4E+00	6.2E-02	1.6E+00	1.5E+00
Sodium	3	3	3.4E+00	5.8E+00	4.2E+00	7.8E-01	6.5E+00	3.4E+00
Vanadium	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	3	3	3.4E-03	2.2E-02	1.2E-02	5.6E-03	2.8E-02	9.7E-03

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
CRM 41.5/Summer/Dissolved								
Aluminum	2	1	7.0E-03	1.5E-02	1.5E-02	.	.	1.5E-02
Antimony	2	2	6.6E-03	1.1E-02	8.7E-03	2.1E-03	2.2E-02	8.7E-03
Barium	2	2	2.1E-02	2.4E-02	2.3E-02	1.2E-03	3.0E-02	2.3E-02
Calcium	2	2	2.5E+01	2.8E+01	2.7E+01	1.6E+00	3.7E+01	2.7E+01
Chloride	3	3	2.7E+00	3.2E+01	1.3E+01	9.6E+00	4.1E+01	3.6E+00
Chromium	2	2	1.3E-03	2.6E-03	2.0E-03	6.5E-04	6.1E-03	2.0E-03
Copper	2	2	3.4E-03	1.1E-02	7.2E-03	3.8E-03	3.1E-02	7.2E-03
Fluoride	3	2	5.0E-02	8.0E-02	6.6E-02	8.1E-03	9.0E-02	5.9E-02
Iron	2	1	1.8E-02	5.1E-01	5.1E-01	.	.	5.1E-01
Magnesium	2	2	6.4E+00	8.1E+00	7.3E+00	8.7E-01	1.3E+01	7.3E+00
Manganese	2	2	1.6E-02	2.7E-02	2.1E-02	5.7E-03	5.7E-02	2.1E-02
Nickel	2	1	1.0E-03	2.8E-03	2.8E-03	.	.	2.8E-03
Nitrate/nitrite	3	3	5.9E-01	6.4E-01	6.1E-01	1.5E-02	6.5E-01	6.0E-01
Potassium	2	2	1.2E+00	1.3E+00	1.2E+00	8.0E-02	1.7E+00	1.2E+00
Selenium	2	1	1.0E-03	3.2E-03	3.2E-03	.	.	3.2E-03
Sodium	2	2	3.0E+00	3.2E+00	3.1E+00	7.0E-02	3.5E+00	3.1E+00
Sulfate	3	3	1.7E+01	1.7E+01	1.7E+01	0.0E+00	1.7E+01	1.7E+01
Zinc	2	2	4.8E-03	6.6E-03	5.7E-03	9.0E-04	1.1E-02	5.7E-03
CRM 41.5/Summer/Total								
Aluminum	3	3	1.0E-01	1.9E-01	1.4E-01	2.7E-02	2.2E-01	1.3E-01
Barium	3	3	2.4E-02	2.5E-02	2.5E-02	6.2E-04	2.7E-02	2.5E-02
Boron	3	1	1.1E-02	3.2E-02	3.2E-02	.	.	3.2E-02

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Calcium	3	3	2.5E+01	2.9E+01	2.7E+01	1.1E+00	3.0E+01	2.8E+01
Chromium	3	3	1.3E-03	2.4E-03	1.7E-03	3.5E-04	2.7E-03	1.4E-03
Copper	3	3	1.6E-03	2.8E-03	2.4E-03	3.9E-04	3.6E-03	2.8E-03
Iron	3	3	1.5E-01	7.4E-01	3.6E-01	1.9E-01	9.1E-01	2.0E-01
Magnesium	3	3	6.4E+00	8.2E+00	7.4E+00	5.3E-01	8.9E+00	7.7E+00
Manganese	3	3	7.5E-02	1.2E-01	9.8E-02	1.2E-02	1.3E-01	1.0E-01
Mercury	3	1	1.9E-06	3.6E-06	3.6E-06	.	.	3.6E-06
Nickel	3	1	1.0E-03	1.5E-03	1.5E-03	.	.	1.5E-03
Potassium	3	3	1.2E+00	1.3E+00	1.3E+00	4.7E-02	1.4E+00	1.2E+00
Sodium	3	3	2.9E+00	3.1E+00	3.0E+00	5.6E-02	3.2E+00	3.1E+00
Zinc	3	3	2.2E-03	8.7E-03	4.8E-03	2.0E-03	1.1E-02	3.4E-03
CRM 6.0/Spring/Dissolved								
Aluminum	3	2	7.0E-03	1.5E-02	1.2E-02	1.5E-03	1.7E-02	1.1E-02
Antimony	3	3	3.9E-03	9.5E-03	6.1E-03	1.7E-03	1.1E-02	4.9E-03
Arsenic	3	1	1.0E-03	3.0E-03	1.7E-03	.	.	1.7E-03
Barium	3	3	2.2E-02	2.3E-02	2.3E-02	4.5E-04	2.4E-02	2.3E-02
Boron	3	2	1.8E-02	5.0E-02	4.9E-02	5.0E-04	5.0E-02	4.8E-02
Calcium	3	3	2.6E+01	2.8E+01	2.7E+01	7.8E-01	2.9E+01	2.6E+01
Chloride	3	3	2.7E+00	3.2E+00	2.9E+00	1.5E-01	3.4E+00	2.9E+00
Chromium	3	1	1.0E-03	1.1E-03	1.1E-03	.	.	1.1E-03
Copper	3	3	1.2E-03	3.6E-03	2.3E-03	7.1E-04	4.3E-03	2.0E-03
Fluoride	3	1	7.0E-02	1.5E-01	7.0E-02	.	.	7.0E-02
Iron	3	2	1.3E-02	7.1E-02	5.0E-02	1.2E-02	8.5E-02	4.0E-02

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Magnesium	3	3	7.7E+00	8.6E+00	8.1E+00	2.6E-01	8.8E+00	8.0E+00
Manganese	3	3	2.2E-03	5.8E-03	3.6E-03	1.1E-03	6.9E-03	2.8E-03
Nickel	3	3	1.7E-03	4.5E-03	3.5E-03	9.2E-04	6.2E-03	4.4E-03
Nitrate/nitrite	3	3	4.2E-01	6.9E-01	5.6E-01	7.8E-02	7.8E-01	5.6E-01
Potassium	3	3	1.3E+00	1.4E+00	1.3E+00	4.2E-02	1.5E+00	1.4E+00
Sodium	3	3	3.3E+00	3.8E+00	3.6E+00	1.5E-01	4.0E+00	3.7E+00
Sulfate	3	3	1.6E+01	1.8E+01	1.7E+01	6.7E-01	1.9E+01	1.8E+01
Zinc	3	3	4.5E-03	6.0E-03	5.1E-03	4.6E-04	6.4E-03	4.8E-03
CRM 6.0/Spring/Total								
Aluminum	3	3	4.9E-02	4.1E-01	2.2E-01	1.0E-01	5.3E-01	2.1E-01
Arsenic	3	1	1.0E-03	3.0E-03	1.3E-03	.	.	1.3E-03
Barium	3	3	2.5E-02	2.8E-02	2.7E-02	9.7E-04	3.0E-02	2.8E-02
Boron	3	3	3.0E-02	4.7E-02	3.9E-02	4.9E-03	5.3E-02	4.1E-02
Calcium	3	3	2.6E+01	2.9E+01	2.7E+01	1.1E+00	3.1E+01	2.7E+01
Chromium	3	2	1.0E-03	1.9E-03	1.4E-03	3.1E-04	2.3E-03	1.1E-03
Copper	3	3	1.2E-03	5.4E-03	2.8E-03	1.3E-03	6.6E-03	1.7E-03
Iron	3	3	8.2E-02	6.2E-01	3.4E-01	1.6E-01	7.9E-01	3.1E-01
Lead	3	1	1.0E-03	2.8E-03	2.8E-03	.	.	2.8E-03
Magnesium	3	3	7.9E+00	8.6E+00	8.3E+00	2.1E-01	8.9E+00	8.4E+00
Manganese	3	3	2.5E-02	8.0E-02	5.4E-02	1.6E-02	1.0E-01	5.8E-02
Mercury	3	3	2.0E-05	6.6E-05	4.0E-05	1.4E-05	8.0E-05	3.3E-05
Nickel	3	3	1.1E-03	4.0E-03	2.6E-03	8.4E-04	5.0E-03	2.7E-03
Potassium	3	3	1.3E+00	1.5E+00	1.4E+00	4.7E-02	1.6E+00	1.5E+00

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Sodium	3	3	3.6E+00	5.4E+00	4.4E+00	5.4E-01	6.0E+00	4.3E+00
Vanadium	3	2	1.0E-03	1.2E-03	1.2E-03	0.0E+00	1.2E-03	1.2E-03
Zinc	3	3	3.3E-03	1.2E-02	6.8E-03	2.7E-03	1.5E-02	4.9E-03
CRM 6.0/Summer/Dissolved								
Aluminum	3	2	6.0E-03	1.7E-02	1.2E-02	3.1E-03	2.1E-02	9.4E-03
Antimony	3	3	4.1E-03	7.5E-03	5.3E-03	1.1E-03	8.5E-03	4.4E-03
Barium	3	3	2.5E-02	2.6E-02	2.6E-02	4.8E-04	2.7E-02	2.6E-02
Boron	3	3	1.6E-02	2.7E-02	2.1E-02	3.3E-03	3.0E-02	1.9E-02
Calcium	3	3	2.6E+01	2.9E+01	2.8E+01	7.3E-01	3.0E+01	2.8E+01
Chloride	3	3	2.8E+00	3.0E+00	2.9E+00	6.7E-02	3.1E+00	2.8E+00
Chromium	3	2	1.0E-03	2.6E-03	1.7E-03	4.9E-04	3.2E-03	1.3E-03
Copper	3	3	1.8E-03	3.6E-03	2.6E-03	5.3E-04	4.1E-03	2.4E-03
Fluoride	3	3	5.9E-02	1.1E-01	7.6E-02	1.7E-02	1.3E-01	6.0E-02
Iron	3	2	1.8E-02	5.3E-01	2.0E-01	1.9E-01	7.6E-01	4.0E-02
Magnesium	3	3	6.3E+00	8.0E+00	7.5E+00	5.7E-01	9.1E+00	8.0E+00
Manganese	3	3	1.6E-03	4.8E-03	3.4E-03	9.4E-04	6.1E-03	3.7E-03
Nickel	3	1	1.0E-03	2.6E-03	2.6E-03	.	.	2.6E-03
Nitrate/nitrite	3	3	4.0E-01	5.2E-01	4.6E-01	3.5E-02	5.6E-01	4.7E-01
Potassium	3	3	1.3E+00	1.4E+00	1.4E+00	1.5E-02	1.4E+00	1.4E+00
Selenium	3	1	1.0E-03	3.3E-03	3.3E-03	.	.	3.3E-03
Sodium	3	3	3.2E+00	3.4E+00	3.2E+00	6.1E-02	3.4E+00	3.2E+00
Sulfate	3	3	1.6E+01	1.7E+01	1.7E+01	3.3E-01	1.8E+01	1.7E+01
Zinc	3	3	2.9E-03	9.4E-03	5.1E-03	2.1E-03	1.1E-02	3.0E-03

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
CRM 6.0/Summer/Total								
Aluminum	3	3	4.2E-02	1.4E-01	7.5E-02	3.1E-02	1.7E-01	4.5E-02
Antimony	3	2	1.0E-03	1.7E-03	1.6E-03	3.8E-05	1.7E-03	1.6E-03
Barium	3	3	2.7E-02	3.0E-02	2.8E-02	8.7E-04	3.1E-02	2.8E-02
Boron	3	1	1.1E-02	2.9E-02	2.9E-02	.	.	2.9E-02
Calcium	3	3	2.6E+01	3.0E+01	2.9E+01	1.3E+00	3.2E+01	2.9E+01
Chromium	3	2	1.0E-03	2.1E-03	1.8E-03	1.5E-04	2.3E-03	1.7E-03
Copper	3	3	1.4E-03	2.5E-03	2.0E-03	3.2E-04	2.9E-03	2.1E-03
Iron	3	3	7.1E-02	6.7E-01	2.7E-01	2.0E-01	8.5E-01	7.6E-02
Magnesium	3	3	6.3E+00	8.4E+00	7.7E+00	6.9E-01	9.7E+00	8.3E+00
Manganese	3	3	4.1E-02	6.4E-02	5.4E-02	6.8E-03	7.3E-02	5.6E-02
Mercury	3	1	1.3E-05	2.0E-05	2.0E-05	.	.	2.0E-05
Nickel	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Potassium	3	3	1.4E+00	1.5E+00	1.4E+00	3.3E-02	1.5E+00	1.4E+00
Sodium	3	3	3.2E+00	3.4E+00	3.3E+00	4.0E-02	3.4E+00	3.3E+00
Vanadium	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	3	3	3.6E-03	5.8E-03	4.8E-03	6.4E-04	6.7E-03	5.0E-03
MBM 0.2/Spring/Dissolved								
Aluminum	3	3	1.1E-02	1.5E-02	1.3E-02	1.2E-03	1.7E-02	1.3E-02
Ammonium nitrogen	3	2	5.0E-02	1.9E-01	1.2E-01	4.3E-02	2.4E-01	7.8E-02
Antimony	3	2	1.0E-03	1.2E-02	6.5E-03	2.9E-03	1.5E-02	4.0E-03
Arsenic	3	1	1.0E-03	3.0E-03	2.2E-03	.	.	2.2E-03
Barium	3	3	2.2E-02	2.4E-02	2.3E-02	5.6E-04	2.4E-02	2.3E-02

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Boron	3	2	1.8E-02	1.1E-01	6.6E-02	2.4E-02	1.4E-01	4.6E-02
Calcium	3	3	2.6E+01	2.9E+01	2.8E+01	7.7E-01	3.0E+01	2.8E+01
Chloride	3	3	2.8E+00	3.0E+00	2.9E+00	5.8E-02	3.1E+00	2.9E+00
Chromium	3	1	1.0E-03	2.2E-03	2.2E-03	.	.	2.2E-03
Copper	3	3	1.5E-03	2.9E-03	2.3E-03	4.3E-04	3.6E-03	2.6E-03
Fluoride	3	1	9.0E-02	1.5E-01	9.0E-02	.	.	9.0E-02
Iron	3	2	1.3E-02	4.9E-02	4.7E-02	1.0E-03	5.0E-02	4.6E-02
Lead	3	1	1.0E-03	1.7E-03	1.7E-03	.	.	1.7E-03
Magnesium	3	3	8.1E+00	9.0E+00	8.5E+00	3.0E-01	9.3E+00	8.3E+00
Manganese	3	2	1.0E-03	7.7E-03	3.6E-03	2.3E-03	1.0E-02	1.6E-03
Nickel	3	3	1.3E-03	1.1E-02	5.2E-03	2.9E-03	1.4E-02	3.5E-03
Nitrate/nitrite	3	3	5.3E-01	7.5E-01	6.2E-01	6.7E-02	8.1E-01	5.8E-01
Potassium	3	3	1.2E+00	1.4E+00	1.3E+00	7.2E-02	1.6E+00	1.4E+00
Sodium	3	3	3.5E+00	3.9E+00	3.7E+00	1.4E-01	4.1E+00	3.6E+00
Sulfate	3	3	1.7E+01	1.8E+01	1.8E+01	3.3E-01	1.9E+01	1.8E+01
Zinc	3	3	4.9E-03	6.5E-03	5.8E-03	4.7E-04	7.2E-03	6.0E-03
MBM 0.2/Spring/Total								
Aluminum	3	3	4.5E-02	2.5E-01	1.6E-01	6.1E-02	3.4E-01	2.0E-01
Arsenic	3	1	1.0E-03	3.0E-03	2.2E-03	.	.	2.2E-03
Barium	3	3	2.6E-02	2.8E-02	2.7E-02	6.5E-04	2.8E-02	2.6E-02
Boron	3	2	1.8E-02	5.3E-02	4.9E-02	2.2E-03	5.5E-02	4.7E-02
Calcium	3	3	2.9E+01	3.5E+01	3.2E+01	1.8E+00	3.7E+01	3.0E+01
Chromium	3	1	1.0E-03	1.6E-03	1.6E-03	.	.	1.6E-03

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Copper	3	3	1.7E-03	5.0E-03	2.9E-03	1.1E-03	6.0E-03	2.0E-03
Iron	3	3	9.7E-02	3.6E-01	2.5E-01	8.1E-02	4.9E-01	3.0E-01
Lead	3	1	1.0E-03	2.2E-03	2.2E-03	.	.	2.2E-03
Magnesium	3	3	8.1E+00	9.1E+00	8.5E+00	3.2E-01	9.4E+00	8.2E+00
Manganese	3	3	4.9E-02	9.0E-02	6.5E-02	1.3E-02	1.0E-01	5.5E-02
Mercury	3	1	2.0E-06	5.8E-06	2.0E-06	.	.	2.0E-06
Nickel	3	3	1.2E-03	3.9E-03	2.5E-03	7.8E-04	4.8E-03	2.5E-03
Potassium	3	3	1.4E+00	1.5E+00	1.4E+00	2.2E-02	1.5E+00	1.4E+00
Sodium	3	3	3.7E+00	5.6E+00	4.4E+00	6.1E-01	6.1E+00	3.8E+00
Vanadium	3	1	1.0E-03	1.1E-03	1.1E-03	.	.	1.1E-03
Zinc	3	3	3.0E-03	1.7E-02	8.6E-03	4.5E-03	2.2E-02	5.4E-03
MBM 0.2/Summer/Dissolved								
Aluminum	3	2	6.0E-03	1.6E-02	1.3E-02	1.2E-03	1.7E-02	1.2E-02
Ammonium nitrogen	3	1	5.0E-02	8.1E-02	8.1E-02	.	.	8.1E-02
Antimony	3	2	1.0E-03	7.0E-03	4.9E-03	1.2E-03	8.3E-03	3.9E-03
Barium	3	2	1.0E-03	2.8E-02	2.6E-02	8.9E-04	2.9E-02	2.5E-02
Boron	3	1	1.1E-02	3.7E-02	3.7E-02	.	.	3.7E-02
Calcium	3	2	2.7E-02	2.8E+01	2.7E+01	5.8E-01	2.9E+01	2.7E+01
Chloride	3	3	2.5E+00	2.9E+00	2.7E+00	1.3E-01	3.0E+00	2.6E+00
Chromium	3	2	1.0E-03	8.1E-03	4.0E-03	2.3E-03	1.1E-02	2.0E-03
Copper	3	2	1.0E-03	6.8E-03	5.9E-03	5.2E-04	7.4E-03	5.4E-03
Fluoride	3	3	6.7E-02	9.0E-02	7.9E-02	6.7E-03	9.8E-02	8.0E-02
Iron	3	1	1.8E-02	2.7E+00	2.7E+00	.	.	2.7E+00

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Magnesium	3	2	9.0E-03	8.0E+00	6.8E+00	6.8E-01	8.8E+00	6.2E+00
Manganese	3	2	1.0E-03	5.7E-02	4.1E-02	9.1E-03	6.7E-02	3.3E-02
Nickel	3	2	1.0E-03	1.3E-02	5.6E-03	4.0E-03	1.7E-02	2.1E-03
Nitrate/nitrite	3	3	4.2E-01	5.7E-01	4.9E-01	4.3E-02	6.2E-01	4.9E-01
Potassium	3	2	1.3E-02	1.3E+00	1.3E+00	2.1E-02	1.3E+00	1.2E+00
Selenium	3	1	1.0E-03	7.5E-03	7.5E-03	.	.	7.5E-03
Sodium	3	3	2.4E-02	3.1E+00	2.1E+00	1.0E+00	5.1E+00	3.1E+00
Sulfate	3	3	1.6E+01	1.7E+01	1.7E+01	3.3E-01	1.8E+01	1.7E+01
Vanadium	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	3	2	2.0E-03	1.1E-02	6.4E-03	2.6E-03	1.4E-02	4.2E-03
MBM 0.2/Summer/Total								
Aluminum	3	2	6.0E-03	2.2E-01	1.3E-01	4.7E-02	2.7E-01	9.3E-02
Antimony	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Barium	3	3	2.4E-02	3.0E-02	2.6E-02	1.7E-03	3.2E-02	2.6E-02
Boron	3	1	1.1E-02	2.9E-02	2.9E-02	.	.	2.9E-02
Calcium	3	3	2.6E+01	2.8E+01	2.7E+01	5.6E-01	2.9E+01	2.8E+01
Chromium	3	2	1.0E-03	2.1E-03	1.7E-03	2.3E-04	2.4E-03	1.5E-03
Copper	3	3	2.2E-03	3.3E-03	2.6E-03	3.5E-04	3.6E-03	2.3E-03
Iron	3	2	1.8E-02	7.6E-01	3.4E-01	2.4E-01	1.0E+00	1.3E-01
Magnesium	3	3	6.4E+00	8.4E+00	7.6E+00	6.2E-01	9.4E+00	8.0E+00
Manganese	3	2	1.0E-03	2.2E-01	1.4E-01	4.2E-02	2.7E-01	1.1E-01
Nickel	3	1	1.0E-03	1.4E-03	1.4E-03	.	.	1.4E-03
Potassium	3	3	1.3E+00	1.5E+00	1.3E+00	5.8E-02	1.5E+00	1.3E+00

Table A13 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Sodium	3	3	3.1E+00	3.3E+00	3.2E+00	4.6E-02	3.3E+00	3.2E+00
Vanadium	3	1	1.0E-03	1.0E-03	1.0E-03	.	.	1.0E-03
Zinc	3	3	2.0E-03	8.7E-03	5.1E-03	1.9E-03	1.1E-02	4.7E-03

Table A14. Differences between seasons for unfiltered and filtered metals (mg/L) for the contaminant remobilization study

Analyte	Filtered or Whole	Season	Number of Obs.	Number of Det.	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Aluminum	FLTR	spring	12	10	0.0070	0.0286	0.0149	0.00	0.0175	0.0150
Aluminum	FLTR	summer	11	7	0.0060	0.0174	0.0111	0.00	0.0130	0.0094
Aluminum	WHOL	spring	12	12	0.0451	0.5760	0.2290	0.05	0.3121	0.2260
Aluminum	WHOL	summer	12	11	0.0060	0.2230	0.1203	0.02	0.1584	0.1137
Antimony	FLTR	spring	12	10	0.0010	0.0115	0.0052	0.00	0.0071	0.0045
Antimony	FLTR	summer	11	10	0.0010	0.0108	0.0058	0.00	0.0071	0.0054
Antimony	WHOL	spring	12	0	0.0010	0.0010				
Antimony	WHOL	summer	12	3	0.0010	0.0017	0.0013	0.00	0.0014	0.0012
Copper	FLTR	spring	12	12	0.0012	0.0036	0.0023	0.00	0.0027	0.0023
Copper	FLTR	summer	11	10	0.0010	0.0109	0.0043	0.00	0.0057	0.0034
Copper	WHOL	spring	12	12	0.0012	0.0060	0.0031	0.00	0.0041	0.0025
Copper	WHOL	summer	12	12	0.0014	0.0034	0.0024	0.00	0.0028	0.0024
Iron	FLTR	spring	12	9	0.0130	0.0707	0.0437	0.01	0.0542	0.0472
Iron	FLTR	summer	11	5	0.0180	2.6500	0.4128	0.25	0.8651	0.0397
Iron	WHOL	spring	12	12	0.0817	0.7770	0.3436	0.06	0.4557	0.3355
Iron	WHOL	summer	12	11	0.0180	0.7940	0.3375	0.09	0.4967	0.1732
Manganese	FLTR	spring	12	11	0.0010	0.0152	0.0056	0.00	0.0078	0.0043
Manganese	FLTR	summer	11	10	0.0010	0.0566	0.0138	0.01	0.0237	0.0037
Manganese	WHOL	spring	12	12	0.0252	0.0919	0.0642	0.01	0.0746	0.0639
Manganese	WHOL	summer	12	11	0.0010	0.2150	0.0869	0.01	0.1116	0.0794
Mercury	FLTR	spring	24	13	0.0000	0.0013	0.0001	0.00	0.0002	0.0000
Mercury	FLTR	summer	23	7	0.0000	0.0002	0.0000	0.00	0.0000	0.0000
Mercury	WHOL	spring	24	12	0.0000	0.0002	0.0000	0.00	0.0000	0.0000
Mercury	WHOL	summer	24	9	0.0000	0.0002	0.0000	0.00	0.0000	0.0000

Table A14 (continued)

Analyte	Filtered or Whole	Season	Number of Obs.	Number of Det.	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Methyl Mercury	FLTR	spring	12	12	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
Methyl Mercury	FLTR	summer	12	12	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
Methyl Mercury	WHOL	spring	12	12	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
Methyl Mercury	WHOL	summer	12	12	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
Nickel	FLTR	spring	12	12	0.0013	0.0136	0.0048	0.00	0.0070	0.0032
Nickel	FLTR	summer	11	5	0.0010	0.0125	0.0026	0.00	0.0045	0.0012
Nickel	WHOL	spring	12	12	0.0011	0.0040	0.0025	0.00	0.0030	0.0026
Nickel	WHOL	summer	12	4	0.0010	0.0019	0.0013	0.00	0.0014	0.0012
Zinc	FLTR	spring	12	12	0.0037	0.0072	0.0055	0.00	0.0061	0.0055
Zinc	FLTR	summer	11	10	0.0020	0.0114	0.0057	0.00	0.0076	0.0042
Zinc	WHOL	spring	12	12	0.0030	0.0223	0.0098	0.00	0.0133	0.0080
Zinc	WHOL	summer	12	12	0.0020	0.0087	0.0049	0.00	0.0061	0.0047
Hardness	WHOL	spring	12	12	75.3231	125.9622	102.3497	4.14	109.7788	104.7260
Hardness	WHOL	summer	12	12	90.1133	110.8912	101.2331	2.03	104.8712	104.1510

Table A15. Metals summary statistics (mg/L) by reach for the contaminant remobilization from sediments study

Analyte	Filtered or Whole	Sub reach	No. of Obs.	No. of Det.	Min.	Max.	Mean	S.E.	95% UCB	Median
Aluminum	FLTR	1	5	4	7.00E-03	1.64E-02	1.55E-02	0	1.61E-02	1.54E-02
Aluminum	FLTR	4.02	6	4	6.00E-03	1.74E-02	1.18E-02	0	1.48E-02	1.01E-02
Aluminum	FLTR	4.04	6	4	6.00E-03	2.86E-02	1.35E-02	0	2.05E-02	9.42E-03
Aluminum	FLTR	7.02	6	5	6.00E-03	1.55E-02	1.31E-02	0	1.47E-02	1.28E-02
Aluminum	WHOL	1	6	6	7.06E-02	3.31E-01	1.77E-01	0.04	2.58E-01	1.59E-01
Aluminum	WHOL	4.02	6	6	4.19E-02	4.09E-01	1.48E-01	0.06	2.67E-01	9.29E-02
Aluminum	WHOL	4.04	6	6	3.44E-02	5.76E-01	2.34E-01	0.08	3.92E-01	2.12E-01
Aluminum	WHOL	7.02	6	5	6.00E-03	2.50E-01	1.41E-01	0.04	2.18E-01	1.46E-01
Antimony	FLTR	1	5	4	1.00E-03	1.14E-02	6.93E-03	0	1.10E-02	6.60E-03
Antimony	FLTR	4.02	6	6	3.90E-03	9.50E-03	5.72E-03	0	7.59E-03	4.65E-03
Antimony	FLTR	4.04	6	6	1.10E-03	7.46E-03	4.58E-03	0	6.37E-03	5.15E-03
Antimony	FLTR	7.02	6	4	1.00E-03	1.15E-02	5.69E-03	0	8.37E-03	3.95E-03
Antimony	WHOL	1	6	0	1.00E-03	1.00E-03	.		.	.
Antimony	WHOL	4.02	6	2	1.00E-03	1.70E-03	1.62E-03	0	1.66E-03	1.60E-03
Antimony	WHOL	4.04	6	0	1.00E-03	1.00E-03	.		.	.
Antimony	WHOL	7.02	6	1	1.00E-03	1.20E-03	1.20E-03		.	1.20E-03
Copper	FLTR	1	5	5	1.90E-03	1.09E-02	4.24E-03	0	7.84E-03	3.00E-03
Copper	FLTR	4.02	6	6	1.20E-03	3.60E-03	2.44E-03	0	3.25E-03	2.21E-03
Copper	FLTR	4.04	6	6	1.80E-03	4.52E-03	3.05E-03	0	3.78E-03	3.05E-03
Copper	FLTR	7.02	6	5	1.00E-03	6.75E-03	3.44E-03	0	5.25E-03	2.75E-03
Copper	WHOL	1	6	6	1.50E-03	6.00E-03	2.84E-03	0	4.19E-03	2.55E-03
Copper	WHOL	4.02	6	6	1.20E-03	5.40E-03	2.38E-03	0	3.66E-03	1.90E-03
Copper	WHOL	4.04	6	6	1.40E-03	5.20E-03	3.17E-03	0	4.18E-03	3.15E-03
Copper	WHOL	7.02	6	6	1.70E-03	5.00E-03	2.75E-03	0	3.76E-03	2.25E-03
Iron	FLTR	1	5	4	1.80E-02	5.11E-01	1.31E-01	0.1	3.41E-01	5.05E-02

Table A15 (continued)

Analyte	Filtered or Whole	Sub reach	No. of Obs.	No. of Det.	Min.	Max.	Mean	S.E.	95% UCB	Median
Iron	FLTR	4.02	6	4	1.30E-02	5.34E-01	1.27E-01	0.09	3.00E-01	4.00E-02
Iron	FLTR	4.04	6	3	1.30E-02	5.68E-01	1.51E-01	0.09	3.38E-01	6.69E-02
Iron	FLTR	7.02	6	3	1.30E-02	2.65E+00	4.80E-01	0.49	1.46E+00	4.58E-02
Iron	WHOL	1	6	6	1.28E-01	7.36E-01	3.51E-01	0.1	5.48E-01	2.92E-01
Iron	WHOL	4.02	6	6	7.13E-02	6.66E-01	3.03E-01	0.11	5.31E-01	1.95E-01
Iron	WHOL	4.04	6	6	7.51E-02	7.94E-01	4.20E-01	0.13	6.73E-01	3.65E-01
Iron	WHOL	7.02	6	5	1.80E-02	7.59E-01	2.92E-01	0.11	5.06E-01	2.19E-01
Manganese	FLTR	1	5	5	7.70E-03	2.71E-02	1.37E-02	0	2.14E-02	8.88E-03
Manganese	FLTR	4.02	6	6	1.60E-03	5.80E-03	3.48E-03	0	4.80E-03	3.24E-03
Manganese	FLTR	4.04	6	6	1.80E-03	1.52E-02	4.66E-03	0	8.93E-03	2.50E-03
Manganese	FLTR	7.02	6	4	1.00E-03	5.66E-02	1.70E-02	0.01	3.68E-02	4.65E-03
Manganese	WHOL	1	6	6	6.39E-02	1.18E-01	8.85E-02	0.01	1.04E-01	8.64E-02
Manganese	WHOL	4.02	6	6	2.52E-02	8.00E-02	5.39E-02	0.01	6.95E-02	5.70E-02
Manganese	WHOL	4.04	6	6	4.18E-02	8.63E-02	6.74E-02	0.01	8.12E-02	6.76E-02
Manganese	WHOL	7.02	6	5	1.00E-03	2.15E-01	9.40E-02	0.03	1.47E-01	7.26E-02
Mercury	FLTR	1	6	4	1.44E-06	8.28E-06	2.85E-06	0	5.20E-06	1.56E-06
Mercury	FLTR	4.02	6	4	1.84E-06	4.34E-06	2.66E-06	0	3.75E-06	1.85E-06
Mercury	FLTR	4.04	6	5	1.54E-06	5.16E-06	3.23E-06	0	4.58E-06	3.06E-06
Mercury	FLTR	7.02	6	6	1.35E-06	5.83E-06	2.79E-06	0	4.27E-06	2.14E-06
Mercury	WHOL	1	6	4	1.91E-06	3.60E-06	2.77E-06	0	3.45E-06	2.88E-06
Mercury	WHOL	4.02	6	6	1.31E-05	6.61E-05	2.82E-05	0	4.44E-05	1.97E-05
Mercury	WHOL	4.04	6	6	1.67E-05	3.64E-05	2.75E-05	0	3.49E-05	2.79E-05
Mercury	WHOL	7.02	6	5	2.01E-06	7.09E-06	4.18E-06	0	5.88E-06	4.09E-06
Methyl Mercury	FLTR	1	6	6	1.80E-08	1.03E-07	5.78E-08	0	8.16E-08	5.50E-08
Methyl Mercury	FLTR	4.02	6	6	4.30E-08	9.60E-08	7.00E-08	0	8.82E-08	6.65E-08

Table A15 (continued)

Analyte	Filtered or Whole	Sub reach	No. of Obs.	No. of Det.	Min.	Max.	Mean	S.E.	95% UCB	Median
Methyl Mercury	FLTR	4.04	6	6	3.20E-08	1.30E-07	6.57E-08	0	9.40E-08	5.65E-08
Methyl Mercury	FLTR	7.02	6	6	3.00E-08	7.10E-08	4.95E-08	0	6.26E-08	4.65E-08
Methyl Mercury	WHOL	1	6	6	3.70E-08	1.43E-07	6.97E-08	0	1.01E-07	5.90E-08
Methyl Mercury	WHOL	4.02	6	6	5.60E-08	1.66E-07	1.00E-07	0	1.34E-07	9.40E-08
Methyl Mercury	WHOL	4.04	6	6	6.40E-08	1.40E-07	1.04E-07	0	1.29E-07	1.07E-07
Methyl Mercury	WHOL	7.02	6	6	3.20E-08	9.40E-08	5.66E-08	0	7.67E-08	5.28E-08
Nickel	FLTR	1	5	4	1.00E-03	9.33E-03	3.49E-03	0	6.78E-03	2.70E-03
Nickel	FLTR	4.02	6	4	1.00E-03	4.50E-03	2.77E-03	0	3.94E-03	2.15E-03
Nickel	FLTR	4.04	6	4	1.00E-03	1.36E-02	3.65E-03	0	7.92E-03	1.50E-03
Nickel	FLTR	7.02	6	5	1.00E-03	1.25E-02	5.25E-03	0	9.49E-03	2.80E-03
Nickel	WHOL	1	6	4	1.00E-03	3.20E-03	1.98E-03	0	2.58E-03	1.65E-03
Nickel	WHOL	4.02	6	4	1.00E-03	4.00E-03	1.87E-03	0	2.93E-03	1.15E-03
Nickel	WHOL	4.04	6	4	1.00E-03	3.20E-03	2.06E-03	0	2.70E-03	1.70E-03
Nickel	WHOL	7.02	6	4	1.00E-03	3.90E-03	1.89E-03	0	2.85E-03	1.28E-03
Zinc	FLTR	1	5	5	4.22E-03	7.20E-03	5.98E-03	0	7.30E-03	6.60E-03
Zinc	FLTR	4.02	6	6	2.91E-03	9.40E-03	5.10E-03	0	7.08E-03	4.65E-03
Zinc	FLTR	4.04	6	6	2.70E-03	1.14E-02	5.46E-03	0	8.04E-03	4.30E-03
Zinc	FLTR	7.02	6	5	2.00E-03	1.10E-02	6.12E-03	0	8.28E-03	5.45E-03
Zinc	WHOL	1	6	6	2.17E-03	2.23E-02	8.28E-03	0	1.45E-02	6.05E-03
Zinc	WHOL	4.02	6	6	3.30E-03	1.21E-02	5.78E-03	0	8.44E-03	4.95E-03
Zinc	WHOL	4.04	6	6	2.70E-03	2.02E-02	8.51E-03	0	1.35E-02	7.30E-03
Zinc	WHOL	7.02	6	6	2.00E-03	1.74E-02	6.86E-03	0	1.15E-02	5.03E-03

Table A16. All organic analytes detected (mg/L) for the contaminant remobilization from sediments study

Reach	River Mile		Season	Analyte	Process	Result
1	CRM	41.5	summer	Bis(2-ethylhexyl)phthalate	Filtered	2.70E-02
4.02	CRM	6	spring	Bis(2-ethylhexyl)phthalate	Filtered	1.00E-03
4.04	CRM	1	summer	Bis(2-ethylhexyl)phthalate	Filtered	3.00E-02
7.02	MBM	0.2	summer	Bis(2-ethylhexyl)phthalate	Total	6.00E-03
1	CRM	41.5	spring	Di-n-butylphthalate	Filtered	1.00E-03
4.02	CRM	6	summer	Di-n-butylphthalate	Filtered	1.00E-03
7.02	MBM	0.2	spring	Di-n-butylphthalate	Filtered	1.00E-03
1	CRM	41.5	spring	Di-n-butylphthalate	Total	1.00E-03
7.02	MBM	0.2	summer	Di-n-butylphthalate	Total	4.00E-03
7.02	MBM	0.2	spring	alpha-BHC	Filtered	1.80E-05
7.02	MBM	0.2	spring	alpha-BHC	Total	1.30E-05

Table A17. Radionuclide water data for the contaminant remobilization study by reach, sité, and season

Reach	Site	Season	Analyte	Process	Obs.	Detects	Max.	Min.	Mean	95% UCB	Median	Std. Error	Units
1	CRM 41.5	spring	Cesium-137	Cart. Filter	3	1	4.26E+00	-1.44E+00	0.00E+00	.	0.00E+00	.	PCI/L
1	CRM 41.5	summer	Cesium-137	Cart. Filter	3	2	-6.00E-01	-2.71E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	PCI/L
4.02	CRM 6.0	spring	Cesium-137	Cart. Filter	3	2	6.13E+00	-1.22E+00	1.00E-02	3.00E-02	8.00E-03	1.00E-02	PCI/L
4.02	CRM 6.0	summer	Cesium-137	Cart. Filter	3	2	-1.53E+00	-3.12E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	PCI/L
4.04	CRM 1.0	spring	Cesium-137	Cart. Filter	4	2	1.12E+01	-1.12E+00	3.80E-01	1.27E+00	3.78E-01	3.80E-01	PCI/L
4.04	CRM 1.0	summer	Cesium-137	Cart. Filter	4	0	9.14E+00	0.00E+00	.	.	.	.	PCI/L
7.02	MBM 0.2	spring	Cesium-137	Cart. Filter	3	1	1.29E+01	-2.94E+00	0.00E+00	.	0.00E+00	.	PCI/L
7.02	MBM 0.2	summer	Cesium-137	Cart. Filter	4	1	7.56E+00	-2.00E+00	0.00E+00	.	0.00E+00	.	PCI/L
1	CRM 41.5	spring	Cesium-137	Cart. Filter	3	0	2.40E-01	5.00E-02	.	.	.	.	PCI/L
1	CRM 41.5	summer	Cesium-137	Cart. Filter	3	0	1.30E-01	-4.00E-02	.	.	.	.	PCI/L
4.02	CRM 6.0	spring	Cesium-137	Cart. Filter	3	0	2.10E-01	-6.00E-02	.	.	.	.	PCI/L
4.02	CRM 6.0	summer	Cesium-137	Cart. Filter	3	0	2.00E-01	3.00E-02	.	.	.	.	PCI/L
4.04	CRM 1.0	spring	Cesium-137	Cart. Filter	5	0	2.70E-01	-1.30E-01	.	.	.	.	PCI/L
4.04	CRM 1.0	summer	Cesium-137	Cart. Filter	4	1	2.10E-01	-9.00E-02	2.10E-01	.	2.12E-01	.	PCI/L
7.02	MBM 0.2	spring	Cesium-137	Cart. Filter	3	0	1.00E-01	-4.80E-01	.	.	.	.	PCI/L
7.02	MBM 0.2	summer	Cesium-137	Cart. Filter	4	0	-2.00E-02	-2.90E-01	.	.	.	.	PCI/L
1	CRM 41.5	spring	Cobalt-60	Cart. Filter	3	0	4.94E+00	7.30E-01	.	.	.	.	PCI/L
1	CRM 41.5	summer	Cobalt-60	Cart. Filter	3	0	7.60E-01	-6.81E+00	.	.	.	.	PCI/L
4.02	CRM 6.0	spring	Cobalt-60	Cart. Filter	3	0	1.12E+00	1.60E-01	.	.	.	.	PCI/L
4.02	CRM 6.0	summer	Cobalt-60	Cart. Filter	3	0	5.15E+00	2.00E-01	.	.	.	.	PCI/L
4.04	CRM 1.0	spring	Cobalt-60	Cart. Filter	4	0	1.11E+00	-3.60E+00	.	.	.	.	PCI/L
4.04	CRM 1.0	summer	Cobalt-60	Cart. Filter	4	0	4.80E+00	-1.08E+00	.	.	.	.	PCI/L
7.02	MBM 0.2	spring	Cobalt-60	Cart. Filter	3	0	5.99E+00	-4.24E+00	.	.	.	.	PCI/L
7.02	MBM 0.2	summer	Cobalt-60	Cart. Filter	4	0	5.44E+00	-2.05E+00	.	.	.	.	PCI/L
1	CRM 41.5	spring	Cobalt-60	Cart. Filter	3	0	1.50E-01	-3.30E-01	.	.	.	.	PCI/L
1	CRM 41.5	summer	Cobalt-60	Cart. Filter	3	0	-4.00E-02	-1.10E-01	.	.	.	.	PCI/L
4.02	CRM 6.0	spring	Cobalt-60	Cart. Filter	3	0	1.20E-01	-7.00E-02	.	.	.	.	PCI/L

Table A17 (continued)

Reach	Site	Season	Analyte	Process	Obs.	Detects	Max.	Min.	Mean	95% UCB	Median	Std. Error	Units
4.02	CRM 6.0	summer	Cobalt-60	Cart. Filter	3	0	-1.30E-01	-3.90E-01	.	.	.	.	PCI/L
4.04	CRM 1.0	spring	Cobalt-60	Cart. Filter	5	0	4.60E-01	-3.20E-01	.	.	.	.	PCI/L
4.04	CRM 1.0	summer	Cobalt-60	Cart. Filter	4	0	2.40E-01	-2.10E-01	.	.	.	.	PCI/L
7.02	MBM 0.2	spring	Cobalt-60	Cart. Filter	3	0	2.00E-02	-2.20E-01	.	.	.	.	PCI/L
7.02	MBM 0.2	summer	Cobalt-60	Cart. Filter	4	0	1.10E-01	-5.70E-01	.	.	.	.	PCI/L
1	CRM 41.5	spring	Gross alpha activity		3	1	1.97E+00	4.20E-01	1.97E+00	.	1.97E+00	.	PCI/L
1	CRM 41.5	summer	Gross alpha activity		3	0	6.60E-01	-8.43E+00	.	.	.	.	PCI/L
4.02	CRM 6.0	spring	Gross alpha activity		3	2	1.21E+00	6.80E-01	9.70E-01	1.37E+00	8.50E-01	1.40E-01	PCI/L
4.02	CRM 6.0	summer	Gross alpha activity		3	1	1.76E+00	-1.08E+01	0.00E+00	.	0.00E+00	.	PCI/L
4.04	CRM 1.0	spring	Gross alpha activity		4	0	8.60E-01	1.70E-01	.	.	.	.	PCI/L
4.04	CRM 1.0	summer	Gross alpha activity		3	0	2.75E+00	-1.29E+01	.	.	.	.	PCI/L
7.02	MBM 0.2	spring	Gross alpha activity		3	1	1.08E+00	2.90E-01	1.08E+00	.	1.08E+00	.	PCI/L
7.02	MBM 0.2	summer	Gross alpha activity		4	0	4.20E-01	-8.22E+00	.	.	.	.	PCI/L
1	CRM 41.5	spring	Gross alpha activity		3	2	5.79E+00	2.08E+00	4.74E+00	6.51E+00	4.22E+00	6.00E-01	PCI/L
1	CRM 41.5	summer	Gross alpha activity		3	3	1.34E+01	4.82E+00	8.91E+00	1.62E+01	8.51E+00	2.48E+00	PCI/L
4.02	CRM 6.0	spring	Gross alpha activity		3	2	5.53E+00	1.84E+00	4.86E+00	5.99E+00	4.53E+00	3.80E-01	PCI/L
4.02	CRM 6.0	summer	Gross alpha activity		3	2	7.74E+00	3.80E-01	6.91E+00	8.31E+00	6.49E+00	4.80E-01	PCI/L
4.04	CRM 1.0	spring	Gross alpha activity		4	2	2.88E+00	1.61E+00	2.46E+00	2.86E+00	2.32E+00	1.70E-01	PCI/L
4.04	CRM 1.0	summer	Gross alpha activity		3	2	8.95E+00	9.90E-01	6.35E+00	1.07E+01	5.05E+00	1.50E+00	PCI/L
7.02	MBM 0.2	spring	Gross alpha activity		3	2	6.26E+00	-2.80E-01	3.57E+00	8.11E+00	2.22E+00	1.55E+00	PCI/L
7.02	MBM 0.2	summer	Gross alpha activity		4	4	8.14E+00	3.15E+00	6.07E+00	8.63E+00	6.50E+00	1.09E+00	PCI/L
1	CRM 41.5	spring	Particle associated Co-60	Cart. Filter	3	0	8.81E+00	-3.98E+01	.	.	.	.	PCI/G
1	CRM 41.5	summer	Particle associated Co-60	Cart. Filter	3	0	-3.75E+00	-2.98E+01	.	.	.	.	PCI/G
4.02	CRM 6.0	spring	Particle associated Co-60	Cart. Filter	3	0	1.27E+01	-1.92E+01	.	.	.	.	PCI/G
4.02	CRM 6.0	summer	Particle associated Co-60	Cart. Filter	3	0	-1.80E+01	-6.55E+01	.	.	.	.	PCI/G
4.04	CRM 1.0	spring	Particle associated Co-60	Cart. Filter	3	0	5.30E+01	9.42E+00	.	.	.	.	PCI/G
4.04	CRM 1.0	summer	Particle associated Co-60	Cart. Filter	3	0	3.29E+01	0.00E+00	.	.	.	.	PCI/G

Table A17 (continued)

Reach	Site	Season	Analyte	Process	Obs.	Detects	Max.	Min.	Mean	95% UCB	Median	Std. Error	Units
7.02	MBM 0.2	spring	Particle associated Co-60	Cart. Filter	3	0	4.03E+00	-2.52E+01	.	.	.	.	PCI/G
7.02	MBM 0.2	summer	Particle associated Co-60	Cart. Filter	3	0	3.24E+01	-2.61E+00	.	.	.	.	PCI/G
1	CRM 41.5	spring	Particle associated Cs-137	Cart. Filter	3	0	2.86E+01	3.06E+00	.	.	.	.	PCI/G
1	CRM 41.5	summer	Particle associated Cs-137	Cart. Filter	3	0	3.55E+01	-6.18E+00	.	.	.	.	PCI/G
4.02	CRM 6.0	spring	Particle associated Cs-137	Cart. Filter	3	0	5.59E+01	-6.27E+00	.	.	.	.	PCI/G
4.02	CRM 6.0	summer	Particle associated Cs-137	Cart. Filter	3	0	1.44E+01	4.78E+00	.	.	.	.	PCI/G
4.04	CRM 1.0	spring	Particle associated Cs-137	Cart. Filter	3	0	2.54E+01	4.43E+00	.	.	.	.	PCI/G
4.04	CRM 1.0	summer	Particle associated Cs-137	Cart. Filter	3	0	1.16E+01	-6.12E+00	.	.	.	.	PCI/G
7.02	MBM 0.2	spring	Particle associated Cs-137	Cart. Filter	3	0	1.70E+01	-5.76E+01	.	.	.	.	PCI/G
7.02	MBM 0.2	summer	Particle associated Cs-137	Cart. Filter	3	0	-6.59E+00	-3.98E+01	.	.	.	.	PCI/G
1	CRM 41.5	spring	Strontium-90		3	0	2.47E+00	4.90E-01	.	.	.	.	PCI/L
1	CRM 41.5	summer	Strontium-90		3	0	7.90E-01	0.00E+00	.	.	.	.	PCI/L
4.02	CRM 6.0	spring	Strontium-90		3	0	1.99E+00	0.00E+00	.	.	.	.	PCI/L
4.02	CRM 6.0	summer	Strontium-90		3	1	8.16E+00	-1.40E-01	8.16E+00	.	8.16E+00	.	PCI/L
4.04	CRM 1.0	spring	Strontium-90		4	1	1.22E+01	0.00E+00	1.22E+01	.	1.22E+01	.	PCI/L
4.04	CRM 1.0	summer	Strontium-90		3	0	1.30E-01	0.00E+00	.	.	.	.	PCI/L
7.02	MBM 0.2	spring	Strontium-90		3	0	1.80E+00	0.00E+00	.	.	.	.	PCI/L
7.02	MBM 0.2	summer	Strontium-90		3	1	1.07E+00	4.70E-01	1.07E+00	.	1.07E+00	.	PCI/L
1	CRM 41.5	spring	Tritium		3	0	4.87E+01	0.00E+00	.	.	.	.	PCI/L
1	CRM 41.5	summer	Tritium		3	0	7.24E+01	-1.48E+02	.	.	.	.	PCI/L
4.02	CRM 6.0	spring	Tritium		3	3	9.52E+02	2.93E+02	7.17E+02	1.34E+03	9.06E+02	2.12E+02	PCI/L
4.02	CRM 6.0	summer	Tritium		3	1	3.44E+02	-1.03E+02	3.44E+02	.	3.44E+02	.	PCI/L
4.04	CRM 1.0	spring	Tritium		4	3	3.46E+02	1.57E+02	2.53E+02	3.34E+02	2.28E+02	3.45E+01	PCI/L
4.04	CRM 1.0	summer	Tritium		3	3	2.43E+02	-1.53E+02	8.11E+01	3.18E+02	0.00E+00	8.11E+01	PCI/L
7.02	MBM 0.2	spring	Tritium		3	0	3.52E+01	0.00E+00	.	.	.	.	PCI/L
7.02	MBM 0.2	summer	Tritium		4	0	2.88E+01	-1.91E+02	.	.	.	.	PCI/L

Table A18. TVA Source Area Sampling metals and radionuclide results. To be provided for final draft.

Table A19. Summary statistics for inorganic results (mg/L) in Poplar Creek by reach

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach 3.01 /Dissolved								
Aluminum	13	13	1.00e-02	1.80e-01	3.60e-02	1.30e-02	5.80e-02	2.40e-02
Antimony	13	8	1.00e-03	7.30e-03	4.10e-03	6.10e-04	5.20e-03	2.50e-03
Arsenic	13	2	1.00e-03	3.00e-03	1.10e-03	2.70e-05	1.20e-03	1.10e-03
Barium	13	13	2.20e-02	4.80e-02	3.30e-02	3.70e-02	3.90e-02	3.40e-02
Boron	13	12	3.20e-03	1.60e-01	5.30e-02	1.30e-02	7.50e-02	4.00e-02
Calcium	13	13	1.20e+01	3.90e+01	2.60e+01	2.30e+00	3.00e+01	2.70e+01
Chromium	13	8	1.00e-03	3.80e-03	1.70e-03	2.00e-04	2.10e-03	1.30e-03
Copper	13	13	1.00e-03	6.20e-03	3.00e-03	4.30e-04	3.80e-03	2.90e-03
Iron	13	12	1.80e-02	3.80e-01	9.10e-02	2.80e-02	1.40e-01	4.90e-02
Lead	13	2	1.00e-03	1.50e-03	1.40e-03	1.30e-05	1.40e-03	1.40e-03
Magnesium	13	13	3.70e+00	9.60e+00	7.00e+00	5.20e-01	7.90e+00	7.30e+00
Manganese	13	13	1.60e-02	1.00e-01	5.20e-02	6.70e-03	6.40e-02	4.90e-02
Mercury (BR)	13	2	2.20e-07	1.40e-05	5.00e-06	9.90e-07	6.80e-06	4.30e-06
Molybdenum	13	1	1.00e-03	5.00e-03	1.20e-03	.	.	1.20e-03
Nickel	13	13	1.90e-03	9.10e-03	4.20e-03	5.50e-04	5.20e-03	3.80e-03
Potassium	13	13	9.90e-01	3.20e+00	1.80e+00	2.00e-01	2.20e+00	1.70e+00
Selenium	13	2	1.00e-03	4.70e-03	4.60e-03	1.00e-05	4.60e-03	4.60e-03
Sodium	13	13	1.80e+00	6.70e+00	4.00e+00	4.80e-01	4.90e+00	4.10e+00
Sulfate	13	13	1.80e+01	4.50e+01	2.60e+01	2.10e+00	3.00e+01	2.50e+01
Uranium	13	8	1.00e-03	2.50e-03	1.60e-03	1.20e-04	1.80e-03	1.40e-03
Zinc	13	13	3.90e-03	1.20e-02	7.30e-03	7.90e-04	8.70e-03	6.30e-03
Reach 3.01/Total								
Aluminum	13	13	1.20e-01	7.00e-01	4.00e-01	4.80e-02	4.90e-01	4.30e-01
Antimony	13	1	1.00e-03	1.40e-03	1.40e-03	.	.	1.40e-03
Barium	13	13	3.00e-02	5.10e-02	3.80e-02	1.80e-03	4.20e-02	3.90e-02
Boron	13	12	4.60e-03	1.40e-01	5.10e-02	1.20e-02	7.20e-02	3.70e-02
Calcium	13	12	2.70e-02	3.90e+01	2.50e+01	2.50e+00	2.90e+01	2.70e+01
Chromium	13	12	1.00e-03	3.10e-03	2.10e-03	1.60e-04	2.40e-03	2.20e-03
Cobalt	13	4	1.00e-03	1.60e-03	1.10e-03	5.20e-05	1.20e-03	1.00e-03
Copper	13	13	1.50e-03	1.10e-02	4.60e-03	7.20e-04	5.90e-03	5.30e-03
Iron	13	13	2.70e-01	1.20e+00	6.60e-01	7.70e-02	8.00e-01	6.80e-01

Table A19 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Lead	13	8	1.00e-03	3.00e-03	1.50e-03	1.60e-04	1.80e-03	1.30e-03
Magnesium	13	12	9.00e-03	9.90e+00	6.70e+00	5.70e-01	7.70e+00	6.80e+00
Manganese	13	13	4.90e-02	1.30e-01	8.60e-02	7.90e-03	1.00e-01	7.70e-02
Mercury	13	1	2.00e-04	2.50e-04	2.50e-04			2.50e-04
Mercury (BR)	13	13	4.30e-07	1.40e-04	4.90e-05	1.10e-05	6.90e-05	3.00e-05
Methyl mercury (BR)	12	1	8.40e-08	4.30e-07	4.30e-07	.	.	4.30e-07
Molybdenum	13	2	1.00e-03	5.00e-03	1.10e-03	1.30e-05	1.10e-03	1.10e-03
Nickel	13	13	2.40e-03	5.60e-03	3.90e-03	3.10e-04	4.50e-03	3.80e-03
Potassium	13	12	1.30e-02	3.10e+00	1.80e+00	2.00e-01	2.20e+00	1.40e+00
Sodium	13	12	2.00e-02	7.20e+00	4.60e+00	4.30e-01	5.40e+00	4.80e+00
Uranium	13	9	1.00e-03	2.50e-03	1.80e-03	1.20e-04	2.00e-03	1.70e-03
Vanadium	13	7	1.00e-03	1.60e-03	1.20e-03	6.60e-05	1.30e-03	1.00e-03
Zinc	13	13	6.20e-03	4.70e-02	1.70e-02	2.90e-03	2.20e-02	1.60e-02
Reach 3.02/ Dissolved								
Aluminum	13	12	7.00e-03	4.90e-02	2.00e-02	3.10e-03	2.50e-02	1.70e-02
Antimony	13	10	1.00e-03	1.00e-02	6.30e-03	4.20e-04	7.00e-03	5.40e-03
Arsenic	13	2	1.00e-03	3.00e-03	1.30e-03	1.00e-05	1.40e-03	1.30e-03
Barium	13	13	2.10e-02	4.20e-02	3.40e-02	1.70e-03	3.70e-02	3.30e-02
Boron	13	12	8.60e-03	1.00e-01	5.00e-02	8.10e-03	6.40e-02	5.20e-02
Calcium	13	13	1.40e+01	3.90e+01	2.90e+01	2.10e+00	3.30e+01	2.80e+01
Chromium	13	9	1.00e-03	2.70e-03	1.40e-03	1.60e-04	1.60e-03	1.10e-03
Copper	13	13	1.20e-03	5.90e-03	3.20e-03	3.80e-04	3.90e-03	3.50e-03
Iron	13	11	1.30e-02	2.50e-01	8.00e-02	2.20e-02	1.20e-01	5.10e-02
Lead	13	1	1.00e-03	2.20e-03	2.20e-03	.	.	2.20e-03
Magnesium	13	13	4.30e+00	1.00e+01	7.70e+00	5.00e-01	8.60e+00	7.70e+00
Manganese	13	13	9.30e-03	9.60e-02	4.80e-02	6.90e-03	6.10e-02	4.80e-02
Mercury	13	1	2.00e-04	2.30e-04	2.30e-04			2.30e-04
Mercury (BR)	13	4	2.80e-06	8.40e-06	5.10e-06	4.30e-07	5.90e-06	4.50e-06
Molybdenum	13	2	1.00e-03	5.00e-03	1.10e-03	4.90e-05	1.20e-03	1.10e-03
Nickel	13	13	2.20e-03	8.50e-03	4.10e-03	4.50e-04	4.90e-03	4.00e-03
Potassium	13	13	9.70e-01	2.60e+00	1.80e+00	1.50e-01	2.00e+00	1.60e+00

Table A19 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Selenium	13	2	1.00e-03	4.70e-03	3.70e-03	1.10e-04	3.90e-03	3.60e-03
Sodium	13	13	2.00e+00	8.70e+00	4.80e+00	5.90e-01	5.90e+00	4.20e+00
Sulfate	13	13	1.70e+01	3.90e+01	2.70e+01	1.40e+00	3.00e+01	2.70e+01
Uranium	13	12	1.00e-03	3.50e-03	2.20e-03	1.90e-04	2.50e-03	2.30e-03
Zinc	13	13	3.00e-03	1.60e-02	7.40e-03	1.00e-03	9.30e-03	7.30e-03
Reach 3.02/Total								
Aluminum	13	13	1.20e-01	1.10e+00	3.40e-01	7.60e-02	4.80e-01	2.50e-01
Antimony	13	1	1.00e-03	1.20e-03	1.20e-03	.	.	1.20e-03
Arsenic	13	1	1.00e-03	3.00e-03	1.40e-03	.	.	1.40e-03
Barium	13	13	2.80e-02	4.60e-02	3.80e-02	1.50e-03	4.00e-02	3.80e-02
Boron	13	12	1.10e-02	1.20e-01	5.00e-02	9.90e-03	6.80e-02	4.70e-02
Calcium	13	13	1.60e+01	3.80e+01	2.90e+01	1.90e+00	3.30e+01	2.80e+01
Chromium	13	11	1.00e-03	2.90e-03	1.60e-03	1.40e-04	1.90e-03	1.40e-03
Copper	13	13	1.10e-03	5.20e-03	2.80e-03	3.50e-04	3.40e-03	2.40e-03
Iron	13	13	2.20e-01	1.10e+00	5.10e-01	7.10e-02	6.40e-01	4.50e-01
Lead	13	4	1.00e-03	1.80e-03	1.20e-03	9.50e-05	1.30e-03	1.00e-03
Magnesium	13	13	4.40e+00	1.00e+01	7.80e+00	5.00e-01	8.70e+00	8.10e+00
Manganese	13	13	4.60e-02	1.20e-01	7.60e-02	6.80e-03	8.90e-02	6.50e-02
Mercury	13	1	2.00e-04	3.80e-04	3.80e-04			3.80e-04
Mercury (BR)	13	12	4.10e-06	1.40e-04	7.80e-05	1.10e-05	9.80e-05	1.00e-04
Methyl mercury (BR)	12	4	9.40e-08	4.10e-07	3.00e-07	1.40e-08	3.20e-07	2.80e-07
Molybdenum	13	2	1.00e-03	5.00e-03	1.00e-03	4.90e-05	1.10e-03	1.00e-03
Nickel	13	13	1.50e-03	5.40e-03	3.50e-03	3.60e-04	4.20e-03	4.20e-03
Potassium	13	13	1.00e+00	2.50e+00	1.80e+00	1.50e-01	2.10e+00	1.80e+00
Sodium	13	13	2.50e+00	8.70e+00	5.30e+00	5.80e-01	6.30e+00	4.90e+00
Uranium	13	13	1.10e-03	3.60e-03	2.40e-03	1.90e-04	2.70e-03	2.50e-03
Vanadium	13	3	1.00e-03	1.70e-03	1.20e-03	5.90e-05	1.30e-03	1.10e-03
Zinc	13	13	4.80e-03	2.30e-02	1.00e-02	1.40e-03	1.20e-02	8.40e-03
Reach 3.03/ Dissolved								
Aluminum	13	11	7.00e-03	3.60e-02	1.80e-02	2.00e-03	2.10e-02	1.60e-02

Table A19 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Antimony	13	12	1.00e-03	1.10e-02	5.60e-03	6.20e-04	6.70e-03	4.70e-03
Arsenic	13	3	1.00e-03	3.00e-03	1.20e-03	7.00e-05	1.30e-03	1.10e-03
Barium	13	13	2.20e-02	3.80e-02	3.00e-02	1.40e-03	3.20e-02	3.00e-02
Boron	13	10	3.00e-03	8.10e-02	4.10e-02	6.70e-03	5.30e-02	4.30e-02
Calcium	13	13	1.30e+01	3.50e+01	2.50e+01	1.90e+00	2.90e+01	2.60e+01
Chromium	13	10	1.00e-03	2.50e-03	1.50e-03	1.30e-04	1.70e-03	1.30e-03
Copper	13	11	1.00e-03	6.50e-03	3.20e-03	3.70e-04	3.90e-03	2.80e-03
Iron	13	8	1.30e-02	2.90e-01	9.10e-02	2.70e-02	1.40e-01	2.60e-02
Lead	13	1	1.00e-03	1.20e-03	1.20e-03	.	.	1.20e-03
Magnesium	13	13	4.30e+00	9.10e+00	6.70e+00	4.10e-01	7.40e+00	6.90e+00
Manganese	13	13	5.10e-03	7.50e-02	4.40e-02	5.40e-03	5.40e-02	4.60e-02
Mercury	13	1	2.00e-04	7.30e-04	7.30e-04			7.30e-04
Mercury (BR)	13	2	4.10e-06	9.00e-06	6.50e-06	2.80e-07	7.00e-06	6.30e-06
Methyl mercury (BR)	13	1	5.80e-08	2.40e-07	7.10e-08	.	.	7.10e-08
Nickel	13	13	1.40e-03	1.10e-02	4.40e-03	8.40e-04	5.90e-03	3.30e-03
Potassium	13	13	1.20e+00	2.90e+00	1.80e+00	1.60e-01	2.00e+00	1.40e+00
Sodium	13	13	1.50e+00	6.90e+00	4.30e+00	4.30e-01	5.00e+00	4.30e+00
Sulfate	13	13	1.70e+01	2.90e+01	2.50e+01	1.10e+00	2.70e+01	2.70e+01
Uranium	13	10	1.00e-03	3.20e-03	2.00e-03	1.50e-04	2.30e-03	2.00e-03
Zinc	13	12	2.30e-03	1.90e-02	6.20e-03	1.30e-03	8.50e-03	4.80e-03
Reach 3.03/Total								
Aluminum	13	13	1.50e-01	8.30e-01	3.80e-01	5.60e-02	4.80e-01	3.90e-01
Arsenic	13	3	1.00e-03	3.00e-03	1.30e-03	1.00e-04	1.50e-03	1.20e-03
Barium	13	13	2.80e-02	4.40e-02	3.60e-02	1.30e-03	3.80e-02	3.50e-02
Boron	13	10	3.00e-03	9.90e-02	3.40e-02	7.30e-03	4.70e-02	3.00e-02
Calcium	13	13	1.40e+01	3.60e+01	2.60e+01	2.00e+00	3.00e+01	2.60e+01
Chromium	13	11	1.00e-03	2.90e-03	2.00e-03	1.60e-04	2.30e-03	1.90e-03
Cobalt	13	1	1.00e-03	1.30e-03	1.30e-03	.	.	1.30e-03
Copper	13	12	1.60e-03	8.80e-03	4.20e-03	6.80e-04	5.40e-03	3.30e-03
Iron	13	13	2.30e-01	1.40e+00	6.00e-01	8.90e-02	7.60e-01	5.60e-01
Lead	13	9	1.00e-03	3.00e-03	1.70e-03	1.80e-04	2.00e-03	1.60e-03
Magnesium	13	13	4.20e+00	9.20e+00	6.70e+00	4.30e-01	7.50e+00	7.10e+00

Table A19 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Manganese	13	13	5.60e-02	1.20e-01	8.00e-02	5.40e-03	9.00e-02	8.10e-02
Mercury	13	3	2.00e-04	4.60e-04	2.20e-04	2.30e-05	2.60e-04	2.00e-04
Mercury (BR)	13	13	3.80e-05	2.00e-04	1.10e-04	1.60e-05	1.40e-04	1.20e-04
Methyl mercury (BR)	13	4	9.90e-08	4.60e-07	2.40e-07	2.10e-08	2.70e-07	2.20e-07
Nickel	13	13	2.00e-03	6.40e-03	3.60e-03	3.70e-04	4.20e-03	3.40e-03
Potassium	13	13	1.20e+00	3.00e+00	1.80e+00	1.60e-01	2.10e+00	1.60e+00
Sodium	13	13	3.30e+00	7.10e+00	5.30e+00	3.60e-01	5.90e+00	5.80e+00
Uranium	13	11	1.00e-03	8.50e-03	2.70e-03	5.00e-04	3.60e-03	2.10e-03
Vanadium	13	4	1.00e-03	1.70e-03	1.20e-03	6.90e-05	1.30e-03	1.10e-03
Zinc	13	12	4.90e-03	3.30e-02	1.30e-02	2.50e-03	1.80e-02	1.10e-02
Reach 3.04/ Dissolved								
Aluminum	12	11	9.50e-03	3.30e-02	1.80e-02	2.20e-03	2.10e-02	1.60e-02
Antimony	12	11	1.00e-03	1.30e-02	5.50e-03	7.60e-04	6.80e-03	5.10e-03
Arsenic	12	2	1.00e-03	3.00e-03	1.40e-03	2.50e-05	1.50e-03	1.40e-03
Barium	12	12	2.00e-02	3.80e-02	3.00e-02	1.50e-03	3.30e-02	3.00e-02
Boron	12	11	3.50e-03	1.10e-01	4.00e-02	8.20e-03	5.40e-02	3.70e-02
Calcium	12	11	2.70e-02	3.40e+01	2.50e+01	1.80e+00	2.80e+01	2.50e+01
Chromium	12	8	1.00e-03	4.60e-03	1.80e-03	2.80e-04	2.30e-03	1.60e-03
Copper	12	11	1.50e-03	5.50e-03	3.30e-03	3.70e-04	4.00e-03	3.00e-03
Iron	12	9	1.80e-02	3.20e-01	8.50e-02	2.90e-02	1.40e-01	3.20e-02
Lead	12	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Magnesium	12	11	9.00e-03	9.20e+00	6.90e+00	5.40e-01	7.80e+00	7.40e+00
Manganese	12	12	3.90e-03	8.30e-02	4.90e-02	8.00e-03	6.30e-02	5.60e-02
Mercury	12	1	2.00e-04	2.30e-04	2.30e-04			2.30e-04
Mercury (BR)	12	2	2.90e-06	3.00e-05	5.70e-06	3.00e-06	1.10e-05	3.50e-06
Nickel	12	12	1.40e-03	1.00e-02	3.90e-03	6.70e-04	5.10e-03	3.50e-03
Potassium	12	11	1.30e-02	2.70e+00	1.70e+00	1.60e-01	2.00e+00	1.40e+00
Selenium	12	1	1.00e-03	3.30e-03	3.30e-03	.	.	3.30e-03
Sodium	12	11	2.00e-02	7.50e+00	4.00e+00	4.90e-01	4.90e+00	3.90e+00
Sulfate	12	12	1.60e+01	2.80e+01	2.50e+01	1.20e+00	2.70e+01	2.60e+01
Uranium	12	10	1.00e-03	3.00e-03	1.90e-03	1.80e-04	2.20e-03	2.00e-03

Table A19 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Zinc	12	11	3.90e-03	1.70e-02	6.70e-03	1.10e-03	8.60e-03	5.10e-03
Reach 3.04/Total								
Aluminum	12	12	2.50e-01	1.50e+00	4.60e-01	9.70e-02	6.40e-01	3.50e-01
Antimony	12	2	1.00e-03	1.80e-03	1.70e-03	1.10e-05	1.70e-03	1.70e-03
Arsenic	12	3	1.00e-03	3.00e-03	1.10e-03	8.50e-05	1.20e-03	1.00e-03
Barium	12	12	3.00e-02	4.10e-02	3.60e-02	9.40e-04	3.80e-02	3.60e-02
Boron	12	10	3.00e-03	1.20e-01	4.10e-02	9.80e-03	5.90e-02	3.50e-02
Calcium	12	11	2.70e-02	3.40e+01	2.60e+01	1.70e+00	2.90e+01	2.50e+01
Chromium	12	10	1.00e-03	3.10e-03	2.10e-03	2.30e-04	2.50e-03	2.20e-03
Cobalt	12	2	1.00e-03	1.50e-03	1.10e-03	4.50e-05	1.20e-03	1.10e-03
Copper	12	11	1.70e-03	1.00e-02	4.10e-03	7.20e-04	5.40e-03	4.20e-03
Iron	12	12	4.10e-01	1.90e+00	6.90e-01	1.20e-01	8.90e-01	5.50e-01
Lead	12	7	1.00e-03	4.30e-03	1.60e-03	2.70e-04	2.10e-03	1.30e-03
Magnesium	12	11	9.00e-03	9.60e+00	6.90e+00	5.10e-01	7.80e+00	7.40e+00
Manganese	12	12	7.20e-02	1.10e-01	8.70e-02	4.00e-03	9.40e-02	8.10e-02
Mercury	12	4	2.00e-04	9.00e-04	2.70e-04	6.30e-05	3.90e-04	2.10e-04
Mercury (BR)	12	12	3.00e-05	5.50e-04	1.40e-04	3.90e-05	2.10e-04	1.10e-04
Methyl mercury (BR)	11	2	7.60e-08	7.00e-07	3.30e-07	5.00e-08	4.20e-07	2.90e-07
Molybdenum	12	1	1.00e-03	5.00e-03	2.10e-03	.	.	2.10e-03
Nickel	12	12	2.00e-03	6.50e-03	3.90e-03	3.90e-04	4.60e-03	3.60e-03
Potassium	12	11	1.30e-02	2.70e+00	1.70e+00	1.70e-01	2.00e+00	1.50e+00
Sodium	12	11	2.00e-02	9.20e+00	4.90e+00	5.40e-01	5.90e+00	4.80e+00
Uranium	12	11	1.00e-03	3.20e-03	2.10e-03	1.80e-04	2.40e-03	2.10e-03
Vanadium	12	5	1.00e-03	3.20e-03	1.30e-03	2.00e-04	1.70e-03	1.10e-03
Zinc	12	11	5.50e-03	3.50e-02	1.50e-02	2.90e-03	2.00e-02	1.20e-02
Reach 13/ Dissolved								
Aluminum	46	36	7.00e-03	4.20e-01	2.50e-02	8.90e-03	4.00e-02	1.60e-02
Ammonium nitrogen	47	16	5.00e-02	1.50e-01	5.80e-02	3.00e-03	6.30e-02	5.10e-02
Antimony	46	42	1.00e-03	1.20e-02	5.00e-03	4.10e-04	5.70e-03	4.60e-03
Arsenic	46	6	1.00e-03	3.00e-03	1.10e-03	3.10e-05	1.10e-03	1.00e-03

Table A19 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Barium	46	46	2.10e-02	5.20e-02	3.70e-02	1.30e-03	4.00e-02	3.60e-02
Boron	46	38	3.00e-03	9.10e-02	4.20e-02	3.20e-03	4.70e-02	3.60e-02
Cadmium	46	1	1.00e-03	2.40e-03	2.40e-03	.	.	2.40e-03
Calcium	46	46	1.00e+01	3.80e+01	2.50e+01	1.10e+00	2.70e+01	2.30e+01
Chromium	46	34	1.00e-03	3.00e-03	1.60e-03	9.30e-05	1.70e-03	1.40e-03
Copper	46	46	1.00e-03	2.00e-02	3.50e-03	4.70e-04	4.20e-03	2.80e-03
Iron	46	41	1.20e-02	1.20e+00	1.00e-01	2.70e-02	1.40e-01	4.90e-02
Lead	46	3	1.00e-03	1.40e-03	1.10e-03	6.60e-06	1.10e-03	1.10e-03
Magnesium	46	46	3.50e+00	1.30e+01	8.00e+00	3.10e-01	8.50e+00	7.90e+00
Manganese	46	46	1.70e-02	1.80e-01	7.00e-02	5.70e-03	8.00e-02	6.00e-02
Mercury	46	2	2.00e-04	6.60e-04	3.10e-04	1.10e-05	3.30e-04	3.00e-04
Mercury (BR)	46	1	7.5e--08	5.50e-06	5.50e-06			5.50e-06
Nickel	46	46	1.50e-03	1.60e-02	4.60e-03	4.80e-04	5.40e-03	3.90e-03
Potassium	46	46	9.70e-01	3.30e+00	1.80e+00	8.40e-02	1.90e+00	1.70e+00
Selenium	46	5	1.00e-03	4.80e-03	1.30e-03	1.30e-04	1.60e-03	1.10e-03
Silver	46	1	1.00e-03	1.50e-03	1.50e-03	.	.	1.50e-03
Sodium	46	46	1.50e+00	4.80e+00	3.20e+00	1.20e-01	3.40e+00	3.20e+00
Sulfate	47	47	1.80e+01	4.60e+01	2.70e+01	7.70e-01	2.80e+01	2.70e+01
Zinc	46	46	2.20e-03	1.90e-02	6.00e-03	5.60e-04	6.90e-03	4.50e-03
Reach 13/Total								
Aluminum	48	48	9.60e-02	1.60e+00	4.40e-01	4.40e-02	5.10e-01	4.10e-01
Antimony	48	2	1.00e-03	2.30e-03	1.10e-03	3.50e-05	1.20e-03	1.10e-03
Arsenic	48	9	1.00e-03	3.00e-03	1.20e-03	3.80e-05	1.30e-03	1.20e-03
Barium	48	48	3.10e-02	6.00e-02	4.30e-02	1.30e-03	4.50e-02	4.10e-02
Boron	48	43	3.00e-03	1.60e-01	4.70e-02	4.20e-03	5.40e-02	3.90e-02
Calcium	48	48	1.20e+01	3.80e+01	2.50e+01	1.00e+00	2.70e+01	2.30e+01
Chromium	48	42	1.00e-03	6.70e-03	2.10e-03	1.50e-04	2.30e-03	2.10e-03
Cobalt	48	7	1.00e-03	2.00e-03	1.20e-03	3.40e-05	1.20e-03	1.10e-03
Copper	48	47	1.00e-03	2.40e-02	4.10e-03	5.70e-04	5.00e-03	2.70e-03
Iron	48	48	1.90e-01	2.70e+00	7.00e-01	6.60e-02	8.10e-01	6.30e-01
Lead	48	22	1.00e-03	3.70e-03	1.40e-03	9.30e-05	1.60e-03	1.10e-03
Magnesium	48	48	3.70e+00	1.30e+01	8.00e+00	3.20e-01	8.50e+00	7.70e+00

Table A19 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Manganese	48	48	4.80e-02	2.30e-01	1.10e-01	7.70e-03	1.30e-01	9.10e-02
Mercury	48	2	2.00e-04	2.60e-04	2.30e-04	8.70e-07	2.30e-04	2.30e-04
Mercury (BR)	48	15	9.90e-08	2.70e-05	5.40e-06	8.40e-07	6.80e-06	2.60e-06
Methyl mercury (BR)	47	3	4.50e-08	2.90e-07	1.00e-07	5.70e-09	1.10e-07	9.60e-08
Molybdenum	48	1	1.00e-03	5.00e-03	1.50e-03	.	.	1.50e-03
Nickel	48	48	1.60e-03	8.80e-03	3.90e-03	2.40e-04	4.30e-03	3.60e-03
Potassium	48	48	1.00e+00	3.30e+00	1.80e+00	8.40e-02	2.00e+00	1.90e+00
Selenium	48	1	1.00e-03	3.00e-03	1.20e-03	.	.	1.20e-03
Silver	48	1	1.00e-03	1.60e-03	1.60e-03	.	.	1.60e-03
Sodium	48	48	2.50e+00	7.30e+00	4.00e+00	1.80e-01	4.30e+00	3.70e+00
Vanadium	48	24	1.00e-03	3.20e-03	1.20e-03	6.00e-05	1.30e-03	1.00e-03
Zinc	48	48	2.90e-03	4.30e-02	1.20e-02	1.20e-03	1.40e-02	8.30e-03

Table A20. Summary statistics for inorganic analysis (mg/L) in Poplar Creek by season

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Spring/ Dissolved								
Aluminum	31	22	7.00e-03	4.20e-01	2.80e-02	1.30e-02	5.00e-02	1.40e-02
Antimony	31	27	1.00e-03	1.30e-02	4.70e-03	4.90e-04	5.50e-03	4.30e-03
Arsenic	31	5	1.00e-03	3.00e-03	1.20e-03	4.10e-05	1.30e-03	1.10e-03
Barium	31	31	2.10e-02	5.00e-02	3.50e-02	1.80e-03	3.80e-02	3.40e-02
Boron	31	27	1.80e-02	1.00e-01	4.50e-02	4.90e-03	5.40e-02	3.60e-02
Cadmium	31	1	1.00e-03	2.40e-03	2.40e-03	.	.	2.40e-03
Calcium	31	31	1.10e+01	3.80e+01	2.50e+01	1.50e+00	2.80e+01	2.70e+01
Chromium	31	15	1.00e-03	3.00e-03	1.30e-03	9.20e-05	1.50e-03	1.10e-03
Copper	31	29	1.00e-03	4.70e-03	2.60e-03	1.60e-04	2.90e-03	2.40e-03
Iron	31	28	1.20e-02	4.30e-01	5.30e-02	1.30e-02	7.50e-02	3.50e-02
Lead	31	2	1.00e-03	2.20e-03	1.50e-03	3.10e-05	1.60e-03	1.50e-03
Magnesium	31	31	4.20e+00	1.10e+01	8.00e+00	4.20e-01	8.70e+00	8.50e+00
Manganese	31	31	9.30e-03	8.30e-02	3.70e-02	2.80e-03	4.20e-02	3.70e-02
Mercury (BR)	31	3	7.50e-08	6.50e-06	3.60e-06	1.10e-07	3.80e-06	3.50e-06
Molybdenum	31	2	1.00e-03	1.50e-03	1.20e-03	1.30e-05	1.20e-03	1.20e-03
Nickel	31	31	1.90e-03	1.40e-02	4.60e-03	5.50e-04	5.50e-03	3.60e-03
Potassium	31	31	1.20e+00	2.50e+00	1.60e+00	6.40e-02	1.70e+00	1.60e+00
Selenium	31	4	3.00e-03	4.80e-03	3.60e-03	6.30e-05	3.70e-03	3.50e-03
Silver	31	1	1.00e-03	1.50e-03	1.50e-03	.	.	1.50e-03
Sodium	31	31	1.50e+00	8.70e+00	3.50e+00	2.80e-01	4.00e+00	3.90e+00
Sulfate	30	30	1.70e+01	3.50e+01	2.50e+01	9.50e-01	2.60e+01	2.50e+01
Uranium	31	12	1.00e-03	3.00e-03	1.50e-03	8.70e-05	1.70e-03	1.20e-03
Zinc	31	29	2.70e-03	1.90e-02	7.40e-03	7.80e-04	8.80e-03	6.10e-03
Spring/Total								
Aluminum	31	31	1.30e-01	8.80e-01	3.70e-01	3.90e-02	4.40e-01	3.40e-01
Antimony	31	1	1.00e-03	1.80e-03	1.80e-03	.	.	1.80e-03
Arsenic	31	3	1.00e-03	3.00e-03	1.20e-03	6.60e-05	1.30e-03	1.10e-03
Barium	31	31	2.80e-02	5.40e-02	3.90e-02	1.60e-03	4.20e-02	3.70e-02
Boron	31	28	1.80e-02	1.20e-01	5.10e-02	5.00e-03	5.90e-02	4.70e-02
Calcium	31	31	1.20e+01	3.80e+01	2.60e+01	1.50e+00	2.80e+01	2.80e+01
Chromium	31	20	1.00e-03	6.70e-03	1.70e-03	1.90e-04	2.00e-03	1.50e-03

Table A20 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Cobalt	31	3	1.00e-03	1.10e-03	1.00e-03	5.40e-06	1.00e-03	1.00e-03
Copper	31	28	1.00e-03	2.40e-02	4.50e-03	8.20e-04	5.90e-03	2.70e-03
Iron	31	31	2.30e-01	1.10e+00	5.60e-01	4.70e-02	6.40e-01	4.60e-01
Lead	31	17	1.00e-03	3.70e-03	1.60e-03	1.20e-04	1.80e-03	1.10e-03
Magnesium	31	31	4.20e+00	1.10e+01	8.10e+00	4.30e-01	8.80e+00	8.40e+00
Manganese	31	31	4.60e-02	1.40e-01	6.80e-02	3.80e-03	7.50e-02	6.20e-02
Mercury	31	3	2.00e-04	2.50e-04	2.10e-04	1.60e-06	2.10e-04	2.10e-04
Mercury (BR)	31	19	9.90e-08	1.90e-04	4.10e-05	1.00e-05	5.80e-05	2.00e-05
Methyl mercury (BR)	29	3	6.40e-08	4.30e-07	3.00e-07	6.50e-09	3.10e-07	2.90e-07
Molybdenum	31	3	1.00e-03	1.50e-03	1.20e-03	1.40e-05	1.20e-03	1.20e-03
Nickel	31	31	2.10e-03	8.80e-03	3.80e-03	2.10e-04	4.20e-03	3.80e-03
Potassium	31	31	1.20e+00	2.70e+00	1.70e+00	6.40e-02	1.80e+00	1.70e+00
Silver	31	1	1.00e-03	1.60e-03	1.60e-03	.	.	1.60e-03
Sodium	31	31	2.80e+00	8.70e+00	4.50e+00	2.50e-01	4.90e+00	4.10e+00
Uranium	31	13	1.00e-03	3.20e-03	1.50e-03	1.10e-04	1.70e-03	1.10e-03
Vanadium	31	11	1.00e-03	2.00e-03	1.20e-03	4.70e-05	1.30e-03	1.10e-03
Zinc	31	29	4.50e-03	4.30e-02	1.30e-02	1.60e-03	1.60e-02	9.70e-03
Summer/ Dissolved								
Aluminum	33	32	7.00e-03	6.00e-02	1.50e-02	1.60e-03	1.80e-02	1.40e-02
Antimony	33	33	1.90e-03	1.10e-02	6.20e-03	4.00e-04	6.90e-03	6.40e-03
Arsenic	33	6	1.00e-03	3.00e-03	1.10e-03	3.40e-05	1.10e-03	1.00e-03
Barium	33	33	2.00e-02	5.20e-02	3.80e-02	1.30e-03	4.00e-02	3.80e-02
Boron	33	31	1.80e-02	1.60e-01	5.80e-02	4.90e-03	6.60e-02	5.50e-02
Calcium	33	32	2.70e-02	3.90e+01	2.90e+01	1.00e+00	3.10e+01	3.00e+01
Chromium	33	29	1.00e-03	4.60e-03	2.00e-03	1.40e-04	2.20e-03	1.90e-03
Copper	33	33	2.00e-03	2.00e-02	4.40e-03	5.50e-04	5.40e-03	3.70e-03
Iron	33	24	1.30e-02	1.20e+00	7.10e-02	3.40e-02	1.30e-01	2.70e-02
Lead	33	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Magnesium	33	32	9.00e-03	1.30e+01	7.70e+00	3.40e-01	8.30e+00	8.00e+00
Manganese	33	33	3.90e-03	1.80e-01	7.60e-02	7.90e-03	9.00e-02	7.70e-02
Mercury	33	5	2.00e-04	7.30e-04	2.60e-04	2.20e-05	2.90e-04	2.30e-04

Table A20 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Mercury (BR)	33	7	1.60e-06	3.00e-05	5.50e-06	8.50e-07	6.90e-06	4.30e-06
Molybdenum	33	1	1.00e-03	5.00e-03	1.10e-03	.	.	1.10e-03
Nickel	33	33	1.40e-03	1.60e-02	4.20e-03	6.30e-04	5.30e-03	2.40e-03
Potassium	33	32	1.30e-02	3.30e+00	2.30e+00	6.20e-02	2.40e+00	2.30e+00
Selenium	33	5	1.00e-03	4.70e-03	1.40e-03	1.70e-04	1.70e-03	1.10e-03
Sodium	33	32	2.00e-02	8.00e+00	4.30e+00	2.70e-01	4.70e+00	3.80e+00
Sulfate	33	33	1.60e+01	3.10e+01	2.50e+01	6.30e-01	2.60e+01	2.50e+01
Uranium	33	13	1.00e-03	3.20e-03	1.60e-03	1.10e-04	1.80e-03	1.30e-03
Zinc	33	33	2.60e-03	1.80e-02	5.30e-03	5.60e-04	6.20e-03	4.60e-03
Summer/ Total								
Aluminum	33	33	1.00e-01	1.50e+00	4.80e-01	4.80e-02	5.60e-01	4.60e-01
Antimony	33	3	1.00e-03	2.30e-03	1.20e-03	4.80e-05	1.20e-03	1.10e-03
Arsenic	33	6	1.00e-03	3.00e-03	1.20e-03	4.20e-05	1.30e-03	1.20e-03
Barium	33	33	3.60e-02	6.00e-02	4.50e-02	1.10e-03	4.70e-02	4.20e-02
Boron	33	31	1.80e-02	1.60e-01	6.50e-02	6.00e-03	7.50e-02	6.40e-02
Calcium	33	31	2.70e-02	3.80e+01	2.90e+01	1.00e+00	3.10e+01	3.00e+01
Chromium	33	33	1.30e-03	3.30e-03	2.30e-03	1.20e-04	2.50e-03	2.40e-03
Cobalt	33	1	1.00e-03	1.50e-03	1.50e-03	.	.	1.50e-03
Copper	33	33	1.60e-03	1.00e-02	3.80e-03	3.70e-04	4.40e-03	2.60e-03
Iron	33	33	2.20e-01	1.90e+00	6.60e-01	5.30e-02	7.50e-01	6.40e-01
Lead	33	16	1.00e-03	4.30e-03	1.40e-03	1.30e-04	1.70e-03	1.00e-03
Magnesium	33	31	9.00e-03	1.30e+01	7.70e+00	3.60e-01	8.30e+00	7.80e+00
Manganese	33	33	8.10e-02	2.30e-01	1.30e-01	7.50e-03	1.50e-01	1.20e-01
Mercury	33	6	2.00e-04	9.00e-04	2.40e-04	2.50e-05	2.80e-04	2.00e-04
Mercury (BR)	33	24	2.50e-06	5.50e-04	7.60e-05	1.90e-05	1.10e-04	3.00e-05
Methyl mercury (BR)	33	9	5.90e-08	7.00e-07	2.50e-07	1.80e-08	2.80e-07	2.10e-07
Molybdenum	33	2	1.00e-03	5.00e-03	1.10e-03	1.20e-04	1.30e-03	1.00e-03
Nickel	33	33	1.50e-03	6.50e-03	2.90e-03	1.90e-04	3.20e-03	2.60e-03
Potassium	33	31	1.30e-02	3.30e+00	2.40e+00	5.90e-02	2.50e+00	2.30e+00
Selenium	33	1	1.00e-03	3.00e-03	1.20e-03	.	.	1.20e-03
Sodium	33	31	2.00e-02	9.20e+00	5.00e+00	2.70e-01	5.50e+00	5.10e+00

Table A20 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Uranium	33	15	1.00e-03	8.50e-03	1.90e-03	2.40e-04	2.30e-03	1.20e-03
Vanadium	33	21	1.00e-03	3.20e-03	1.30e-03	7.40e-05	1.40e-03	1.10e-03
Zinc	33	33	2.90e-03	4.70e-02	1.40e-02	1.90e-03	1.70e-02	8.20e-03
Winter/ Dissolved								
Aluminum	33	29	1.00e-02	1.80e-01	2.90e-02	5.20e-03	3.80e-02	2.40e-02
Antimony	33	23	1.00e-03	1.20e-02	4.20e-03	4.50e-04	4.90e-03	4.20e-03
Arsenic	33	4	1.00e-03	1.60e-03	1.10e-03	2.50e-05	1.20e-03	1.10e-03
Barium	33	33	2.20e-02	4.80e-02	3.10e-02	9.20e-04	3.20e-02	3.10e-02
Boron	33	25	3.00e-03	8.10e-02	2.60e-02	3.70e-03	3.20e-02	2.40e-02
Calcium	33	33	1.00e+01	3.90e+01	2.30e+01	1.00e+00	2.50e+01	2.30e+01
Chromium	33	25	1.00e-03	2.40e-03	1.40e-03	6.90e-05	1.50e-03	1.30e-03
Copper	33	32	1.00e-03	1.10e-02	2.80e-03	3.50e-04	3.40e-03	2.50e-03
Iron	33	29	1.60e-02	3.80e-01	1.50e-01	1.70e-02	1.80e-01	1.70e-01
Lead	33	5	1.00e-03	1.40e-03	1.10e-03	1.30e-05	1.10e-03	1.10e-03
Magnesium	33	33	3.50e+00	1.00e+01	6.90e+00	2.50e-01	7.30e+00	7.30e+00
Manganese	33	33	3.90e-02	1.20e-01	6.20e-02	3.00e-03	6.70e-02	5.80e-02
Mercury (BR)	33	1	1.60e-06	1.40e-05	1.40e-05	.	.	1.40e-05
Methyl mercury (BR)	32	1	4.10e-08	1.70e-07	7.10e-08	.	.	7.10e-08
Nickel	33	33	1.40e-03	6.20e-03	4.30e-03	1.70e-04	4.60e-03	4.50e-03
Potassium	33	33	9.70e-01	3.10e+00	1.40e+00	8.30e-02	1.50e+00	1.30e+00
Selenium	33	1	3.00e-03	4.70e-03	4.70e-03	.	.	4.70e-03
Sodium	33	33	1.70e+00	6.40e+00	3.50e+00	2.20e-01	3.80e+00	3.10e+00
Sulfate	35	35	1.90e+01	4.60e+01	2.90e+01	9.40e-01	3.10e+01	2.80e+01
Uranium	33	15	1.00e-03	3.50e-03	1.60e-03	1.10e-04	1.80e-03	1.20e-03
Zinc	33	33	2.20e-03	1.90e-02	6.70e-03	6.10e-04	7.80e-03	5.90e-03
Winter/ Total								
Aluminum	35	35	9.60e-02	1.60e+00	4.00e-01	5.40e-02	4.90e-01	3.00e-01
Antimony	35	2	1.00e-03	1.40e-03	1.20e-03	8.00e-06	1.20e-03	1.20e-03
Arsenic	35	7	1.00e-03	2.10e-03	1.10e-03	4.20e-05	1.20e-03	1.00e-03
Barium	35	35	3.00e-02	5.40e-02	3.60e-02	8.20e-04	3.70e-02	3.40e-02
Boron	35	28	3.00e-03	6.10e-02	2.30e-02	2.80e-03	2.80e-02	2.30e-02

Table A20 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Calcium	35	35	1.20e+01	3.90e+01	2.30e+01	9.80e-01	2.50e+01	2.30e+01
Chromium	35	33	1.00e-03	3.50e-03	1.90e-03	1.10e-04	2.10e-03	1.80e-03
Cobalt	35	10	1.00e-03	2.00e-03	1.20e-03	4.50e-05	1.30e-03	1.10e-03
Copper	35	35	1.00e-03	1.40e-02	3.80e-03	4.30e-04	4.50e-03	3.30e-03
Iron	35	35	1.90e-01	2.70e+00	7.30e-01	8.90e-02	8.80e-01	6.30e-01
Lead	35	17	1.00e-03	2.90e-03	1.40e-03	8.70e-05	1.50e-03	1.10e-03
Magnesium	35	35	3.70e+00	9.90e+00	6.70e+00	2.40e-01	7.20e+00	7.30e+00
Manganese	35	35	5.40e-02	2.10e-01	8.70e-02	5.30e-03	9.60e-02	7.80e-02
Mercury	35	2	2.00e-04	2.40e-04	2.40e-04	0.00e+00	2.40e-04	2.40e-04
Mercury (BR)	35	22	1.80e-06	1.40e-04	3.90e-05	7.50e-06	5.20e-05	1.70e-05
Methyl mercury (BR)	33	2	4.50e-08	2.80e-07	1.00e-07	6.50e-09	1.10e-07	9.60e-08
Molybdenum	35	1	1.00e-03	2.00e-03	1.10e-03	.	.	1.10e-03
Nickel	35	35	2.00e-03	7.80e-03	4.80e-03	2.30e-04	5.20e-03	5.00e-03
Potassium	35	35	1.00e+00	3.20e+00	1.40e+00	8.20e-02	1.60e+00	1.30e+00
Sodium	35	35	2.30e+00	8.70e+00	4.10e+00	2.80e-01	4.60e+00	3.40e+00
Uranium	35	16	1.00e-03	3.60e-03	2.00e-03	7.40e-05	2.10e-03	1.70e-03
Vanadium	35	11	1.00e-03	3.20e-03	1.20e-03	7.60e-05	1.30e-03	1.00e-03
Zinc	35	35	3.90e-03	2.40e-02	1.20e-02	1.00e-03	1.40e-02	1.10e-02

Table A21. Summary statistics for inorganic results (mg/L) for each season in Poplar Creek by reach

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
SPRING								
Reach 3.01 / Dissolved								
Aluminum	4	4	1.30e-02	2.60e-02	1.70e-02	3.30e-03	2.40e-02	1.40e-02
Antimony	4	3	1.00e-03	5.60e-03	3.10e-03	8.80e-04	5.20e-03	2.30e-03
Barium	4	4	2.20e-02	3.70e-02	3.00e-02	3.70e-03	3.90e-02	3.10e-02
Boron	4	4	1.80e-02	9.80e-02	5.70e-02	2.10e-02	1.10e-01	5.70e-02
Calcium	4	4	1.30e+01	3.40e+01	2.40e+01	4.90e+00	3.50e+01	2.40e+01
Chromium	4	3	1.00e-03	2.10e-03	1.60e-03	2.00e-04	2.00e-03	1.50e-03
Copper	4	4	2.10e-03	4.40e-03	2.90e-03	5.30e-04	4.10e-03	2.50e-03
Iron	4	4	1.80e-02	7.30e-02	4.10e-02	1.20e-02	6.90e-02	3.60e-02
Lead	4	1	1.00e-03	1.50e-03	1.50e-03	.	.	1.50e-03
Magnesium	4	4	4.40e+00	9.60e+00	7.00e+00	1.20e+00	9.90e+00	7.10e+00
Manganese	4	4	1.60e-02	3.40e-02	2.70e-02	4.00e-03	3.60e-02	2.90e-02
Molybdenum	4	1	1.00e-03	1.20e-03	1.20e-03	.	.	1.20e-03
Nickel	4	4	2.90e-03	9.10e-03	5.00e-03	1.40e-03	8.20e-03	4.00e-03
Potassium	4	4	1.20e+00	2.10e+00	1.60e+00	2.10e-01	2.10e+00	1.50e+00
Selenium	4	1	3.00e-03	4.60e-03	4.60e-03	.	.	4.60e-03
Sodium	4	4	1.90e+00	6.10e+00	3.60e+00	9.90e-01	6.00e+00	3.30e+00

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Sulfate	4	4	1.80e+01	3.00e+01	2.30e+01	2.80e+00	3.00e+01	2.20e+01
Uranium	4	3	1.00e-03	1.90e-03	1.50e-03	1.70e-04	1.90e-03	1.50e-03
Zinc	4	4	4.30e-03	1.10e-02	7.70e-03	1.50e-03	1.10e-02	7.90e-03
Reach 3.01 / Total								
Aluminum	4	4	2.30e-01	7.00e-01	4.20e-01	1.20e-01	7.00e-01	3.90e-01
Barium	4	4	3.00e-02	4.20e-02	3.60e-02	2.90e-03	4.20e-02	3.50e-02
Boron	4	4	2.00e-02	9.10e-02	5.70e-02	1.90e-02	1.00e-01	5.80e-02
Calcium	4	4	1.40e+01	3.50e+01	2.50e+01	5.00e+00	3.60e+01	2.50e+01
Chromium	4	3	1.00e-03	2.40e-03	1.90e-03	2.50e-04	2.50e-03	1.90e-03
Cobalt	4	1	1.00e-03	1.00e-03	1.00e-03	.	.	1.00e-03
Copper	4	4	1.80e-03	1.10e-02	5.40e-03	2.10e-03	1.00e-02	4.40e-03
Iron	4	4	3.90e-01	1.10e+00	6.20e-01	1.60e-01	1.00e+00	5.10e-01
Lead	4	3	1.00e-03	3.00e-03	1.70e-03	4.80e-04	2.80e-03	1.40e-03
Magnesium	4	4	4.40e+00	9.60e+00	7.10e+00	1.20e+00	1.00e+01	7.20e+00
Manganese	4	4	4.90e-02	7.50e-02	5.90e-02	5.70e-03	7.30e-02	5.60e-02
Mercury	8	5	4.30e-07	2.50e-04	5.50e-05	3.10e-05	1.10e-04	2.90e-05
Methyl mercury	4	1	9.30e-08	4.30e-07	4.30e-07	.	.	4.30e-07

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Molybdenum	4	1	1.00e-03	1.20e-03	1.20e-03	.	.	1.20e-03
Nickel	4	4	3.20e-03	4.60e-03	3.90e-03	2.90e-04	4.60e-03	4.00e-03
Potassium	4	4	1.30e+00	2.20e+00	1.70e+00	2.00e-01	2.10e+00	1.60e+00
Sodium	4	4	4.10e+00	6.10e+00	4.80e+00	4.50e-01	5.90e+00	4.50e+00
Uranium	4	3	1.00e-03	2.20e-03	1.70e-03	2.20e-04	2.30e-03	1.70e-03
Vanadium	4	2	1.00e-03	1.60e-03	1.40e-03	4.60e-05	1.50e-03	1.40e-03
Zinc	4	4	6.20e-03	2.30e-02	1.40e-02	3.50e-03	2.30e-02	1.40e-02
Reach 3.02 / Dissolved								
Aluminum	4	3	7.00e-03	2.70e-02	2.10e-02	3.10e-03	2.80e-02	2.00e-02
Antimony	4	3	1.00e-03	1.00e-02	6.40e-03	1.30e-03	9.50e-03	5.20e-03
Arsenic	4	1	1.00e-03	3.00e-03	1.40e-03	.	.	1.40e-03
Barium	4	4	2.10e-02	4.20e-02	3.20e-02	4.20e-03	4.20e-02	3.30e-02
Boron	4	4	3.30e-02	1.00e-01	7.00e-02	1.60e-02	1.10e-01	7.20e-02
Calcium	4	4	1.40e+01	3.80e+01	2.70e+01	4.90e+00	3.90e+01	2.90e+01
Chromium	4	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Copper	4	4	2.00e-03	4.70e-03	3.10e-03	6.20e-04	4.60e-03	2.90e-03
Iron	4	4	2.40e-02	5.10e-02	3.30e-02	6.20e-03	4.70e-02	2.80e-02

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Lead	4	1	1.00e-03	2.20e-03	2.20e-03	.	.	2.20e-03
Magnesium	4	4	4.30e+00	9.80e+00	7.70e+00	1.20e+00	1.10e+01	8.40e+00
Manganese	4	4	9.30e-03	4.80e-02	2.70e-02	7.90e-03	4.60e-02	2.60e-02
Mercury	8	1	3.70e-06	2.00e-04	5.40e-06	.	.	5.40e-06
Molybdenum	4	1	1.00e-03	1.50e-03	1.50e-03	.	.	1.50e-03
Nickel	4	4	2.20e-03	4.90e-03	3.80e-03	5.90e-04	5.10e-03	4.00e-03
Potassium	4	4	1.30e+00	2.40e+00	1.70e+00	2.40e-01	2.30e+00	1.60e+00
Sodium	4	4	2.00e+00	8.70e+00	4.90e+00	1.40e+00	8.20e+00	4.40e+00
Sulfate	4	4	1.70e+01	3.00e+01	2.60e+01	3.10e+00	3.40e+01	2.90e+01
Uranium	4	3	1.00e-03	2.50e-03	2.00e-03	2.80e-04	2.70e-03	2.00e-03
Zinc	4	4	6.60e-03	1.60e-02	1.10e-02	2.10e-03	1.60e-02	1.10e-02
Reach 3.02 / Total								
Aluminum	4	4	2.10e-01	6.70e-01	3.50e-01	1.10e-01	6.00e-01	2.60e-01
Barium	4	4	2.80e-02	4.40e-02	3.60e-02	3.30e-03	4.40e-02	3.50e-02
Boron	4	4	2.80e-02	1.20e-01	7.30e-02	2.20e-02	1.30e-01	7.10e-02
Calcium	4	4	1.60e+01	3.80e+01	2.80e+01	4.60e+00	3.90e+01	3.00e+01
Chromium	4	2	1.00e-03	1.60e-03	1.50e-03	3.10e-05	1.60e-03	1.50e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Copper	4	4	2.10e-03	4.50e-03	2.90e-03	5.40e-04	4.20e-03	2.60e-03
Iron	4	4	3.10e-01	9.00e-01	5.10e-01	1.40e-01	8.30e-01	4.10e-01
Lead	4	1	1.00e-03	1.80e-03	1.80e-03	.	.	1.80e-03
Magnesium	4	4	4.40e+00	1.00e+01	8.10e+00	1.30e+00	1.10e+01	9.00e+00
Manganese	4	4	4.60e-02	6.20e-02	5.60e-02	3.50e-03	6.40e-02	5.80e-02
Mercury	8	4	4.70e-05	2.00e-04	7.90e-05	1.70e-05	1.10e-04	7.80e-05
Methyl mercury	3	1	9.40e-08	3.60e-07	3.60e-07	.	.	3.60e-07
Molybdenum	4	1	1.00e-03	1.40e-03	1.40e-03	.	.	1.40e-03
Nickel	4	4	2.40e-03	4.50e-03	3.90e-03	4.90e-04	5.00e-03	4.30e-03
Potassium	4	4	1.40e+00	2.40e+00	1.80e+00	2.20e-01	2.30e+00	1.70e+00
Sodium	4	4	4.20e+00	8.70e+00	5.50e+00	1.10e+00	8.10e+00	4.60e+00
Uranium	4	4	1.10e-03	2.70e-03	2.00e-03	4.00e-04	2.90e-03	2.00e-03
Vanadium	4	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Zinc	4	4	9.20e-03	1.30e-02	1.10e-02	8.80e-04	1.30e-02	1.00e-02
Reach 3.03 / Dissolved								
Aluminum	4	3	1.00e-02	2.40e-02	2.00e-02	1.50e-03	2.40e-02	2.00e-02
Antimony	4	4	4.10e-03	8.00e-03	5.40e-03	9.00e-04	7.50e-03	4.70e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Arsenic	4	1	1.00e-03	1.50e-03	1.50e-03	.	.	1.50e-03
Barium	4	4	2.20e-02	3.10e-02	2.70e-02	2.20e-03	3.20e-02	2.70e-02
Boron	4	3	2.10e-02	4.80e-02	3.10e-02	6.50e-03	4.60e-02	3.00e-02
Calcium	4	4	1.30e+01	2.70e+01	2.10e+01	3.50e+00	2.90e+01	2.20e+01
Chromium	4	2	1.00e-03	2.00e-03	1.50e-03	1.20e-04	1.80e-03	1.40e-03
Copper	4	3	1.60e-03	2.90e-03	2.30e-03	3.50e-04	3.10e-03	2.40e-03
Iron	4	2	1.60e-02	6.60e-02	3.40e-02	1.30e-02	6.50e-02	2.30e-02
Magnesium	4	4	4.30e+00	7.70e+00	6.40e+00	7.30e-01	8.10e+00	6.80e+00
Manganese	4	4	3.70e-02	5.70e-02	4.40e-02	4.80e-03	5.60e-02	4.20e-02
Nickel	4	4	2.00e-03	6.10e-03	3.60e-03	8.90e-04	5.60e-03	3.10e-03
Potassium	4	4	1.20e+00	1.40e+00	1.30e+00	5.90e-02	1.50e+00	1.30e+00
Sodium	4	4	1.50e+00	4.30e+00	3.00e+00	6.70e-01	4.60e+00	3.10e+00
Sulfate	4	4	1.70e+01	2.70e+01	2.30e+01	2.60e+00	2.90e+01	2.30e+01
Uranium	4	3	1.00e-03	2.10e-03	1.70e-03	1.60e-04	2.10e-03	1.70e-03
Zinc	4	3	3.40e-03	5.80e-03	4.90e-03	7.40e-04	6.60e-03	5.50e-03
Reach 3.03 / Total								
Aluminum	4	4	1.60e-01	3.90e-01	3.10e-01	5.60e-02	4.40e-01	3.40e-01

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Barium	4	4	2.80e-02	3.40e-02	3.00e-02	1.20e-03	3.30e-02	3.00e-02
Boron	4	3	2.30e-02	6.10e-02	3.50e-02	9.40e-03	5.70e-02	3.00e-02
Calcium	4	4	1.40e+01	2.80e+01	2.10e+01	3.40e+00	3.00e+01	2.20e+01
Chromium	4	2	1.00e-03	2.10e-03	1.60e-03	2.10e-04	2.10e-03	1.40e-03
Copper	4	3	1.60e-03	8.30e-03	3.70e-03	1.70e-03	7.60e-03	2.70e-03
Iron	4	4	2.30e-01	5.60e-01	4.30e-01	7.00e-02	5.90e-01	4.60e-01
Lead	4	3	1.00e-03	3.00e-03	2.10e-03	3.30e-04	2.90e-03	1.90e-03
Magnesium	4	4	4.20e+00	7.90e+00	6.40e+00	8.10e-01	8.30e+00	6.70e+00
Manganese	4	4	5.60e-02	7.40e-02	6.30e-02	4.30e-03	7.40e-02	6.20e-02
Mercury	8	5	3.80e-05	2.10e-04	1.00e-04	3.20e-05	1.60e-04	7.90e-05
Nickel	4	4	2.10e-03	4.90e-03	3.40e-03	5.80e-04	4.80e-03	3.30e-03
Potassium	4	4	1.20e+00	1.40e+00	1.40e+00	5.10e-02	1.50e+00	1.40e+00
Sodium	4	4	3.30e+00	4.30e+00	3.90e+00	2.30e-01	4.40e+00	4.00e+00
Uranium	4	3	1.00e-03	2.10e-03	1.80e-03	1.50e-04	2.20e-03	1.80e-03
Zinc	4	3	5.40e-03	1.50e-02	8.70e-03	2.40e-03	1.40e-02	7.60e-03
Reach 3.04 / Dissolved								
Aluminum	3	2	1.00e-02	2.40e-02	2.00e-02	2.30e-03	2.60e-02	1.80e-02

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Antimony	3	2	1.00e-03	1.30e-02	6.60e-03	3.80e-03	1.80e-02	3.30e-03
Barium	3	3	2.10e-02	3.40e-02	3.00e-02	4.10e-03	4.10e-02	3.30e-02
Boron	3	2	2.60e-02	6.30e-02	4.00e-02	1.40e-02	8.10e-02	4.00e-02
Calcium	3	3	1.60e+01	3.10e+01	2.60e+01	5.00e+00	4.10e+01	3.10e+01
Copper	3	2	2.40e-03	2.90e-03	2.50e-03	5.00e-05	2.60e-03	2.50e-03
Iron	3	2	2.40e-02	3.70e-02	2.80e-02	5.10e-03	4.30e-02	2.40e-02
Magnesium	3	3	5.80e+00	9.20e+00	7.80e+00	1.00e+00	1.10e+01	8.50e+00
Manganese	3	3	4.50e-02	8.30e-02	5.90e-02	1.20e-02	9.50e-02	4.80e-02
Mercury	6	1	3.40e-06	2.00e-04	3.50e-06	.	.	3.50e-06
Nickel	3	3	2.40e-03	3.60e-03	3.10e-03	3.50e-04	4.10e-03	3.20e-03
Potassium	3	3	1.30e+00	1.70e+00	1.50e+00	1.30e-01	1.90e+00	1.60e+00
Sodium	3	3	2.00e+00	5.00e+00	3.90e+00	9.50e-01	6.70e+00	4.70e+00
Sulfate	3	3	1.90e+01	2.80e+01	2.50e+01	2.80e+00	3.30e+01	2.70e+01
Uranium	3	3	1.40e-03	3.00e-03	2.20e-03	4.60e-04	3.60e-03	2.30e-03
Zinc	3	2	4.30e-03	1.70e-02	1.00e-02	3.70e-03	2.10e-02	6.90e-03
Reach 3.04 / Total								
Aluminum	3	3	3.40e-01	5.00e-01	4.10e-01	4.80e-02	5.40e-01	3.80e-01

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Antimony	3	1	1.00e-03	1.80e-03	1.80e-03	.	.	1.80e-03
Arsenic	3	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Barium	3	3	3.00e-02	3.70e-02	3.40e-02	2.30e-03	4.10e-02	3.60e-02
Boron	3	2	3.30e-02	6.10e-02	4.20e-02	1.10e-02	7.30e-02	3.30e-02
Calcium	3	3	1.70e+01	3.20e+01	2.70e+01	4.70e+00	4.10e+01	3.10e+01
Chromium	3	1	1.00e-03	2.00e-03	1.40e-03	.	.	1.40e-03
Copper	3	2	2.50e-03	6.60e-03	2.60e-03	1.00e-04	2.90e-03	2.60e-03
Iron	3	3	4.40e-01	6.10e-01	5.30e-01	5.00e-02	6.80e-01	5.60e-01
Lead	3	1	1.00e-03	1.60e-03	1.60e-03	.	.	1.60e-03
Magnesium	3	3	6.00e+00	9.60e+00	8.00e+00	1.00e+00	1.10e+01	8.40e+00
Manganese	3	3	7.20e-02	1.10e-01	8.40e-02	1.10e-02	1.20e-01	7.30e-02
Mercury	6	4	8.90e-05	2.10e-04	1.60e-04	2.60e-05	2.10e-04	1.50e-04
Methyl mercury	2	1	1.90e-07	2.90e-07	2.90e-07	.	.	2.90e-07
Nickel	3	3	3.10e-03	4.30e-03	3.80e-03	3.60e-04	4.90e-03	4.00e-03
Potassium	3	3	1.40e+00	1.80e+00	1.60e+00	1.20e-01	2.00e+00	1.70e+00
Sodium	3	3	4.10e+00	5.00e+00	4.60e+00	2.80e-01	5.40e+00	4.70e+00
Uranium	3	3	1.60e-03	3.20e-03	2.40e-03	4.60e-04	3.80e-03	2.50e-03
Vanadium	3	1	1.00e-03	1.80e-03	1.80e-03	.	.	1.80e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Zinc	3	2	7.50e-03	1.80e-02	9.40e-03	1.90e-03	1.50e-02	9.40e-03
Reach 13 / Dissolved								
Aluminum	16	10	7.00e-03	4.20e-01	3.80e-02	2.60e-02	8.30e-02	1.00e-02
Antimony	16	15	1.00e-03	8.60e-03	4.60e-03	5.20e-04	5.50e-03	4.40e-03
Arsenic	16	3	1.00e-03	3.00e-03	1.30e-03	9.80e-05	1.40e-03	1.10e-03
Barium	16	16	2.10e-02	5.00e-02	3.90e-02	2.60e-03	4.40e-02	4.30e-02
Boron	16	14	1.80e-02	9.10e-02	4.10e-02	5.80e-03	5.10e-02	3.50e-02
Cadmium	16	1	1.00e-03	2.40e-03	2.40e-03	.	.	2.40e-03
Calcium	16	16	1.10e+01	3.50e+01	2.60e+01	2.30e+00	3.00e+01	2.70e+01
Chromium	16	9	1.00e-03	3.00e-03	1.40e-03	1.60e-04	1.70e-03	1.10e-03
Copper	16	16	1.00e-03	4.30e-03	2.50e-03	2.10e-04	2.90e-03	2.30e-03
Iron	16	16	1.20e-02	4.30e-01	7.10e-02	2.50e-02	1.10e-01	4.90e-02
Magnesium	16	16	4.20e+00	1.10e+01	8.70e+00	6.30e-01	9.80e+00	9.70e+00
Manganese	16	16	1.70e-02	6.80e-02	3.70e-02	3.50e-03	4.30e-02	3.60e-02
Mercury	32	1	7.50e-08	2.00e-04	5.50e-06	.	.	5.50e-06
Nickel	16	16	1.90e-03	1.40e-02	5.30e-03	9.50e-04	7.00e-03	4.00e-03
Potassium	16	16	1.20e+00	2.50e+00	1.70e+00	9.10e-02	1.80e+00	1.70e+00

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Selenium	16	3	3.00e-03	4.80e-03	3.60e-03	1.00e-04	3.80e-03	3.50e-03
Silver	16	1	1.00e-03	1.50e-03	1.50e-03	.	.	1.50e-03
Sodium	16	16	1.50e+00	4.70e+00	3.20e+00	2.60e-01	3.70e+00	3.40e+00
Sulfate	15	15	1.80e+01	3.50e+01	2.50e+01	1.40e+00	2.80e+01	2.30e+01
Zinc	16	16	2.70e-03	1.90e-02	6.90e-03	1.10e-03	8.90e-03	5.50e-03
Reach 13 / Total								
Aluminum	16	16	1.30e-01	8.80e-01	3.80e-01	6.50e-02	4.90e-01	3.10e-01
Arsenic	16	2	1.00e-03	3.00e-03	1.80e-03	3.70e-05	1.90e-03	1.80e-03
Barium	16	16	3.10e-02	5.40e-02	4.40e-02	2.40e-03	4.80e-02	5.00e-02
Boron	16	15	1.80e-02	9.40e-02	4.90e-02	5.70e-03	5.90e-02	4.80e-02
Calcium	16	16	1.20e+01	3.50e+01	2.60e+01	2.20e+00	3.00e+01	2.80e+01
Chromium	16	12	1.00e-03	6.70e-03	2.00e-03	3.50e-04	2.60e-03	1.90e-03
Cobalt	16	2	1.00e-03	1.10e-03	1.10e-03	0.00e+00	1.10e-03	1.10e-03
Copper	16	15	1.00e-03	2.40e-02	5.10e-03	1.50e-03	7.70e-03	3.10e-03
Iron	16	16	2.60e-01	1.10e+00	6.00e-01	7.50e-02	7.30e-01	4.50e-01
Lead	16	9	1.00e-03	3.70e-03	1.60e-03	1.80e-04	1.90e-03	1.30e-03
Magnesium	16	16	4.30e+00	1.10e+01	8.80e+00	6.30e-01	9.90e+00	9.70e+00

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Manganese	16	16	4.80e-02	1.40e-01	7.20e-02	6.50e-03	8.40e-02	6.60e-02
Mercury	32	4	9.90e-08	2.00e-04	5.40e-06	2.00e-06	8.80e-06	2.60e-06
Molybdenum	16	1	1.00e-03	1.50e-03	1.50e-03	.	.	1.50e-03
Nickel	16	16	2.40e-03	8.80e-03	3.80e-03	3.70e-04	4.50e-03	3.60e-03
Potassium	16	16	1.30e+00	2.70e+00	1.80e+00	9.20e-02	1.90e+00	1.80e+00
Silver	16	1	1.00e-03	1.60e-03	1.60e-03	.	.	1.60e-03
Sodium	16	16	2.80e+00	7.30e+00	4.20e+00	3.70e-01	4.90e+00	3.80e+00
Vanadium	16	7	1.00e-03	2.00e-03	1.20e-03	7.60e-05	1.40e-03	1.10e-03
Zinc	16	16	4.50e-03	4.30e-02	1.50e-02	2.80e-03	2.00e-02	9.30e-03
							3.28e-01	
SUMMER								
Reach 3.01 / Dissolved								
Aluminum	4	4	1.00e-02	6.00e-02	2.70e-02	1.10e-02	5.40e-02	1.90e-02
Antimony	4	4	5.40e-03	7.30e-03	6.30e-03	4.40e-04	7.30e-03	6.20e-03
Arsenic	4	2	1.00e-03	3.00e-03	1.20e-03	8.50e-05	1.40e-03	1.10e-03
Barium	4	4	3.10e-02	4.00e-02	3.60e-02	2.10e-03	4.10e-02	3.70e-02
Boron	4	3	1.80e-02	1.60e-01	8.80e-02	2.80e-02	1.50e-01	6.80e-02
Calcium	4	4	2.40e+01	3.60e+01	3.00e+01	2.40e+00	3.60e+01	3.00e+01

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Chromium	4	3	1.00e-03	3.80e-03	2.40e-03	5.00e-04	3.60e-03	1.90e-03
Copper	4	4	3.10e-03	6.20e-03	4.50e-03	6.40e-04	6.00e-03	4.30e-03
Iron	4	3	1.80e-02	4.90e-02	3.90e-02	3.70e-03	4.70e-02	3.50e-02
Magnesium	4	4	6.00e+00	8.70e+00	7.40e+00	5.70e-01	8.80e+00	7.50e+00
Manganese	4	4	5.20e-02	1.00e-01	7.50e-02	9.90e-03	9.90e-02	7.50e-02
Mercury	8	1	4.30e-06	2.00e-04	4.30e-06	.	.	4.30e-06
Nickel	4	4	1.90e-03	7.20e-03	3.80e-03	1.20e-03	6.60e-03	3.10e-03
Potassium	4	4	1.90e+00	3.20e+00	2.40e+00	2.90e-01	3.10e+00	2.30e+00
Selenium	4	1	1.00e-03	4.70e-03	4.70e-03	.	.	4.70e-03
Sodium	4	4	3.20e+00	6.70e+00	4.70e+00	7.50e-01	6.40e+00	4.40e+00
Sulfate	4	4	1.80e+01	2.90e+01	2.40e+01	2.30e+00	3.00e+01	2.50e+01
Uranium	4	2	1.00e-03	2.00e-03	1.80e-03	9.50e-05	2.00e-03	1.70e-03
Zinc	4	4	4.90e-03	1.20e-02	7.10e-03	1.80e-03	1.10e-02	5.50e-03
Reach 3.01 / Total								
Aluminum	4	4	2.10e-01	5.00e-01	3.80e-01	6.10e-02	5.30e-01	4.10e-01
Barium	4	4	3.90e-02	4.70e-02	4.20e-02	1.90e-03	4.70e-02	4.10e-02
Boron	4	3	1.80e-02	1.40e-01	8.00e-02	2.80e-02	1.50e-01	7.00e-02

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Calcium	4	3	2.70e-02	3.20e+01	2.90e+01	1.20e+00	3.20e+01	2.80e+01
Chromium	4	4	1.40e-03	3.10e-03	2.30e-03	3.50e-04	3.10e-03	2.40e-03
Copper	4	4	2.00e-03	5.70e-03	4.40e-03	8.60e-04	6.40e-03	5.00e-03
Iron	4	4	4.10e-01	7.30e-01	5.90e-01	7.30e-02	7.60e-01	6.10e-01
Lead	4	3	1.00e-03	1.70e-03	1.50e-03	1.10e-04	1.70e-03	1.50e-03
Magnesium	4	3	9.00e-03	7.50e+00	6.90e+00	3.00e-01	7.60e+00	6.80e+00
Manganese	4	4	9.70e-02	1.30e-01	1.20e-01	7.50e-03	1.30e-01	1.20e-01
Mercury	8	4	3.00e-05	2.00e-04	6.90e-05	1.80e-05	1.00e-04	7.30e-05
Nickel	4	4	2.40e-03	3.00e-03	2.60e-03	1.30e-04	2.90e-03	2.60e-03
Potassium	4	3	1.30e-02	3.10e+00	2.40e+00	2.70e-01	3.00e+00	2.20e+00
Sodium	4	3	2.00e-02	5.60e+00	5.20e+00	2.50e-01	5.70e+00	5.20e+00
Uranium	4	3	1.00e-03	2.50e-03	2.10e-03	1.30e-04	2.40e-03	2.00e-03
Vanadium	4	2	1.00e-03	1.60e-03	1.20e-03	1.80e-04	1.60e-03	1.00e-03
Zinc	4	4	7.20e-03	4.70e-02	2.40e-02	8.30e-03	4.30e-02	2.00e-02
Reach 3.02 / Dissolved								
Aluminum	4	4	7.30e-03	1.70e-02	1.40e-02	2.30e-03	2.00e-02	1.60e-02
Antimony	4	4	6.30e-03	7.70e-03	7.00e-03	2.90e-04	7.60e-03	6.90e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Arsenic	4	1	1.30e-03	3.00e-03	1.30e-03	.	.	1.30e-03
Barium	4	4	3.10e-02	4.20e-02	3.60e-02	2.60e-03	4.20e-02	3.50e-02
Boron	4	3	1.80e-02	6.90e-02	5.90e-02	4.50e-03	7.00e-02	5.80e-02
Calcium	4	4	2.60e+01	3.90e+01	3.20e+01	3.20e+00	4.00e+01	3.20e+01
Chromium	4	3	1.00e-03	2.70e-03	1.70e-03	3.50e-04	2.50e-03	1.40e-03
Copper	4	4	3.30e-03	4.20e-03	3.70e-03	2.10e-04	4.20e-03	3.80e-03
Iron	4	3	1.30e-02	8.20e-02	4.70e-02	1.40e-02	8.10e-02	4.00e-02
Magnesium	4	4	5.90e+00	1.00e+01	7.70e+00	9.30e-01	9.90e+00	7.60e+00
Manganese	4	4	2.70e-02	9.60e-02	5.50e-02	1.50e-02	8.90e-02	4.80e-02
Mercury	8	4	4.50e-06	2.30e-04	3.40e-05	3.00e-05	9.10e-05	7.60e-06
Molybdenum	4	1	1.00e-03	5.00e-03	1.10e-03	.	.	1.10e-03
Nickel	4	4	2.30e-03	8.50e-03	4.20e-03	1.50e-03	7.60e-03	3.00e-03
Potassium	4	4	2.00e+00	2.60e+00	2.30e+00	1.40e-01	2.60e+00	2.30e+00
Selenium	4	1	1.00e-03	3.60e-03	3.60e-03	.	.	3.60e-03
Sodium	4	4	3.30e+00	8.00e+00	5.40e+00	1.10e+00	8.00e+00	5.20e+00
Sulfate	4	4	2.30e+01	2.90e+01	2.50e+01	1.30e+00	2.80e+01	2.50e+01
Uranium	4	4	1.30e-03	3.00e-03	2.20e-03	4.50e-04	3.20e-03	2.20e-03
Zinc	4	4	3.00e-03	9.10e-03	5.90e-03	1.60e-03	9.60e-03	5.70e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Reach 3.02 / Total								
Aluminum	4	4	1.60e-01	1.10e+00	4.90e-01	2.20e-01	9.90e-01	3.30e-01
Arsenic	4	1	1.40e-03	3.00e-03	1.40e-03	.	.	1.40e-03
Barium	4	4	3.80e-02	4.60e-02	4.20e-02	1.70e-03	4.60e-02	4.20e-02
Boron	4	3	1.80e-02	7.60e-02	7.10e-02	2.20e-03	7.60e-02	6.90e-02
Calcium	4	4	2.60e+01	3.80e+01	3.20e+01	2.90e+00	3.90e+01	3.20e+01
Chromium	4	4	1.30e-03	2.90e-03	1.90e-03	3.80e-04	2.70e-03	1.60e-03
Copper	4	4	2.20e-03	5.20e-03	3.10e-03	7.00e-04	4.80e-03	2.60e-03
Iron	4	4	2.20e-01	1.10e+00	5.80e-01	1.80e-01	1.00e+00	5.20e-01
Lead	4	2	1.00e-03	1.60e-03	1.20e-03	1.80e-04	1.60e-03	1.00e-03
Magnesium	4	4	6.10e+00	9.80e+00	7.80e+00	8.50e-01	9.80e+00	7.70e+00
Manganese	4	4	8.70e-02	1.20e-01	1.00e-01	7.70e-03	1.20e-01	9.80e-02
Mercury	8	5	1.00e-04	3.80e-04	1.40e-04	3.60e-05	2.10e-04	1.10e-04
Methyl mercury	4	3	2.80e-07	4.10e-07	3.30e-07	3.40e-08	4.00e-07	3.10e-07
Molybdenum	4	1	1.00e-03	5.00e-03	1.00e-03	.	.	1.00e-03
Nickel	4	4	1.50e-03	2.80e-03	2.20e-03	3.50e-04	3.00e-03	2.20e-03
Potassium	4	4	2.00e+00	2.50e+00	2.40e+00	1.10e-01	2.60e+00	2.40e+00

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Sodium	4	4	3.80e+00	7.60e+00	5.90e+00	8.00e-01	7.80e+00	6.20e+00
Uranium	4	4	1.60e-03	3.00e-03	2.40e-03	3.10e-04	3.20e-03	2.60e-03
Vanadium	4	2	1.00e-03	1.70e-03	1.50e-03	9.20e-05	1.70e-03	1.40e-03
Zinc	4	4	4.80e-03	2.30e-02	1.10e-02	4.00e-03	2.00e-02	8.40e-03
Reach 3.03 / Dissolved								
Aluminum	5	4	7.00e-03	1.70e-02	1.30e-02	1.60e-03	1.60e-02	1.10e-02
Antimony	5	5	3.20e-03	1.10e-02	6.00e-03	1.30e-03	8.80e-03	4.70e-03
Arsenic	5	1	1.00e-03	3.00e-03	1.10e-03	.	.	1.10e-03
Barium	5	5	2.80e-02	3.80e-02	3.40e-02	1.90e-03	3.80e-02	3.50e-02
Boron	5	5	4.50e-02	7.80e-02	5.80e-02	5.70e-03	7.00e-02	5.70e-02
Calcium	5	5	2.40e+01	3.50e+01	3.10e+01	2.10e+00	3.60e+01	3.30e+01
Chromium	5	4	1.00e-03	2.50e-03	1.70e-03	3.20e-04	2.30e-03	1.30e-03
Copper	5	5	2.60e-03	6.50e-03	4.10e-03	6.50e-04	5.50e-03	3.90e-03
Iron	5	2	1.30e-02	8.10e-02	3.70e-02	1.40e-02	6.70e-02	2.60e-02
Magnesium	5	5	5.10e+00	9.10e+00	7.40e+00	7.00e-01	8.90e+00	7.80e+00
Manganese	5	5	5.10e-03	7.50e-02	3.50e-02	1.20e-02	6.10e-02	2.50e-02
Mercury	10	3	4.10e-06	7.30e-04	7.90e-05	8.40e-05	2.30e-04	6.30e-06

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Nickel	5	5	1.40e-03	1.10e-02	5.40e-03	2.10e-03	9.80e-03	2.90e-03
Potassium	5	5	2.20e+00	2.90e+00	2.40e+00	1.30e-01	2.70e+00	2.30e+00
Sodium	5	5	3.10e+00	6.90e+00	5.40e+00	6.70e-01	6.80e+00	5.60e+00
Sulfate	5	5	1.90e+01	2.70e+01	2.40e+01	1.50e+00	2.70e+01	2.50e+01
Uranium	5	5	1.80e-03	3.20e-03	2.40e-03	2.40e-04	3.00e-03	2.50e-03
Zinc	5	5	2.70e-03	9.30e-03	4.90e-03	1.20e-03	7.50e-03	4.10e-03
Reach 3.03 / Total								
Aluminum	5	5	1.60e-01	6.40e-01	4.20e-01	8.00e-02	5.90e-01	4.60e-01
Arsenic	5	1	1.00e-03	3.00e-03	1.20e-03	.	.	1.20e-03
Barium	5	5	3.70e-02	4.40e-02	4.00e-02	1.20e-03	4.30e-02	4.00e-02
Boron	5	5	2.80e-02	9.90e-02	4.90e-02	1.30e-02	7.80e-02	3.30e-02
Calcium	5	5	2.40e+01	3.60e+01	3.20e+01	2.30e+00	3.70e+01	3.40e+01
Chromium	5	5	1.40e-03	2.90e-03	2.10e-03	3.20e-04	2.80e-03	2.30e-03
Copper	5	5	2.00e-03	8.80e-03	4.30e-03	1.40e-03	7.20e-03	2.50e-03
Iron	5	5	2.50e-01	1.00e+00	5.80e-01	1.30e-01	8.60e-01	6.00e-01
Lead	5	2	1.00e-03	2.80e-03	1.80e-03	3.00e-04	2.50e-03	1.60e-03
Magnesium	5	5	5.00e+00	9.20e+00	7.50e+00	7.30e-01	9.10e+00	7.80e+00

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Manganese	5	5	8.10e-02	1.20e-01	9.50e-02	7.30e-03	1.10e-01	9.00e-02
Mercury	10	7	1.20e-04	4.60e-04	1.90e-04	3.20e-05	2.50e-04	1.60e-04
Methyl mercury	5	3	2.20e-07	4.60e-07	2.70e-07	5.20e-08	3.80e-07	2.30e-07
Nickel	5	5	2.00e-03	4.00e-03	2.80e-03	3.90e-04	3.70e-03	2.40e-03
Potassium	5	5	2.30e+00	3.00e+00	2.50e+00	1.30e-01	2.70e+00	2.30e+00
Sodium	5	5	5.80e+00	7.10e+00	6.40e+00	2.60e-01	6.90e+00	6.40e+00
Uranium	5	5	2.10e-03	8.50e-03	3.70e-03	1.20e-03	6.30e-03	2.70e-03
Vanadium	5	3	1.00e-03	1.70e-03	1.30e-03	1.40e-04	1.60e-03	1.10e-03
Zinc	5	5	4.90e-03	3.30e-02	1.40e-02	5.50e-03	2.60e-02	6.80e-03
Reach 3.04 / Dissolved								
Aluminum	4	4	9.50e-03	2.20e-02	1.30e-02	3.00e-03	2.00e-02	1.00e-02
Antimony	4	4	3.50e-03	6.60e-03	5.00e-03	6.80e-04	6.60e-03	5.00e-03
Arsenic	4	1	1.00e-03	3.00e-03	1.40e-03	.	.	1.40e-03
Barium	4	4	2.00e-02	3.80e-02	3.00e-02	3.70e-03	3.90e-02	3.10e-02
Boron	4	4	3.70e-02	1.10e-01	6.00e-02	1.60e-02	9.70e-02	4.80e-02
Calcium	4	3	2.70e-02	3.40e+01	2.50e+01	4.90e+00	3.70e+01	2.50e+01
Chromium	4	4	1.20e-03	4.60e-03	2.50e-03	7.40e-04	4.30e-03	2.20e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Copper	4	4	3.00e-03	5.00e-03	4.20e-03	4.40e-04	5.30e-03	4.50e-03
Iron	4	2	1.80e-02	4.80e-02	3.20e-02	6.40e-03	4.70e-02	2.70e-02
Magnesium	4	3	9.00e-03	8.90e+00	6.10e+00	1.50e+00	9.50e+00	5.80e+00
Manganese	4	4	3.90e-03	3.90e-02	1.60e-02	8.00e-03	3.50e-02	1.10e-02
Mercury	8	2	3.00e-06	2.30e-04	5.40e-05	3.20e-05	1.20e-04	3.00e-05
Nickel	4	4	1.90e-03	1.00e-02	4.70e-03	1.90e-03	9.20e-03	3.30e-03
Potassium	4	3	1.30e-02	2.70e+00	2.50e+00	9.60e-02	2.70e+00	2.50e+00
Selenium	4	1	1.00e-03	3.30e-03	3.30e-03	.	.	3.30e-03
Sodium	4	3	2.00e-02	7.50e+00	4.20e+00	1.40e+00	7.50e+00	3.70e+00
Sulfate	4	4	1.60e+01	2.60e+01	2.20e+01	2.10e+00	2.60e+01	2.20e+01
Uranium	4	2	1.00e-03	2.50e-03	1.60e-03	3.70e-04	2.50e-03	1.30e-03
Zinc	4	4	3.90e-03	6.40e-03	5.00e-03	5.20e-04	6.20e-03	4.80e-03
Reach 3.04 / Total								
Aluminum	4	4	3.30e-01	1.50e+00	6.40e-01	2.90e-01	1.30e+00	3.70e-01
Antimony	4	1	1.00e-03	1.70e-03	1.70e-03	.	.	1.70e-03
Arsenic	4	1	1.00e-03	3.00e-03	1.80e-03	.	.	1.80e-03
Barium	4	4	3.60e-02	4.10e-02	3.90e-02	1.10e-03	4.20e-02	4.00e-02

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Boron	4	4	3.50e-02	1.20e-01	6.60e-02	2.00e-02	1.10e-01	5.20e-02
Calcium	4	3	2.70e-02	3.40e+01	2.60e+01	4.30e+00	3.60e+01	2.50e+01
Chromium	4	4	2.90e-03	3.10e-03	3.00e-03	4.10e-05	3.10e-03	3.00e-03
Cobalt	4	1	1.00e-03	1.50e-03	1.50e-03	.	.	1.50e-03
Copper	4	4	2.00e-03	1.00e-02	5.50e-03	1.70e-03	9.40e-03	5.10e-03
Iron	4	4	4.10e-01	1.90e+00	8.20e-01	3.40e-01	1.60e+00	5.20e-01
Lead	4	3	1.00e-03	4.30e-03	2.40e-03	6.90e-04	4.00e-03	1.80e-03
Magnesium	4	3	9.00e-03	8.60e+00	6.10e+00	1.30e+00	9.20e+00	5.90e+00
Manganese	4	4	8.10e-02	1.00e-01	9.30e-02	5.80e-03	1.10e-01	9.40e-02
Mercury	8	5	8.70e-05	9.00e-04	2.60e-04	1.10e-04	4.70e-04	1.20e-04
Methyl mercury	4	1	2.10e-07	7.00e-07	7.00e-07	.	.	7.00e-07
Molybdenum	4	1	2.10e-03	5.00e-03	2.10e-03	.	.	2.10e-03
Nickel	4	4	2.50e-03	6.50e-03	3.80e-03	9.20e-04	5.90e-03	3.00e-03
Potassium	4	3	1.30e-02	2.70e+00	2.60e+00	2.40e-02	2.70e+00	2.60e+00
Sodium	4	3	2.00e-02	9.20e+00	6.00e+00	1.10e+00	8.60e+00	4.90e+00
Uranium	4	3	1.00e-03	2.80e-03	1.70e-03	4.00e-04	2.70e-03	1.50e-03
Vanadium	4	3	1.00e-03	3.20e-03	1.80e-03	5.10e-04	3.00e-03	1.40e-03
Zinc	4	4	5.50e-03	3.50e-02	2.30e-02	6.40e-03	3.90e-02	2.70e-02

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Reach 13 / Dissolved								
Aluminum	16	16	7.40e-03	2.20e-02	1.40e-02	1.10e-03	1.60e-02	1.40e-02
Antimony	16	16	1.90e-03	1.10e-02	6.40e-03	6.90e-04	7.60e-03	6.70e-03
Arsenic	16	1	1.00e-03	3.00e-03	1.00e-03	.	.	1.00e-03
Barium	16	16	3.00e-02	5.20e-02	4.20e-02	1.80e-03	4.50e-02	4.40e-02
Boron	16	16	2.50e-02	8.90e-02	5.30e-02	5.20e-03	6.20e-02	5.70e-02
Calcium	16	16	1.80e+01	3.80e+01	2.80e+01	1.30e+00	3.00e+01	3.00e+01
Chromium	16	15	1.00e-03	2.70e-03	2.00e-03	1.50e-04	2.30e-03	2.00e-03
Copper	16	16	2.00e-03	2.00e-02	4.80e-03	1.10e-03	6.70e-03	3.50e-03
Iron	16	14	1.80e-02	1.20e+00	1.10e-01	7.10e-02	2.30e-01	4.10e-02
Lead	16	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Magnesium	16	16	5.30e+00	1.30e+01	8.30e+00	5.00e-01	9.20e+00	8.30e+00
Manganese	16	16	3.80e-02	1.80e-01	1.10e-01	8.30e-03	1.20e-01	1.10e-01
Mercury	32	2	1.60e-06	6.60e-04	3.10e-04	1.60e-05	3.40e-04	3.00e-04
Nickel	16	16	1.50e-03	1.60e-02	3.90e-03	1.00e-03	5.60e-03	2.20e-03
Potassium	16	16	2.00e+00	3.30e+00	2.30e+00	9.00e-02	2.40e+00	2.10e+00
Selenium	16	2	1.00e-03	3.20e-03	1.20e-03	1.80e-04	1.50e-03	1.10e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Sodium	16	16	2.70e+00	4.80e+00	3.60e+00	1.50e-01	3.90e+00	3.50e+00
Sulfate	16	16	1.90e+01	3.10e+01	2.60e+01	8.60e-01	2.70e+01	2.70e+01
Zinc	16	16	2.60e-03	1.80e-02	4.90e-03	9.40e-04	6.50e-03	3.70e-03
Reach 13 / Total								
Aluminum	16	16	1.00e-01	9.10e-01	4.70e-01	4.70e-02	5.50e-01	4.80e-01
Antimony	16	2	1.00e-03	2.30e-03	1.20e-03	1.00e-04	1.40e-03	1.10e-03
Arsenic	16	3	1.00e-03	3.00e-03	1.20e-03	3.20e-05	1.20e-03	1.20e-03
Barium	16	16	4.00e-02	6.00e-02	4.90e-02	1.60e-03	5.20e-02	5.20e-02
Boron	16	16	2.70e-02	1.60e-01	6.70e-02	8.40e-03	8.20e-02	6.80e-02
Calcium	16	16	2.00e+01	3.80e+01	2.90e+01	1.30e+00	3.10e+01	3.00e+01
Chromium	16	16	1.30e-03	3.30e-03	2.30e-03	1.70e-04	2.60e-03	2.40e-03
Copper	16	16	1.60e-03	6.40e-03	3.20e-03	3.80e-04	3.90e-03	2.50e-03
Iron	16	16	3.30e-01	1.10e+00	6.80e-01	4.80e-02	7.70e-01	6.80e-01
Lead	16	6	1.00e-03	3.50e-03	1.50e-03	1.50e-04	1.80e-03	1.30e-03
Magnesium	16	16	5.60e+00	1.30e+01	8.50e+00	5.20e-01	9.40e+00	8.50e+00
Manganese	16	16	9.50e-02	2.30e-01	1.70e-01	8.50e-03	1.80e-01	1.70e-01
Mercury	32	9	2.50e-06	2.60e-04	2.10e-05	1.10e-05	4.00e-05	4.70e-06

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Methyl mercury	16	2	5.90e-08	2.90e-07	2.20e-07	6.20e-09	2.30e-07	2.10e-07
Nickel	16	16	1.60e-03	6.10e-03	2.90e-03	2.70e-04	3.30e-03	2.70e-03
Potassium	16	16	1.90e+00	3.30e+00	2.40e+00	8.80e-02	2.50e+00	2.30e+00
Selenium	16	1	1.00e-03	3.00e-03	1.20e-03	.	.	1.20e-03
Sodium	16	16	3.10e+00	6.60e+00	4.30e+00	3.00e-01	4.90e+00	3.90e+00
Vanadium	16	11	1.00e-03	1.60e-03	1.20e-03	5.50e-05	1.30e-03	1.10e-03
Zinc	16	16	2.90e-03	2.10e-02	9.90e-03	1.60e-03	1.30e-02	7.00e-03
							3.28e-01	
WINTER								
Reach 3.01 / Dissolved								
Aluminum	5	5	2.10e-02	1.80e-01	5.70e-02	3.10e-02	1.20e-01	2.70e-02
Antimony	5	1	1.00e-03	7.00e-03	7.00e-03	.	.	7.00e-03
Barium	5	5	2.30e-02	4.80e-02	3.20e-02	4.20e-03	4.10e-02	3.10e-02
Boron	5	5	3.20e-03	4.40e-02	3.10e-02	7.20e-03	4.60e-02	3.30e-02
Calcium	5	5	1.20e+01	3.90e+01	2.40e+01	4.50e+00	3.40e+01	2.40e+01
Chromium	5	2	1.00e-03	1.80e-03	1.40e-03	1.30e-04	1.70e-03	1.30e-03
Copper	5	5	1.00e-03	4.00e-03	2.00e-03	6.00e-04	3.30e-03	1.20e-03
Iron	5	5	5.60e-02	3.80e-01	1.80e-01	5.60e-02	3.00e-01	1.70e-01

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Lead	5	1	1.00e-03	1.40e-03	1.40e-03	.	.	1.40e-03
Magnesium	5	5	3.70e+00	9.60e+00	6.60e+00	9.80e-01	8.70e+00	6.60e+00
Manganese	5	5	4.00e-02	8.10e-02	5.40e-02	7.00e-03	6.90e-02	4.90e-02
Mercury	10	1	3.60e-06	2.00e-04	1.40e-05	.	.	1.40e-05
Nickel	5	5	3.00e-03	5.00e-03	4.00e-03	4.10e-04	4.90e-03	4.40e-03
Potassium	5	5	9.90e-01	3.00e+00	1.50e+00	3.60e-01	2.30e+00	1.20e+00
Sodium	5	5	1.80e+00	6.20e+00	3.70e+00	8.60e-01	5.60e+00	3.10e+00
Sulfate	5	5	1.90e+01	4.50e+01	3.00e+01	4.20e+00	3.90e+01	2.80e+01
Uranium	5	3	1.00e-03	2.50e-03	1.70e-03	2.50e-04	2.30e-03	1.40e-03
Zinc	5	5	3.90e-03	1.20e-02	7.20e-03	1.30e-03	9.80e-03	6.80e-03
Reach 3.01 / Total								
Aluminum	5	5	1.20e-01	6.40e-01	4.00e-01	8.80e-02	5.80e-01	4.30e-01
Antimony	5	1	1.00e-03	1.40e-03	1.40e-03	.	.	1.40e-03
Barium	5	5	3.20e-02	5.10e-02	3.80e-02	3.60e-03	4.50e-02	3.40e-02
Boron	5	5	4.60e-03	5.10e-02	2.80e-02	8.60e-03	4.70e-02	3.00e-02
Calcium	5	5	1.20e+01	3.90e+01	2.40e+01	4.50e+00	3.40e+01	2.30e+01
Chromium	5	5	1.40e-03	2.90e-03	2.00e-03	2.60e-04	2.60e-03	1.90e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Cobalt	5	3	1.00e-03	1.60e-03	1.20e-03	1.10e-04	1.40e-03	1.10e-03
Copper	5	5	1.50e-03	6.20e-03	4.10e-03	9.50e-04	6.10e-03	5.30e-03
Iron	5	5	2.70e-01	1.20e+00	7.50e-01	1.50e-01	1.10e+00	7.60e-01
Lead	5	2	1.00e-03	2.30e-03	1.60e-03	2.30e-04	2.10e-03	1.40e-03
Magnesium	5	5	3.70e+00	9.90e+00	6.70e+00	1.00e+00	8.90e+00	6.80e+00
Manganese	5	5	5.80e-02	1.20e-01	8.50e-02	1.10e-02	1.10e-01	7.70e-02
Mercury	10	5	1.50e-05	2.00e-04	5.10e-05	2.30e-05	9.40e-05	2.90e-05
Molybdenum	5	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Nickel	5	5	3.80e-03	5.60e-03	4.90e-03	3.30e-04	5.60e-03	5.20e-03
Potassium	5	5	1.00e+00	3.10e+00	1.60e+00	3.80e-01	2.40e+00	1.30e+00
Sodium	5	5	2.30e+00	7.20e+00	4.50e+00	9.80e-01	6.60e+00	3.40e+00
Uranium	5	3	1.00e-03	2.50e-03	1.90e-03	1.80e-04	2.20e-03	1.70e-03
Vanadium	5	3	1.00e-03	1.30e-03	1.10e-03	6.40e-05	1.20e-03	1.00e-03
Zinc	5	5	6.60e-03	2.00e-02	1.40e-02	2.50e-03	1.90e-02	1.40e-02
Reach 3.02 / Dissolved								
Aluminum	5	5	1.20e-02	4.90e-02	2.50e-02	6.60e-03	3.90e-02	2.10e-02
Antimony	5	3	1.00e-03	7.60e-03	5.70e-03	5.10e-04	6.80e-03	5.20e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Barium	5	5	2.70e-02	4.20e-02	3.30e-02	2.70e-03	3.90e-02	3.10e-02
Boron	5	5	8.60e-03	6.50e-02	3.40e-02	9.90e-03	5.50e-02	3.90e-02
Calcium	5	5	2.10e+01	3.90e+01	2.80e+01	3.20e+00	3.50e+01	2.60e+01
Chromium	5	5	1.00e-03	2.40e-03	1.40e-03	2.50e-04	2.00e-03	1.40e-03
Copper	5	5	1.20e-03	5.90e-03	2.80e-03	8.80e-04	4.70e-03	1.80e-03
Iron	5	4	1.60e-02	2.50e-01	1.60e-01	3.70e-02	2.40e-01	1.80e-01
Magnesium	5	5	5.30e+00	1.00e+01	7.60e+00	7.40e-01	9.20e+00	7.60e+00
Manganese	5	5	4.20e-02	8.10e-02	6.10e-02	8.00e-03	7.80e-02	5.10e-02
Nickel	5	5	3.60e-03	4.80e-03	4.20e-03	2.20e-04	4.70e-03	4.10e-03
Potassium	5	5	9.70e-01	2.10e+00	1.40e+00	2.00e-01	1.80e+00	1.30e+00
Selenium	5	1	3.00e-03	4.70e-03	4.70e-03	.	.	4.70e-03
Sodium	5	5	2.60e+00	6.40e+00	4.30e+00	8.20e-01	6.00e+00	3.30e+00
Sulfate	5	5	2.50e+01	3.90e+01	3.00e+01	2.60e+00	3.50e+01	2.70e+01
Uranium	5	5	1.80e-03	3.50e-03	2.40e-03	2.90e-04	3.10e-03	2.30e-03
Zinc	5	5	3.40e-03	7.70e-03	5.90e-03	7.60e-04	7.60e-03	5.70e-03
Reach 3.02 / Total								
Aluminum	5	5	1.20e-01	4.00e-01	2.20e-01	4.80e-02	3.30e-01	1.80e-01

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Antimony	5	1	1.00e-03	1.20e-03	1.20e-03	.	.	1.20e-03
Barium	5	5	3.00e-02	4.10e-02	3.60e-02	1.90e-03	4.00e-02	3.60e-02
Boron	5	5	1.10e-02	5.30e-02	2.60e-02	8.90e-03	4.50e-02	1.50e-02
Calcium	5	5	2.00e+01	3.70e+01	2.80e+01	2.90e+00	3.40e+01	2.60e+01
Chromium	5	5	1.20e-03	2.30e-03	1.60e-03	2.00e-04	2.00e-03	1.40e-03
Copper	5	5	1.10e-03	5.00e-03	2.50e-03	6.70e-04	3.90e-03	2.10e-03
Iron	5	5	2.70e-01	7.00e-01	4.70e-01	8.70e-02	6.50e-01	4.50e-01
Lead	5	1	1.00e-03	1.70e-03	1.70e-03	.	.	1.70e-03
Magnesium	5	5	5.30e+00	9.50e+00	7.60e+00	6.70e-01	9.10e+00	7.70e+00
Manganese	5	5	5.40e-02	1.10e-01	7.30e-02	1.00e-02	9.50e-02	6.50e-02
Mercury	10	4	4.10e-06	2.00e-04	5.50e-05	2.40e-05	9.90e-05	4.30e-05
Nickel	5	5	2.70e-03	5.40e-03	4.40e-03	4.60e-04	5.40e-03	4.50e-03
Potassium	5	5	1.00e+00	1.90e+00	1.40e+00	1.50e-01	1.70e+00	1.30e+00
Sodium	5	5	2.50e+00	8.70e+00	4.60e+00	1.10e+00	7.10e+00	3.40e+00
Uranium	5	5	2.10e-03	3.60e-03	2.60e-03	2.80e-04	3.20e-03	2.50e-03
Zinc	5	5	5.30e-03	1.60e-02	8.60e-03	2.00e-03	1.30e-02	7.20e-03

Reach 3.03 / Dissolved

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Aluminum	4	4	1.50e-02	3.60e-02	2.30e-02	4.80e-03	3.40e-02	2.00e-02
Antimony	4	3	1.00e-03	7.90e-03	5.90e-03	8.10e-04	7.80e-03	5.50e-03
Arsenic	4	1	1.00e-03	1.60e-03	1.60e-03	.	.	1.60e-03
Barium	4	4	2.40e-02	3.20e-02	2.70e-02	1.60e-03	3.10e-02	2.60e-02
Boron	4	2	3.00e-03	8.10e-02	3.10e-02	2.00e-02	7.90e-02	1.50e-02
Calcium	4	4	1.60e+01	2.60e+01	2.20e+01	2.20e+00	2.70e+01	2.30e+01
Chromium	4	4	1.20e-03	1.70e-03	1.40e-03	1.10e-04	1.70e-03	1.40e-03
Copper	4	3	1.00e-03	4.10e-03	3.20e-03	4.40e-04	4.20e-03	3.10e-03
Iron	4	4	1.70e-01	2.90e-01	2.20e-01	2.70e-02	2.80e-01	2.00e-01
Lead	4	1	1.00e-03	1.20e-03	1.20e-03	.	.	1.20e-03
Magnesium	4	4	4.60e+00	7.60e+00	6.00e+00	6.30e-01	7.50e+00	6.00e+00
Manganese	4	4	4.00e-02	7.30e-02	5.50e-02	6.80e-03	7.10e-02	5.40e-02
Methyl mercury	4	1	5.80e-08	1.00e-07	7.10e-08	.	.	7.10e-08
Nickel	4	4	1.90e-03	5.20e-03	4.10e-03	7.50e-04	5.90e-03	4.70e-03
Potassium	4	4	1.30e+00	1.50e+00	1.40e+00	4.20e-02	1.50e+00	1.40e+00
Sodium	4	4	3.20e+00	4.90e+00	4.10e+00	4.10e-01	5.10e+00	4.20e+00
Sulfate	4	4	2.30e+01	2.90e+01	2.70e+01	1.40e+00	3.10e+01	2.90e+01
Uranium	4	2	1.00e-03	2.40e-03	2.10e-03	1.20e-04	2.40e-03	2.00e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Zinc	4	4	2.30e-03	1.90e-02	9.30e-03	3.70e-03	1.80e-02	8.10e-03
Reach 3.03 / Total								
Aluminum	4	4	1.50e-01	8.30e-01	4.10e-01	1.60e-01	7.80e-01	3.30e-01
Arsenic	4	2	1.00e-03	2.10e-03	1.50e-03	2.40e-04	2.10e-03	1.30e-03
Barium	4	4	3.30e-02	3.70e-02	3.50e-02	9.70e-04	3.70e-02	3.50e-02
Boron	4	2	3.00e-03	3.90e-02	1.60e-02	9.70e-03	3.80e-02	7.60e-03
Calcium	4	4	1.60e+01	2.60e+01	2.30e+01	2.40e+00	2.90e+01	2.50e+01
Chromium	4	4	1.90e-03	2.70e-03	2.20e-03	1.90e-04	2.60e-03	2.10e-03
Cobalt	4	1	1.00e-03	1.30e-03	1.30e-03	.	.	1.30e-03
Copper	4	4	3.30e-03	5.70e-03	4.50e-03	5.40e-04	5.70e-03	4.50e-03
Iron	4	4	4.00e-01	1.40e+00	7.90e-01	2.20e-01	1.30e+00	6.70e-01
Lead	4	4	1.10e-03	2.10e-03	1.60e-03	2.10e-04	2.00e-03	1.50e-03
Magnesium	4	4	4.70e+00	7.60e+00	6.10e+00	6.10e-01	7.50e+00	6.00e+00
Manganese	4	4	6.10e-02	9.70e-02	7.90e-02	9.40e-03	1.00e-01	7.90e-02
Mercury	8	4	3.90e-05	2.00e-04	7.80e-05	1.90e-05	1.10e-04	7.20e-05
Methyl mercury	4	1	1.00e-07	2.40e-07	2.40e-07	.	.	2.40e-07
Nickel	4	4	3.00e-03	6.40e-03	4.70e-03	7.40e-04	6.40e-03	4.70e-03

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Potassium	4	4	1.30e+00	1.70e+00	1.50e+00	8.80e-02	1.70e+00	1.50e+00
Sodium	4	4	3.90e+00	6.70e+00	5.30e+00	6.20e-01	6.70e+00	5.30e+00
Uranium	4	3	1.00e-03	2.50e-03	2.20e-03	1.80e-04	2.60e-03	2.20e-03
Vanadium	4	1	1.00e-03	1.60e-03	1.60e-03	.	.	1.60e-03
Zinc	4	4	1.10e-02	2.40e-02	1.70e-02	3.40e-03	2.50e-02	1.60e-02
Reach 3.04 / Dissolved								
Aluminum	5	5	1.40e-02	3.30e-02	2.20e-02	3.40e-03	2.90e-02	2.00e-02
Antimony	5	5	4.70e-03	5.80e-03	5.20e-03	2.00e-04	5.60e-03	5.30e-03
Arsenic	5	1	1.00e-03	1.60e-03	1.60e-03	.	.	1.60e-03
Barium	5	5	2.70e-02	3.50e-02	3.00e-02	1.40e-03	3.30e-02	2.90e-02
Boron	5	5	3.50e-03	5.70e-02	2.40e-02	9.70e-03	4.50e-02	1.70e-02
Calcium	5	5	2.30e+01	2.60e+01	2.50e+01	4.70e-01	2.60e+01	2.50e+01
Chromium	5	4	1.00e-03	2.00e-03	1.60e-03	1.20e-04	1.90e-03	1.60e-03
Copper	5	5	1.50e-03	5.50e-03	3.20e-03	6.60e-04	4.60e-03	3.00e-03
Iron	5	5	2.30e-02	3.20e-01	1.60e-01	5.10e-02	2.70e-01	1.90e-01
Lead	5	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Magnesium	5	5	5.60e+00	7.70e+00	6.90e+00	4.00e-01	7.80e+00	7.30e+00

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Manganese	5	5	6.40e-02	7.90e-02	6.90e-02	2.50e-03	7.50e-02	6.80e-02
Nickel	5	5	1.40e-03	5.10e-03	3.80e-03	6.80e-04	5.30e-03	4.20e-03
Potassium	5	5	1.10e+00	1.50e+00	1.30e+00	6.90e-02	1.50e+00	1.40e+00
Sodium	5	5	2.90e+00	5.40e+00	3.80e+00	4.80e-01	4.90e+00	3.30e+00
Sulfate	5	5	2.60e+01	2.80e+01	2.70e+01	4.90e-01	2.80e+01	2.80e+01
Uranium	5	5	1.20e-03	2.40e-03	2.00e-03	2.10e-04	2.40e-03	2.00e-03
Zinc	5	5	4.10e-03	1.20e-02	6.50e-03	1.40e-03	9.50e-03	5.20e-03
Reach 3.04 / Total								
Aluminum	5	5	2.50e-01	5.40e-01	3.50e-01	4.90e-02	4.60e-01	3.20e-01
Arsenic	5	1	1.00e-03	1.00e-03	1.00e-03	.	.	1.00e-03
Barium	5	5	3.30e-02	3.50e-02	3.40e-02	4.30e-04	3.50e-02	3.50e-02
Boron	5	4	3.00e-03	6.10e-02	2.20e-02	1.10e-02	4.50e-02	1.60e-02
Calcium	5	5	2.30e+01	2.70e+01	2.50e+01	6.50e-01	2.60e+01	2.50e+01
Chromium	5	5	1.20e-03	2.60e-03	1.90e-03	2.70e-04	2.50e-03	1.80e-03
Cobalt	5	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Copper	5	5	1.70e-03	6.70e-03	3.80e-03	9.30e-04	5.80e-03	4.20e-03
Iron	5	5	4.90e-01	9.80e-01	6.60e-01	9.50e-02	8.70e-01	5.70e-01

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Lead	5	3	1.00e-03	2.10e-03	1.40e-03	2.00e-04	1.80e-03	1.10e-03
Magnesium	5	5	5.60e+00	7.70e+00	6.90e+00	3.90e-01	7.80e+00	7.30e+00
Manganese	5	5	7.50e-02	1.10e-01	8.40e-02	6.20e-03	9.70e-02	7.80e-02
Mercury	10	7	3.00e-05	2.40e-04	1.10e-04	2.60e-05	1.60e-04	1.10e-04
Nickel	5	5	2.00e-03	5.30e-03	4.10e-03	6.70e-04	5.50e-03	5.00e-03
Potassium	5	5	1.10e+00	1.50e+00	1.40e+00	7.00e-02	1.50e+00	1.40e+00
Sodium	5	5	2.80e+00	7.10e+00	4.70e+00	8.40e-01	6.50e+00	4.30e+00
Uranium	5	5	1.90e-03	2.40e-03	2.20e-03	1.00e-04	2.40e-03	2.30e-03
Vanadium	5	1	1.00e-03	1.10e-03	1.10e-03	.	.	1.10e-03
Zinc	5	5	6.30e-03	1.90e-02	1.20e-02	2.60e-03	1.80e-02	1.20e-02
Reach 13 / Dissolved								
Aluminum	14	10	1.00e-02	6.00e-02	2.60e-02	3.50e-03	3.20e-02	2.20e-02
Antimony	14	11	1.00e-03	1.20e-02	4.00e-03	8.00e-04	5.50e-03	3.30e-03
Arsenic	14	2	1.00e-03	1.40e-03	1.10e-03	2.40e-05	1.20e-03	1.10e-03
Barium	14	14	2.20e-02	3.90e-02	3.00e-02	1.10e-03	3.20e-02	3.10e-02
Boron	14	8	3.00e-03	6.00e-02	3.10e-02	3.10e-03	3.70e-02	2.40e-02
Calcium	14	14	1.00e+01	2.60e+01	2.00e+01	1.10e+00	2.20e+01	2.10e+01

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Chromium	14	10	1.00e-03	2.10e-03	1.40e-03	1.10e-04	1.60e-03	1.20e-03
Copper	14	14	1.00e-03	1.10e-02	3.00e-03	7.10e-04	4.30e-03	2.40e-03
Iron	14	11	1.60e-02	2.50e-01	1.20e-01	2.40e-02	1.70e-01	1.50e-01
Lead	14	2	1.00e-03	1.40e-03	1.10e-03	2.10e-05	1.20e-03	1.10e-03
Magnesium	14	14	3.50e+00	8.00e+00	6.90e+00	3.40e-01	7.50e+00	7.40e+00
Manganese	14	14	3.90e-02	1.20e-01	6.40e-02	5.50e-03	7.30e-02	5.90e-02
Nickel	14	14	3.10e-03	6.20e-03	4.60e-03	2.20e-04	5.00e-03	4.50e-03
Potassium	14	14	9.70e-01	3.10e+00	1.30e+00	1.40e-01	1.50e+00	1.20e+00
Sodium	14	14	1.70e+00	4.10e+00	2.70e+00	1.40e-01	3.00e+00	2.60e+00
Sulfate	16	16	2.20e+01	4.60e+01	3.00e+01	1.40e+00	3.20e+01	3.00e+01
Zinc	14	14	2.20e-03	1.10e-02	6.20e-03	7.80e-04	7.60e-03	6.40e-03
Reach 13 / Total								
Aluminum	16	16	9.60e-02	1.60e+00	4.70e-01	1.10e-01	6.60e-01	3.10e-01
Arsenic	16	4	1.00e-03	1.60e-03	1.30e-03	2.40e-05	1.40e-03	1.30e-03
Barium	16	16	3.30e-02	5.40e-02	3.50e-02	1.30e-03	3.80e-02	3.40e-02
Boron	16	12	3.00e-03	4.50e-02	2.70e-02	2.10e-03	3.00e-02	2.70e-02
Calcium	16	16	1.20e+01	2.60e+01	2.00e+01	9.50e-01	2.20e+01	2.20e+01

Table A21 (continued)

Analyte	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median
Chromium	16	14	1.00e-03	3.50e-03	1.90e-03	2.10e-04	2.30e-03	1.70e-03
Cobalt	16	5	1.00e-03	2.00e-03	1.60e-03	4.50e-05	1.70e-03	1.50e-03
Copper	16	16	1.00e-03	1.40e-02	3.90e-03	8.20e-04	5.30e-03	2.60e-03
Iron	16	16	1.90e-01	2.70e+00	8.10e-01	1.80e-01	1.10e+00	6.20e-01
Lead	16	7	1.00e-03	2.90e-03	1.40e-03	1.60e-04	1.70e-03	1.10e-03
Magnesium	16	16	3.70e+00	7.90e+00	6.60e+00	3.30e-01	7.20e+00	7.20e+00
Manganese	16	16	5.90e-02	2.10e-01	9.60e-02	1.00e-02	1.10e-01	7.70e-02
Mercury	32	4	1.80e-06	2.00e-04	7.70e-06	1.40e-06	1.00e-05	5.90e-06
Methyl mercury	15	1	4.50e-08	1.10e-07	9.60e-08	.	.	9.60e-08
Nickel	16	16	2.20e-03	7.80e-03	5.10e-03	3.80e-04	5.70e-03	5.20e-03
Potassium	16	16	1.00e+00	3.20e+00	1.40e+00	1.30e-01	1.60e+00	1.30e+00
Sodium	16	16	2.50e+00	4.90e+00	3.40e+00	2.00e-01	3.70e+00	3.10e+00
Vanadium	16	6	1.00e-03	3.20e-03	1.30e-03	1.60e-04	1.60e-03	1.00e-03
Zinc	16	16	3.90e-03	2.30e-02	1.20e-02	1.70e-03	1.50e-02	1.00e-02

Table A22. Summary statistics of organics (mg/L) in Poplar Creek by reach

Parameter	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UB	Median
Reach 3.01/Dissolved								
Bis(2-ethylhexyl)phthalate	1	1	4.00E-03	4.00E-03	4.00E-03	.	.	4.00E-03
Di-n-butylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Reach 3.01/Total								
Di-n-butylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
PCB-1254	1	1	2.90E-04	2.90E-04	2.90E-04	.	.	2.90E-04
Reach 3.02/Total								
Bis(2-ethylhexyl)phthalate	2	2	2.00E-03	7.00E-03	4.50E-03	0	2.03E-02	4.50E-03
Butylbenzylphthalate	1	1	4.00E-03	4.00E-03	4.00E-03	.	.	4.00E-03
Di-n-octylphthlate	1	1	2.00E-03	2.00E-03	2.00E-03	.	.	2.00E-03
Reach 3.03/Dissolved								
Diethylphthalate	1	1	3.00E-03	3.00E-03	3.00E-03	.	.	3.00E-03
Reach 3.03/Total								
Bis(2-ethylhexyl)phthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Diethylphthalate	1	1	2.00E-03	2.00E-03	2.00E-03	.	.	2.00E-03
Reach 3.04/Total								
PCB-1254	1	1	1.40E-04	1.40E-04	1.40E-04	.	.	1.40E-04
Reach 13/Dissolved								
Benzoic acid	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Benzoic acid	1	1	2.00E-03	2.00E-03	2.00E-03	.	.	2.00E-03
Bis(2-ethylhexyl)phthalate	1	1	3.65E-02	3.65E-02	3.65E-02	.	.	3.65E-02
Bis(2-ethylhexyl)phthalate	3	3	1.00E-03	2.30E-01	7.80E-02	0.08	3.00E-01	3.00E-03
Di-n-butylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Diethylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03

Table A22 (continued)

Parameter	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UB	Median
Diethylphthalate	2	2	1.00E-03	2.00E-03	1.50E-03	0	4.66E-03	1.50E-03
Reach 13/Total								
Di-n-butylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Di-n-butylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Di-n-butylphthalate	1	1	2.00E-03	2.00E-03	2.00E-03	.	.	2.00E-03
Diethylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Diethylphthalate	2	2	1.00E-03	2.00E-03	1.50E-03	0	4.66E-03	1.50E-03
Diethylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
PCB-1254	1	1	4.60E-04	4.60E-04	4.60E-04	.	.	4.60E-04
PCB-1260	1	1	1.02E-03	1.02E-03	1.02E-03	.	.	1.02E-03

Table A23. Summary statistics of organics (mg/L) in Poplar Creek by season

Parameter	Obs.	Detects	Max.	Min.	Mean	Std. Error	95% UCB	Median
Winter/Dissolved								
Benzoic acid	2	2	2.00E-03	1.00E-03	1.50E-03	0	4.66E-03	1.50E-03
Bis(2-ethylhexyl)phthalate	2	2	3.65E-02	1.00E-03	1.88E-02	0.02	1.31E-01	1.88E-02
Di-n-butylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Diethylphthalate	4	4	3.00E-03	1.00E-03	1.75E-03	0	2.88E-03	1.50E-03
Winter/Total								
Bis(2-ethylhexyl)phthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Diethylphthalate	5	5	2.00E-03	1.00E-03	1.40E-03	0	1.92E-03	1.00E-03
PCB-1254	3	3	4.60E-04	1.40E-04	2.97E-04	0	5.67E-04	2.90E-04
PCB-1260	1	1	1.02E-03	1.02E-03	1.02E-03	.	.	1.02E-03
Spring/Dissolved								
Bis(2-ethylhexyl)phthalate	2	2	4.00E-03	3.00E-03	3.50E-03	0	6.66E-03	3.50E-03
Di-n-butylphthalate	1	1	1.00E-03	1.00E-03	1.00E-03	.	.	1.00E-03
Spring/Total								
Bis(2-ethylhexyl)phthalate	1	1	7.00E-03	7.00E-03	7.00E-03	.	.	7.00E-03
Di-n-butylphthalate	2	2	2.00E-03	1.00E-03	1.50E-03	0	4.66E-03	1.50E-03
Summer/Dissolved								
Bis(2-ethylhexyl)phthalate	1	1	2.30E-01	2.30E-01	2.30E-01	.	.	2.30E-01
Summer/Total								
Bis(2-ethylhexyl)phthalate	1	1	2.00E-03	2.00E-03	2.00E-03	.	.	2.00E-03
Butylbenzylphthalate	1	1	4.00E-03	4.00E-03	4.00E-03	.	.	4.00E-03
Di-n-butylphthalate	2	2	1.00E-03	1.00E-03	1.00E-03	0	1.00E-03	1.00E-03
Di-n-octylphthlate	1	1	2.00E-03	2.00E-03	2.00E-03	.	.	2.00E-03

Table A24. Summary statistics for radionuclide results for Poplar Creek by season

Analyte	Media	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median	Units
Spring										
Cesium-137	Dissolved	34	12	-4.08E+00	1.65E+01	2.20E-01	1.00E-01	3.90E-01	0.00E+00	pCi/L
Cesium-137	Residue	36	0	-3.60E-01	4.70E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	34	0	-5.34E+00	7.08E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	36	0	-9.25E+00	4.50E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	34	21	-5.70E-01	4.13E+00	1.23E+00	1.30E-01	1.46E+00	1.08E+00	pCi/L
Gross beta activity	Total	34	26	-2.17E+00	2.27E+01	3.28E+00	6.40E-01	4.36E+00	2.45E+00	pCi/L
Particle associated Co-60		31	0	-1.59E+02	6.21E+01	.	.	.	.	pCi/G
Particle associated Cs-137		28	0	-4.07E+01	4.32E+01	.	.	.	.	pCi/G
Strontium-90	Total	34	4	0.00E+00	3.80E+00	2.32E+00	6.00E-02	2.41E+00	2.24E+00	pCi/L
Tritium	Total	34	0	0.00E+00	1.99E+02	.	.	.	.	pCi/L
Summer										
Cesium-137	Dissolved	37	15	-3.54E+00	1.22E+01	3.30E-01	2.00E-01	6.70E-01	0.00E+00	pCi/L
Cesium-137	Residue	40	0	-3.50E-01	4.50E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	37	0	-5.48E+00	8.13E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	40	0	-5.10E-01	4.50E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	36	11	-7.10E+01	4.33E+00	5.80E-01	1.90E-01	9.00E-01	0.00E+00	pCi/L
Gross beta activity	Total	36	21	-4.60E-01	2.22E+01	4.66E+00	7.30E-01	5.90E+00	2.76E+00	pCi/L
Particle associated Co-60		33	0	-2.98E+01	5.49E+01	.	.	.	.	pCi/G
Particle associated Cs-137		32	0	-5.82E+01	3.98E+01	.	.	.	.	pCi/G
Strontium-90	Total	36	10	-4.35E+00	8.01E+00	2.42E+00	1.90E-01	2.74E+00	2.04E+00	pCi/L
Tritium	Total	36	2	-2.63E+02	1.12E+03	3.26E+02	3.17E+01	3.80E+02	3.03E+02	pCi/L
Winter										
Cesium-137	Dissolved	36	15	-3.17E+00	1.27E+01	3.10E-01	1.50E-01	5.60E-01	5.00E-03	pCi/L
Cesium-137	Residue	36	0	-4.40E-01	5.90E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	36	1	-6.78E+00	6.59E+00	0.00E+00	.	.	0.00E+00	pCi/L

Table A24 (continued)

Analyte	Media	Observations	Detects	Minimum	Maximum	Mean	Std. Error	95% UCB	Median	Units
Cobalt-60	Residue	36	0	-5.30E-01	6.60E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	35	14	-1.28E+00	3.66E+00	1.43E+00	1.10E-01	1.63E+00	1.08E+00	pCi/L
Gross beta activity	Total	35	17	-6.30E+00	8.80E+00	2.42E+00	2.70E-01	2.87E+00	1.50E+00	pCi/L
Particle associated Co-60		31	0	-1.10E+02	9.96E+01	.	.	.	.	pCi/G
Particle associated Cs-137		29	0	-6.55E+01	5.67E+01	.	.	.	.	pCi/G
Strontium-90	Total	38	1	0.00E+00	2.76E+00	2.76E+00	.	.	2.76E+00	pCi/L
Tritium	Total	35	2	0.00E+00	1.89E+03	8.54E+02	4.23E+01	9.26E+02	8.24E+02	pCi/L

Table A25. Summary statistics for radionuclide results for Poplar Creek subreaches

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Subreach 3.01										
Cesium-137	Dissolved	16	6	-2.25E+00	8.66E+00	2.80E-01	1.90E-01	6.20E-01	0.00E+00	pCi/L
Cesium-137	Residue	14	0	-1.90E-01	4.70E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	16	0	-3.25E+00	6.14E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	14	0	-5.10E-01	4.10E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	14	6	-1.62E+01	1.89E+00	1.30E+00	8.00E-02	1.43E+00	1.13E+00	pCi/L
Gross beta activity	Total	14	7	4.10E-01	7.21E+00	3.14E+00	4.80E-01	3.98E+00	2.02E+00	pCi/L
Particle Associated Co-60		12	0	-2.33E+01	2.51E+01	.	.	.	.	pCi/G
Particle Associated Cs-137		12	0	-2.89E+01	3.11E+01	.	.	.	.	pCi/G
Strontium-90	Total	15	2	-1.07E+00	2.49E+00	2.14E+00	3.00E-02	2.20E+00	2.12E+00	pCi/L
Tritium	Total	15	1	-2.19E+02	1.89E+03	1.89E+03	.	.	1.89E+03	pCi/L
Subreach 3.02										
Cesium-137	Dissolved	14	7	-4.08E+00	1.65E+01	1.40E-01	1.40E-01	3.90E-01	0.00E+00	pCi/L
Cesium-137	Residue	17	0	-3.50E-01	3.50E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	14	1	-5.53E+00	3.92E+00	0.00E+00	.	.	0.00E+00	pCi/L
Cobalt-60	Residue	17	0	-4.00E-01	6.60E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	13	8	-4.72E+01	3.58E+00	1.62E+00	2.30E-01	2.02E+00	1.47E+00	pCi/L
Gross beta activity	Total	13	11	5.40E-01	8.80E+00	3.98E+00	5.90E-01	5.03E+00	3.27E+00	pCi/L
Particle Associated Co-60		12	0	-4.18E+01	5.13E+01	.	.	.	.	pCi/G
Particle Associated Cs-137		12	0	-2.70E+01	5.43E+01	.	.	.	.	pCi/G
Strontium-90	Total	14	3	-1.33E+00	3.82E+00	2.84E+00	1.20E-01	3.06E+00	2.69E+00	pCi/L
Tritium	Total	13	1	-1.55E+02	8.24E+02	8.24E+02	.	.	8.24E+02	pCi/L
Subreach 3.03										

Table A25 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Cesium-137	Dissolved	13	6	-2.40E+00	1.02E+01	3.50E-01	2.10E-01	7.20E-01	8.12E-02	pCi/L
Cesium-137	Residue	13	6	-4.40E-01	3.40E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	13	0	-5.48E+00	6.98E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	13	0	-3.00E-01	5.20E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	13	10	-1.66E+01	4.33E+00	1.67E+00	2.50E-01	2.12E+00	1.44E+00	pCi/L
Gross beta activity	Total	13	10	4.00E-02	6.46E+00	3.32E+00	3.60E-01	3.97E+00	3.12E+00	pCi/L
Particle Associated Co-60		13	0	-4.07E+01	5.67E+01	.	.	.	.	pCi/G
Particle Associated Cs-137		13	0	-1.65E+01	6.21E+01	.	.	.	.	pCi/G
Strontium-90	Total	13	1	-2.29E+00	4.14E+00	4.14E+00	.	.	4.14E+00	pCi/L
Tritium	Total	13	0	-2.63E+02	1.09E+02	.	.	.	.	pCi/L
Subreach 3.04										
Cesium-137	Dissolved	14	6	-2.54E+00	1.18E+01	5.10E-01	2.90E-01	1.03E+00	0.00E+00	pCi/L
Cesium-137	Residue	16	0	-4.30E-01	4.40E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	14	0	-3.11E+00	7.08E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	16	0	-4.30E-01	3.90E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	14	11	-7.10E+01	3.85E+00	1.99E+00	2.30E-01	2.40E+00	1.87E+00	pCi/L
Gross beta activity	Total	14	12	1.05E+00	1.65E+01	4.33E+00	9.90E-01	6.09E+00	3.07E+00	pCi/L
Particle Associated Co-60		12	0	-3.24E+01	4.08E+01	.	.	.	.	pCi/G
Particle Associated Cs-137		12	0	-1.66E+01	4.37E+01	.	.	.	.	pCi/G
Strontium-90	Total	14	1	-4.35E+00	3.98E+00	2.36E+00	.	.	2.37E+00	pCi/L
Tritium	Total	14	1	-2.07E+02	3.03E+02	3.03E+02	.	.	3.03E+02	pCi/L

Table A25 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Subreach 13										
Cesium-137	Dissolved	15	6	-1.30E+00	1.22E+01	1.10E-01	9.00E-02	2.60E-01	1.00E-02	pCi/L
Cesium-137	Dissolved	12	4	-3.92E+00	9.36E+00	3.40E-01	3.60E-01	9.80E-01	0.00E+00	pCi/L
Cesium-137	Dissolved	11	5	-2.74E+00	1.17E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	pCi/L
Cesium-137	Dissolved	12	2	-2.17E+00	1.33E+01	8.20E-01	1.06E+00	2.73E+00	0.00E+00	pCi/L
Cesium-137	Residue	15	0	-1.60E-01	5.90E-01	.	.	.	.	pCi/L
Cesium-137	Residue	13	0	-2.90E-01	1.90E-01	.	.	.	.	pCi/L
Cesium-137	Residue	12	0	-3.90E-01	4.50E-01	.	.	.	.	pCi/L
Cesium-137	Residue	12	0	-2.10E-01	1.80E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	15	0	-5.34E+00	6.59E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	12	0	-2.37E+00	6.09E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	11	0	-2.11E+00	8.13E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	12	0	-6.78E+00	6.11E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	15	0	-4.70E-01	4.50E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	13	0	-9.25E+00	1.90E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	12	0	-5.40E-01	5.60E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	12	0	-5.30E-01	3.60E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	14	2	-5.62E+01	1.26E+00	1.09E+00	2.00E-02	1.12E+00	1.08E+00	pCi/L
Gross alpha activity	Total	13	3	-5.39E+01	4.13E+00	1.39E+00	2.80E-01	1.89E+00	1.10E+00	pCi/L
Gross alpha activity	Total	12	3	-4.04E+00	1.23E+00	1.90E-01	1.50E-01	4.60E-01	0.00E+00	pCi/L
Gross alpha activity	Total	12	3	-2.38E+01	1.37E+00	6.70E-01	8.00E-02	8.10E-01	6.00E-01	pCi/L
Gross beta activity	Total	14	6	-3.74E+00	7.95E+00	3.09E+00	4.40E-01	3.87E+00	2.43E+00	pCi/L
Gross beta activity	Total	13	8	-1.48E+00	2.27E+01	4.97E+00	2.21E+00	8.92E+00	1.50E+00	pCi/L
Gross beta activity	Total	12	6	-6.30E+00	1.02E+01	2.99E+00	8.90E-01	4.58E+00	1.45E+00	pCi/L

Table A25 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Gross beta activity	Total	12	4	-2.17E+00	9.51E+00	2.51E+00	7.70E-01	3.90E+00	1.54E+00	pCi/L
Particle Associated Co-60		13	0	-6.15E+01	9.96E+01	.	.	.	.	pCi/G
Particle Associated Co-60		11	0	-9.95E+01	1.63E+01	.	.	.	.	pCi/G
Particle Associated Co-60		11	0	-1.59E+02	9.29E+01	.	.	.	.	pCi/G
Particle Associated Co-60		11	0	-1.10E+02	5.02E+01	.	.	.	.	pCi/G
Particle Associated Cs-137		10	0	-4.63E+01	5.12E+01	.	.	.	.	pCi/G
Particle Associated Cs-137		11	0	-4.87E+01	2.92E+01	.	.	.	.	pCi/G
Particle Associated Cs-137		8	0	-6.55E+01	2.71E+01	.	.	.	.	pCi/G
Particle Associated Cs-137		11	0	-1.41E+01	4.32E+01	.	.	.	.	pCi/G
Strontium-90	Total	15	2	-2.15E+00	2.76E+00	2.47E+00	3.00E-02	2.52E+00	2.45E+00	pCi/L
Strontium-90	Total	13	2	-2.79E+00	3.21E+00	2.28E+00	5.00E-02	2.38E+00	2.24E+00	pCi/L
Strontium-90	Total	12	2	-2.13E+00	8.01E+00	3.15E+00	6.00E-01	4.23E+00	2.71E+00	pCi/L
Strontium-90	Total	12	2	-3.67E+00	3.80E+00	2.18E+00	2.00E-01	2.54E+00	2.03E+00	pCi/L
Tritium	Total	14	1	-2.48E+02	1.12E+03	1.12E+03	.	.	1.12E+03	pCi/L
Tritium	Total	12	0	-1.95E+02	1.99E+02	.	.	.	.	pCi/L
Tritium	Total	12	0	-1.86E+02	1.47E+02	.	.	.	.	pCi/L
Tritium	Total	12	0	-2.00E+02	4.47E+01	.	.	.	.	pCi/L

Table A26. Summary statistics for radionuclides by season for each Poplar Creek subreach

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Spring, Subreach 3.01										
Cesium-137	Dissolved	6	2	-2.25E+00	8.66E+00	0.00E+00	0	0.00E+00	0.00E+00	pCi/L
Cesium-137	Residue	6	0	-1.91E-01	4.72E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	6	0	-3.25E+00	2.74E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	6	0	-1.45E-01	2.76E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	6	4	-5.72E-01	1.89E+00	1.48E+00	0.13	1.73E+00	1.38E+00	pCi/L
Gross beta activity	Total	6	4	6.57E-01	5.21E+00	2.97E+00	0.59	4.16E+00	2.22E+00	pCi/L
Particle associated Co-60[a]		4	0	4.30E+00	3.11E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-2.33E+01	2.51E+01	.	.	.	.	pCi/G
Strontium-90	Total	6	0	0.00E+00	3.70E-01	.	.	.	.	pCi/L
Tritium	Total	6	0	0.00E+00	1.19E+02	.	.	.	.	pCi/L
Spring, Subreach 3.02										
Cesium-137	Dissolved	4	3	-4.08E+00	1.65E+01	4.16E-01	0.42	1.40E+00	0.00E+00	pCi/L
Cesium-137	Residue	5	0	-1.80E-01	1.80E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	4	0	1.19E+00	3.92E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	5	0	-4.03E-01	1.39E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	4	3	9.39E-01	2.63E+00	1.81E+00	0.29	2.50E+00	1.58E+00	pCi/L
Gross beta activity	Total	4	4	2.45E+00	7.98E+00	4.26E+00	1.26	7.22E+00	3.30E+00	pCi/L
Particle associated Co-60		4	0	-1.14E+01	1.16E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-2.72E+01	2.37E+01	.	.	.	.	pCi/G
Strontium-90	Total	4	1	0.00E+00	3.66E+00	2.69E+00	.	.	2.69E+00	pCi/L
Tritium	Total	4	0	1.90E+01	1.11E+02	.	.	.	.	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Spring, Subreach 3.03										
Cesium-137	Dissolved	4	2	-5.99E-01	3.57E+00	3.51E-01	0.35	1.18E+00	3.51E-01	pCi/L
Cesium-137	Residue	4	0	-2.07E-01	-3.76E-02	.	.	.	.	pCi/L
Cobalt-60	Dissolved	4	0	-2.82E+00	6.98E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	4	0	-1.52E-01	4.47E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	4	4	1.02E+00	2.21E+00	1.56E+00	0.27	2.20E+00	1.50E+00	pCi/L
Gross beta activity	Total	4	4	2.20E+00	3.12E+00	2.66E+00	0.21	3.15E+00	2.66E+00	pCi/L
Particle associated Co-60		4	0	-1.41E+01	6.21E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-4.07E+01	-1.65E+00	.	.	.	.	pCi/G
Strontium-90	Total	4	0	0.00E+00	1.05E+00	.	.	.	.	pCi/L
Tritium	Total	4	0	0.00E+00	9.12E+01	.	.	.	.	pCi/L
Spring, Subreach 3.04										
Cesium-137	Dissolved	3	1	-2.54E+00	1.12E+01	8.72E-01	.	.	8.72E-01	pCi/L
Cesium-137	Residue	3	0	-3.37E-02	1.00E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	3	0	-7.57E-01	7.08E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	3	0	1.01E-02	2.10E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	3	3	1.39E+00	2.20E+00	1.78E+00	0.23	2.47E+00	1.76E+00	pCi/L
Gross beta activity	Total	3	3	2.76E+00	4.07E+00	3.35E+00	0.38	4.47E+00	3.23E+00	pCi/L
Particle associated Co-60		3	0	7.78E-01	2.21E+01	.	.	.	.	pCi/G
Particle associated Cs-137		3	0	-3.83E+00	8.09E+00	.	.	.	.	pCi/G
Strontium-90	Total	3	0	4.78E-01	1.55E+00	.	.	.	.	pCi/L
Tritium	Total	3	0	0.00E+00	1.58E+02	.	.	.	.	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Spring, Subreach 13										
Cesium-137	Dissolved	4	1	6.22E-01	1.06E+01	6.22E-01	.	.	6.22E-01	pCi/L
Cesium-137	Dissolved	5	2	-3.92E+00	9.36E+00	0.00E+00	0	0.00E+00	0.00E+00	pCi/L
Cesium-137	Dissolved	4	1	-1.15E+00	1.17E+01	0.00E+00	.	.	0.00E+00	pCi/L
Cesium-137	Dissolved	4	0	-1.60E+00	1.33E+01	.	.	.	.	pCi/L
Cesium-137	Residue	4	0	-8.82E-02	8.53E-02	.	.	.	.	pCi/L
Cesium-137	Residue	6	0	-2.14E-01	1.93E-01	.	.	.	.	pCi/L
Cesium-137	Residue	4	0	-3.61E-01	7.11E-02	.	.	.	.	pCi/L
Cesium-137	Residue	4	0	-2.12E-01	1.56E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	4	0	-5.34E+00	5.00E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	5	0	-2.37E+00	5.94E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	4	0	-1.20E+00	3.26E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	4	0	-1.39E+00	6.11E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	4	0	-4.67E-01	2.80E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	6	0	-9.25E+00	1.54E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	4	0	-5.42E-01	7.87E-02	.	.	.	.	pCi/L
Cobalt-60	Residue	4	0	-3.58E-01	3.12E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	4	1	1.10E-01	1.26E+00	1.26E+00	.	.	1.26E+00	pCi/L
Gross alpha activity	Total	5	2	3.97E-01	4.13E+00	1.71E+00	0.77	3.34E+00	1.10E+00	pCi/L
Gross alpha activity	Total	4	1	-5.15E-01	1.05E+00	1.05E+00	.	.	1.05E+00	pCi/L
Gross alpha activity	Total	4	3	6.00E-01	1.37E+00	8.31E-01	0.19	1.29E+00	7.03E-01	pCi/L
Gross beta activity	Total	4	2	5.43E-01	2.86E+00	2.79E+00	0.03	2.86E+00	2.77E+00	pCi/L
Gross beta activity	Total	5	4	1.19E+00	2.27E+01	6.23E+00	4.27	1.53E+01	2.26E+00	pCi/L
Gross beta activity	Total	4	2	1.13E+00	3.51E+00	1.97E+00	0.63	3.45E+00	1.45E+00	pCi/L
Gross beta activity	Total	4	3	-2.17E+00	5.05E+00	2.45E+00	0.92	4.61E+00	1.60E+00	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Particle associated Co-60		4	0	-1.59E+02	5.89E+00	.	.	.	.	pCi/G
Particle associated Co-60		4	0	-6.15E+01	1.20E+01	.	.	.	.	pCi/G
Particle associated Co-60		4	0	-4.73E+01	1.10E+01	.	.	.	.	pCi/G
Particle associated Co-60		4	0	-4.42E+01	1.79E+01	.	.	.	.	pCi/G
Particle associated Cs-137		2	0	-9.80E+00	-1.80E+00	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-3.14E+01	1.38E+01	.	.	.	.	pCi/G
Particle associated Cs-137		3	0	-3.84E+01	4.44E+00	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-1.22E+01	4.32E+01	.	.	.	.	pCi/G
Strontium-90	Total	4	0	0.00E+00	9.23E-01	.	.	.	.	pCi/L
Strontium-90	Total	5	1	0.00E+00	2.24E+00	2.24E+00	.	.	2.24E+00	pCi/L
Strontium-90	Total	4	1	0.00E+00	2.71E+00	2.71E+00	.	.	2.71E+00	pCi/L
Strontium-90	Total	4	1	2.24E-01	3.80E+00	3.80E+00	.	.	3.80E+00	pCi/L
Tritium	Total	4	0	2.70E+01	1.01E+02	.	.	.	.	pCi/L
Tritium	Total	5	0	0.00E+00	1.99E+02	.	.	.	.	pCi/L
Tritium	Total	4	0	0.00E+00	1.47E+02	.	.	.	.	pCi/L
Tritium	Total	4	0	0.00E+00	3.84E+01	.	.	.	.	pCi/L
Summer, Subreach 3.01										
Cesium-137	Dissolved	4	2	-1.70E+00	1.46E+00	4.43E-01	0.51	1.65E+00	0.00E+00	pCi/L
Cesium-137	Residue	4	0	-5.26E-02	4.25E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	4	0	-8.64E-01	6.14E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	4	0	-5.09E-01	4.08E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	4	1	-1.62E+01	1.60E+00	1.60E+00	.	.	1.60E+00	pCi/L
Gross beta activity	Total	4	2	7.51E-01	7.21E+00	4.24E+00	1.21	7.09E+00	3.25E+00	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Particle associated Co-60		4	0	-2.89E+01	2.27E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-4.27E+00	2.41E+01	.	.	.	.	pCi/G
Strontium-90	Total	4	2	-1.07E+00	2.49E+00	2.21E+00	0.11	2.48E+00	2.12E+00	pCi/L
Tritium	Total	4	0	-2.19E+02	7.73E+01	.	.	.	.	pCi/L
Summer, Subreach 3.02										
Cesium-137	Dissolved	5	2	-3.54E+00	9.14E+00	0.00E+00	0	0.00E+00	0.00E+00	pCi/L
Cesium-137	Residue	6	0	-3.52E-01	3.49E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	5	0	-1.17E+00	1.68E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	6	0	-5.96E-02	3.27E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	4	2	-4.72E+01	1.76E+00	1.19E+00	0.23	1.74E+00	1.00E+00	pCi/L
Gross beta activity	Total	4	2	5.43E-01	5.06E+00	4.03E+00	0.42	5.02E+00	3.69E+00	pCi/L
Particle associated Co-60		4	0	8.72E-01	5.11E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-1.22E+01	3.33E+01	.	.	.	.	pCi/G
Strontium-90	Total	4	2	-1.33E+00	3.82E+00	3.72E+00	0.04	3.82E+00	3.68E+00	pCi/L
Tritium	Total	4	0	-1.55E+02	4.31E+01	.	.	.	.	pCi/L
Summer, Subreach 3.03										
Cesium-137	Dissolved	5	2	-2.40E+00	5.96E+00	8.12E-02	0.08	2.54E-01	8.12E-02	pCi/L
Cesium-137	Residue	5	0	-7.41E-02	3.43E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	5	0	-5.48E+00	1.79E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	5	0	-2.95E-01	4.34E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	5	3	-1.66E+01	4.33E+00	2.17E+00	0.61	3.48E+00	1.44E+00	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Gross beta activity	Total	5	4	9.51E-01	6.46E+00	4.36E+00	0.64	5.73E+00	4.00E+00	pCi/L
Particle associated Co-60		5	0	-1.65E+01	5.05E+01	.	.	.	.	pCi/G
Particle associated Cs-137		5	0	-4.31E+00	3.98E+01	.	.	.	.	pCi/G
Strontium-90	Total	5	1	-2.29E+00	4.14E+00	4.14E+00	.	.	4.14E+00	pCi/L
Tritium	Total	5	0	-2.63E+02	9.95E+01	.	.	.	.	pCi/L
Summer, Subreach 3.04										
Cesium-137	Dissolved	5	3	-1.76E+00	7.93E+00	0.00E+00	0	0.00E+00	0.00E+00	pCi/L
Cesium-137	Residue	6	0	-1.05E-01	2.90E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	5	0	-2.32E+00	5.80E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	6	0	-3.63E-01	1.77E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	5	3	-7.10E+01	3.85E+00	1.97E+00	0.55	3.14E+00	1.27E+00	pCi/L
Gross beta activity	Total	5	4	2.46E+00	1.65E+01	6.54E+00	2.65	1.22E+01	4.56E+00	pCi/L
Particle associated Co-60		4	0	-2.98E+01	1.28E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-1.82E+00	2.10E+01	.	.	.	.	pCi/G
Strontium-90	Total	5	1	-4.35E+00	3.98E+00	2.36E+00	.	.	2.37E+00	pCi/L
Tritium	Total	5	1	-2.07E+02	3.03E+02	3.03E+02	.	.	3.03E+02	pCi/L
Summer, Subreach 13										
Cobalt-60	Dissolved	4	0	-2.11E+00	8.13E+00		.	.	.	pCi/L
Cesium-137	Dissolved	5	1	-1.30E+00	1.22E+01	0.00E+00	.	.	0.00E+00	pCi/L
Cesium-137	Dissolved	4	1	1.08E+00	4.18E+00	2.02E+00	.	.	2.02E+00	pCi/L
Cesium-137	Dissolved	4	2	-7.04E-01	5.91E+00	0.00E+00	0	0.00E+00	0.00E+00	pCi/L
Cesium-137	Dissolved	5	2	-2.17E+00	8.57E+00	1.65E+00	1.9	5.70E+00	0.00E+00	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Cesium-137	Residue	5	0	-1.57E-01	1.58E-01	.	.	.	.	pCi/L
Cesium-137	Residue	4	0	-1.87E-01	1.05E-01	.	.	.	.	pCi/L
Cesium-137	Residue	5	0	-3.26E-01	4.54E-01	.	.	.	.	pCi/L
Cesium-137	Residue	5	0	-1.28E-01	1.83E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	5	0	-3.98E+00	2.60E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	4	0	-4.18E-01	3.06E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	5	0	-4.75E+00	1.93E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	5	0	-2.78E-01	4.50E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	4	0	-7.84E-02	1.95E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	5	0	-1.82E-01	2.51E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	5	0	-2.12E-01	3.63E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	5	0	-5.62E+01	9.93E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	4	0	-5.39E+01	2.06E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	4	2	-4.04E+00	1.23E+00	3.08E-01	0.38	1.19E+00	0.00E+00	pCi/L
Gross alpha activity	Total	5	0	-2.38E+01	9.27E-01	.	.	.	.	pCi/L
Gross beta activity	Total	5	3	-4.59E-01	7.95E+00	4.23E+00	1.14	6.65E+00	2.71E+00	pCi/L
Gross beta activity	Total	4	2	1.18E-01	2.22E+01	7.06E+00	6.18	2.16E+01	2.01E+00	pCi/L
Gross beta activity	Total	4	3	5.85E-01	1.02E+01	5.75E+00	2.06	1.06E+01	5.16E+00	pCi/L
Gross beta activity	Total	5	1	3.26E-01	9.51E+00	9.51E+00	.	.	9.51E+00	pCi/L
Particle associated Co-60		4	0	-1.04E+01	5.49E+01	.	.	.	.	pCi/G
Particle associated Co-60		4	0	-4.00E+00	9.80E+00	.	.	.	.	pCi/G
Particle associated Co-60		4	0	-4.97E+00	4.03E+01	.	.	.	.	pCi/G
Particle associated Co-60		4	0	1.28E+00	5.02E+01	.	.	.	.	pCi/G
Particle associated Cs-137		3	0	-7.68E+00	1.56E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-9.56E+00	5.82E+00	.	.	.	.	pCi/G

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Particle associated Cs-137		4	0	-5.82E+01	2.70E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-1.41E+01	1.09E+01	.	.	.	.	pCi/G
Strontium-90	Total	5	1	-2.15E+00	2.45E+00	2.45E+00	.	.	2.45E+00	pCi/L
Strontium-90	Total	4	1	-2.79E+00	3.21E+00	2.71E+00	.	.	2.71E+00	pCi/L
Strontium-90	Total	4	1	-2.13E+00	8.01E+00	8.01E+00	.	.	8.01E+00	pCi/L
Strontium-90	Total	5	1	-3.67E+00	2.03E+00	2.03E+00	.	.	2.03E+00	pCi/L
Tritium	Total	5	1	-2.48E+02	1.12E+03	1.12E+03	.	.	1.12E+03	pCi/L
Tritium	Total	4	0	-1.95E+02	0.00E+00	.	.	.	.	pCi/L
Tritium	Total	4	0	-1.86E+02	0.00E+00	.	.	.	.	pCi/L
Tritium	Total	5	0	-2.00E+02	0.00E+00	.	.	.	.	pCi/L
Winter, Subreach 3.01										
Cesium-137	Dissolved	6	2	5.14E-03	8.00E+00	3.06E-01	0.35	1.01E+00	1.00E-02	pCi/L
Cesium-137	Residue	4	0	-1.66E-02	9.16E-02	.	.	.	.	pCi/L
Cobalt-60	Dissolved	6	0	-1.14E+00	2.18E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	4	0	1.48E-02	1.88E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	4	1	-6.86E-01	1.13E+00	1.13E+00	.	.	1.13E+00	pCi/L
Gross beta activity	Total	4	1	4.06E-01	5.54E+00	5.54E+00	.	.	5.54E+00	pCi/L
Particle associated Co-60		4	0	1.45E+00	1.81E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-7.61E-01	1.99E+01	.	.	.	.	pCi/G
Strontium-90	Total	5	0	0.00E+00	1.68E+00	.	.	.	.	pCi/L
Tritium	Total	5	1	0.00E+00	1.89E+03	1.89E+03	.	.	1.89E+03	pCi/L
Winter, Subreach 3.02										

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Cesium-137	Dissolved	5	2	-3.17E+00	5.47E+00	0.00E+00	0	0.00E+00	0.00E+00	pCi/L
Cesium-137	Residue	6	0	-3.17E-01	2.48E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	5	1	-5.53E+00	1.87E+00	0.00E+00	.	.	0.00E+00	pCi/L
Cobalt-60	Residue	6	0	-2.21E-01	6.60E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	5	3	3.14E-01	3.58E+00	2.23E+00	0.38	3.03E+00	1.81E+00	pCi/L
Gross beta activity	Total	5	5	2.51E+00	8.80E+00	4.20E+00	1.2	6.75E+00	2.90E+00	pCi/L
Particle associated Co-60		4	0	-2.70E+01	5.43E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-4.18E+01	5.13E+01	.	.	.	.	pCi/G
Strontium-90	Total	6	0	0.00E+00	1.61E+00	.	.	.	.	pCi/L
Tritium	Total	5	1	0.00E+00	8.24E+02	8.24E+02	.	.	8.24E+02	pCi/L
Winter, Subreach 3.03										
Cesium-137	Dissolved	4	2	-4.72E-01	1.02E+01	6.17E-01	0.62	2.07E+00	6.17E-01	pCi/L
Cesium-137	Residue	4	0	-4.37E-01	2.38E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	4	0	-1.11E+00	4.26E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	4	0	3.18E-02	5.15E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	4	3	7.75E-01	1.65E+00	1.42E+00	0.09	1.65E+00	1.38E+00	pCi/L
Gross beta activity	Total	4	2	4.01E-02	4.17E+00	3.40E+00	0.32	4.14E+00	3.14E+00	pCi/L
Particle associated Co-60		4	0	2.15E+00	4.83E+01	.	.	.	.	pCi/G
Particle associated Cs-137		4	0	-9.76E+00	5.67E+01	.	.	.	.	pCi/G
Strontium-90	Total	4	0	0.00E+00	5.23E-01	.	.	.	.	pCi/L
Tritium	Total	4	0	0.00E+00	1.09E+02	.	.	.	.	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Winter, Subreach 3.04										
Cesium-137	Dissolved	6	2	6.95E-01	1.18E+01	1.29E+00	0.68	2.66E+00	6.95E-01	pCi/L
Cesium-137	Residue	7	0	-4.27E-01	4.37E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	6	0	-3.11E+00	2.84E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	7	0	-4.28E-01	3.92E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	6	5	1.11E+00	3.66E+00	2.13E+00	0.36	2.86E+00	1.98E+00	pCi/L
Gross beta activity	Total	6	5	1.05E+00	4.86E+00	3.08E+00	0.47	4.02E+00	2.64E+00	pCi/L
Particle associated Co-60		5	0	-3.24E+01	4.08E+01	.	.	.	.	pCi/G
Particle associated Cs-137		5	0	-1.66E+01	4.37E+01	.	.	.	.	pCi/G
Strontium-90	Total	6	0	0.00E+00	6.73E-01	.	.	.	.	pCi/L
Tritium	Total	6	0	0.00E+00	1.04E+02	.	.	.	.	pCi/L
Winter, Subreach 13										
Cesium-137	Dissolved	6	4	-1.59E-01	4.74E+00	3.47E-02	0.02	7.23E-02	3.40E-02	pCi/L
Cesium-137	Dissolved	3	1	-1.90E+00	8.12E+00	0.00E+00	.	.	0.00E+00	pCi/L
Cesium-137	Dissolved	3	2	-2.74E+00	5.13E+00	0.00E+00	0	0.00E+00	0.00E+00	pCi/L
Cesium-137	Dissolved	3	0	2.29E+00	1.27E+01	.	.	.	.	pCi/L
Cesium-137	Residue	6	0	-1.48E-01	5.88E-01	.	.	.	.	pCi/L
Cesium-137	Residue	3	0	-2.92E-01	1.17E-01	.	.	.	.	pCi/L
Cesium-137	Residue	3	0	-3.93E-01	1.74E-01	.	.	.	.	pCi/L
Cesium-137	Residue	3	0	-4.18E-03	1.56E-01	.	.	.	.	pCi/L
Cobalt-60	Dissolved	6	0	-3.55E+00	6.59E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	3	0	5.62E-01	6.09E+00	.	.	.	.	pCi/L
Cobalt-60	Dissolved	3	0	1.03E+00	3.42E+00	.	.	.	.	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Cobalt-60	Dissolved	3	0	-6.78E+00	1.61E+00	.	.	.	.	pCi/L
Cobalt-60	Residue	6	0	-5.97E-02	3.19E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	3	0	-3.98E-01	9.81E-02	.	.	.	.	pCi/L
Cobalt-60	Residue	3	0	-7.08E-02	5.58E-01	.	.	.	.	pCi/L
Cobalt-60	Residue	3	0	-5.27E-01	1.86E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	5	1	-2.01E-01	1.08E+00	1.08E+00	.	.	1.08E+00	pCi/L
Gross alpha activity	Total	4	1	3.73E-01	1.87E+00	1.87E+00	.	.	1.87E+00	pCi/L
Gross alpha activity	Total	4	0	2.51E-01	6.76E-01	.	.	.	.	pCi/L
Gross alpha activity	Total	3	0	-1.28E+00	9.99E-02	.	.	.	.	pCi/L
Gross beta activity	Total	5	1	-3.74E+00	2.43E+00	2.43E+00	.	.	2.43E+00	pCi/L
Gross beta activity	Total	4	2	-1.48E+00	1.91E+00	1.60E+00	0.13	1.90E+00	1.50E+00	pCi/L
Gross beta activity	Total	4	1	-6.30E+00	1.65E+00	1.65E+00	.	.	1.65E+00	pCi/L
Gross beta activity	Total	3	0	2.49E-02	1.45E+00	.	.	.	.	pCi/L
Particle associated Co-60		5	0	1.82E+00	9.96E+01	.	.	.	.	pCi/G
Particle associated Co-60		3	0	-9.95E+01	1.63E+01	.	.	.	.	pCi/G
Particle associated Co-60		3	0	-2.21E+01	9.29E+01	.	.	.	.	pCi/G
Particle associated Co-60		3	0	-1.10E+02	1.91E+01	.	.	.	.	pCi/G
Particle associated Cs-137		5	0	-4.63E+01	5.12E+01	.	.	.	.	pCi/G
Particle associated Cs-137		3	0	-4.87E+01	2.92E+01	.	.	.	.	pCi/G
Particle associated Cs-137		1	0	-6.55E+01	-6.55E+01	.	.	.	.	pCi/G
Particle associated Cs-137		3	0	-8.71E-01	3.54E+01	.	.	.	.	pCi/G
Strontium-90	Total	6	1	0.00E+00	2.76E+00	2.76E+00	.	.	2.76E+00	pCi/L
Strontium-90	Total	4	0	0.00E+00	0.00E+00	.	.	.	.	pCi/L
Strontium-90	Total	4	0	0.00E+00	6.82E-01	.	.	.	.	pCi/L
Strontium-90	Total	3	0	0.00E+00	7.09E-02	.	.	.	.	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A26 (continued)

Analyte	Media	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median	Units
Tritium	Total	5	0	0.00E+00	1.31E+02	.	.	.	.	pCi/L
Tritium	Total	3	0	0.00E+00	9.15E+01	.	.	.	.	pCi/L
Tritium	Total	4	0	0.00E+00	6.67E+01	.	.	.	.	pCi/L
Tritium	Total	3	0	0.00E+00	4.47E+01	.	.	.	.	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A27. Inorganic concentrations associated with the water toxicity subtask. Nondetectable results are not included. Poplar Creek sites are not included as they are already included in the Poplar Creek Contaminant Study results.

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
CRM	19	2.03	spring	Antimony	Dissolved	4.20e-03
CRM	19	2.03	spring	Barium	Dissolved	2.11e-02
CRM	19	2.03	spring	Boron	Dissolved	7.48e-02
CRM	19	2.03	spring	Calcium	Dissolved	2.74e+01
CRM	19	2.03	spring	Chloride	Dissolved	7.10e+00
CRM	19	2.03	spring	Chromium	Dissolved	2.00e-03
CRM	19	2.03	spring	Copper	Dissolved	3.60e-03
CRM	19	2.03	spring	Iron	Dissolved	3.63e-02
CRM	19	2.03	spring	Lead	Dissolved	1.50e-03
CRM	19	2.03	spring	Magnesium	Dissolved	7.51e+00
CRM	19	2.03	spring	Manganese	Dissolved	5.30e-03
CRM	19	2.03	spring	Nickel	Dissolved	2.60e-03
CRM	19	2.03	spring	Nitrate/nitrite	Dissolved	7.10e-01
CRM	19	2.03	spring	Potassium	Dissolved	1.32e+00
CRM	19	2.03	spring	Sodium	Dissolved	3.41e+00
CRM	19	2.03	spring	Sulfate	Dissolved	1.60e+01
CRM	19	2.03	spring	Zinc	Dissolved	4.40e-03
CRM	19	2.03	summer	Aluminum	Dissolved	9.70e-03
CRM	19	2.03	summer	Antimony	Dissolved	3.20e-03
CRM	19	2.03	summer	Barium	Dissolved	2.43e-02
CRM	19	2.03	summer	Calcium	Dissolved	2.47e+01
CRM	19	2.03	summer	Chloride	Dissolved	3.40e+00
CRM	19	2.03	summer	Chromium	Dissolved	2.70e-03
CRM	19	2.03	summer	Copper	Dissolved	3.20e-03
CRM	19	2.03	summer	Fluoride	Dissolved	7.00e-02
CRM	19	2.03	summer	Iron	Dissolved	4.69e-01
CRM	19	2.03	summer	Magnesium	Dissolved	6.31e+00
CRM	19	2.03	summer	Manganese	Dissolved	1.60e-03
CRM	19	2.03	summer	Nickel	Dissolved	8.30e-03
CRM	19	2.03	summer	Nitrate/nitrite	Dissolved	4.40e-01
CRM	19	2.03	summer	Potassium	Dissolved	1.23e+00
CRM	19	2.03	summer	Selenium	Dissolved	5.00e-03
CRM	19	2.03	summer	Sodium	Dissolved	3.15e+00
CRM	19	2.03	summer	Sulfate	Dissolved	1.70e+01
CRM	19	2.03	summer	Zinc	Dissolved	5.10e-03
CRM	19	2.03	winter	Antimony	Dissolved	5.90e-03
CRM	19	2.03	winter	Barium	Dissolved	2.81e-02
CRM	19	2.03	winter	Calcium	Dissolved	3.33e+01
CRM	19	2.03	winter	Chloride	Dissolved	5.70e+00
CRM	19	2.03	winter	Chromium	Dissolved	1.30e-03
CRM	19	2.03	winter	Copper	Dissolved	3.10e-03

Table A27 (continued)

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
CRM	19	2.03	winter	Iron	Dissolved	2.20e-01
CRM	19	2.03	winter	Magnesium	Dissolved	9.73e+00
CRM	19	2.03	winter	Manganese	Dissolved	6.00e-03
CRM	19	2.03	winter	Nickel	Dissolved	2.70e-03
CRM	19	2.03	winter	Nitrate/nitrite	Dissolved	3.90e-01
CRM	19	2.03	winter	Potassium	Dissolved	1.54e+00
CRM	19	2.03	winter	Sodium	Dissolved	5.37e+00
CRM	19	2.03	winter	Sulfate	Dissolved	2.30e+01
CRM	19	2.03	winter	Zinc	Dissolved	4.20e-03
CRM	19	2.03	spring	Alkalinity as CaCO3	Total	1.70e+00
CRM	19	2.03	spring	Aluminum	Total	2.84e-01
CRM	19	2.03	spring	Barium	Total	2.66e-02
CRM	19	2.03	spring	Boron	Total	6.69e-02
CRM	19	2.03	spring	Calcium	Total	2.93e+01
CRM	19	2.03	spring	Chromium	Total	3.40e-03
CRM	19	2.03	spring	Copper	Total	6.00e-03
CRM	19	2.03	spring	Iron	Total	4.12e-01
CRM	19	2.03	spring	Lead	Total	2.20e-03
CRM	19	2.03	spring	Magnesium	Total	7.88e+00
CRM	19	2.03	spring	Manganese	Total	4.76e-02
CRM	19	2.03	spring	Nickel	Total	3.10e-03
CRM	19	2.03	spring	Potassium	Total	1.47e+00
CRM	19	2.03	spring	Sodium	Total	5.53e+00
CRM	19	2.03	spring	Zinc	Total	1.74e-02
CRM	19	2.03	summer	Alkalinity as CaCO3	Total	1.80e+00
CRM	19	2.03	summer	Aluminum	Total	3.89e-02
CRM	19	2.03	summer	Barium	Total	2.62e-02
CRM	19	2.03	summer	Calcium	Total	2.56e+01
CRM	19	2.03	summer	Chromium	Total	1.60e-03
CRM	19	2.03	summer	Copper	Total	2.10e-03
CRM	19	2.03	summer	Iron	Total	5.13e-01
CRM	19	2.03	summer	Magnesium	Total	6.62e+00
CRM	19	2.03	summer	Manganese	Total	3.44e-02
CRM	19	2.03	summer	Potassium	Total	1.27e+00
CRM	19	2.03	summer	Sodium	Total	3.24e+00
CRM	19	2.03	summer	Zinc	Total	4.70e-03
CRM	19	2.03	winter	Alkalinity as CaCO3	Total	2.10e+00
CRM	19	2.03	winter	Aluminum	Total	7.89e-02
CRM	19	2.03	winter	Barium	Total	3.06e-02
CRM	19	2.03	winter	Calcium	Total	3.42e+01
CRM	19	2.03	winter	Chromium	Total	1.40e-03
CRM	19	2.03	winter	Copper	Total	1.90e-03
CRM	19	2.03	winter	Iron	Total	3.27e-01

Table A27 (continued)

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
CRM	19	2.03	winter	Magnesium	Total	9.98e+00
CRM	19	2.03	winter	Manganese	Total	3.19e-02
CRM	19	2.03	winter	Nickel	Total	2.40e-03
CRM	19	2.03	winter	Potassium	Total	1.54e+00
CRM	19	2.03	winter	Sodium	Total	5.33e+00
CRM	19	2.03	winter	Zinc	Total	6.30e-03
CRM	22	2.01	spring	Aluminum	Dissolved	1.70e-02
CRM	22	2.01	spring	Antimony	Dissolved	3.90e-03
CRM	22	2.01	spring	Barium	Dissolved	2.12e-02
CRM	22	2.01	spring	Boron	Dissolved	1.01e-01
CRM	22	2.01	spring	Calcium	Dissolved	2.76e+01
CRM	22	2.01	spring	Chloride	Dissolved	3.30e+00
CRM	22	2.01	spring	Chromium	Dissolved	1.20e-03
CRM	22	2.01	spring	Copper	Dissolved	3.60e-03
CRM	22	2.01	spring	Iron	Dissolved	3.82e-02
CRM	22	2.01	spring	Lead	Dissolved	2.50e-03
CRM	22	2.01	spring	Magnesium	Dissolved	7.65e+00
CRM	22	2.01	spring	Manganese	Dissolved	5.40e-03
CRM	22	2.01	spring	Nickel	Dissolved	3.70e-03
CRM	22	2.01	spring	Nitrate/nitrite	Dissolved	7.30e-01
CRM	22	2.01	spring	Potassium	Dissolved	1.37e+00
CRM	22	2.01	spring	Sodium	Dissolved	3.46e+00
CRM	22	2.01	spring	Sulfate	Dissolved	1.70e+01
CRM	22	2.01	spring	Zinc	Dissolved	1.26e-02
CRM	22	2.01	summer	Aluminum	Dissolved	3.72e-02
CRM	22	2.01	summer	Antimony	Dissolved	2.90e-03
CRM	22	2.01	summer	Barium	Dissolved	2.27e-02
CRM	22	2.01	summer	Boron	Dissolved	2.22e-02
CRM	22	2.01	summer	Calcium	Dissolved	2.33e+01
CRM	22	2.01	summer	Chloride	Dissolved	3.60e+00
CRM	22	2.01	summer	Chromium	Dissolved	3.17e-03
CRM	22	2.01	summer	Copper	Dissolved	3.04e-03
CRM	22	2.01	summer	Fluoride	Dissolved	1.00e-01
CRM	22	2.01	summer	Iron	Dissolved	4.50e-01
CRM	22	2.01	summer	Magnesium	Dissolved	5.88e+00
CRM	22	2.01	summer	Manganese	Dissolved	1.62e-03
CRM	22	2.01	summer	Nickel	Dissolved	8.49e-03
CRM	22	2.01	summer	Nitrate/nitrite	Dissolved	4.20e-01
CRM	22	2.01	summer	Potassium	Dissolved	1.18e+00
CRM	22	2.01	summer	Selenium	Dissolved	3.20e-03
CRM	22	2.01	summer	Sodium	Dissolved	3.11e+00
CRM	22	2.01	summer	Sulfate	Dissolved	1.80e+01
CRM	22	2.01	summer	Zinc	Dissolved	3.94e-03

Table A27 (continued)

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
CRM	22	2.01	winter	Aluminum	Dissolved	1.16e-02
CRM	22	2.01	winter	Barium	Dissolved	2.94e-02
CRM	22	2.01	winter	Calcium	Dissolved	3.37e+01
CRM	22	2.01	winter	Chloride	Dissolved	4.70e+00
CRM	22	2.01	winter	Chromium	Dissolved	1.20e-03
CRM	22	2.01	winter	Copper	Dissolved	1.30e-03
CRM	22	2.01	winter	Iron	Dissolved	2.23e-01
CRM	22	2.01	winter	Magnesium	Dissolved	9.54e+00
CRM	22	2.01	winter	Manganese	Dissolved	5.60e-03
CRM	22	2.01	winter	Nickel	Dissolved	2.40e-03
CRM	22	2.01	winter	Nitrate/nitrite	Dissolved	3.90e-01
CRM	22	2.01	winter	Potassium	Dissolved	1.48e+00
CRM	22	2.01	winter	Sodium	Dissolved	5.14e+00
CRM	22	2.01	winter	Sulfate	Dissolved	2.30e+01
CRM	22	2.01	winter	Zinc	Dissolved	5.20e-03
CRM	22	2.01	spring	Alkalinity as CaCO3	Total	1.70e+00
CRM	22	2.01	spring	Aluminum	Total	2.43e-01
CRM	22	2.01	spring	Barium	Total	2.51e-02
CRM	22	2.01	spring	Boron	Total	9.02e-02
CRM	22	2.01	spring	Calcium	Total	2.91e+01
CRM	22	2.01	spring	Chromium	Total	2.70e-03
CRM	22	2.01	spring	Copper	Total	5.80e-03
CRM	22	2.01	spring	Iron	Total	3.64e-01
CRM	22	2.01	spring	Lead	Total	2.70e-03
CRM	22	2.01	spring	Magnesium	Total	7.61e+00
CRM	22	2.01	spring	Manganese	Total	4.65e-02
CRM	22	2.01	spring	Nickel	Total	3.60e-03
CRM	22	2.01	spring	Potassium	Total	1.41e+00
CRM	22	2.01	spring	Sodium	Total	5.36e+00
CRM	22	2.01	spring	Zinc	Total	1.36e-02
CRM	22	2.01	summer	Alkalinity as CaCO3	Total	1.80e+00
CRM	22	2.01	summer	Aluminum	Total	6.04e-02
CRM	22	2.01	summer	Antimony	Total	1.30e-03
CRM	22	2.01	summer	Barium	Total	2.75e-02
CRM	22	2.01	summer	Calcium	Total	2.71e+01
CRM	22	2.01	summer	Chromium	Total	1.20e-03
CRM	22	2.01	summer	Copper	Total	2.00e-03
CRM	22	2.01	summer	Iron	Total	5.65e-01
CRM	22	2.01	summer	Magnesium	Total	6.68e+00
CRM	22	2.01	summer	Manganese	Total	4.01e-02
CRM	22	2.01	summer	Potassium	Total	1.33e+00
CRM	22	2.01	summer	Sodium	Total	3.58e+00
CRM	22	2.01	summer	Zinc	Total	3.60e-03

Table A27 (continued)

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
CRM	22	2.01	winter	Alkalinity as CaCO3	Total	2.10e+00
CRM	22	2.01	winter	Aluminum	Total	6.03e-02
CRM	22	2.01	winter	Barium	Total	3.32e-02
CRM	22	2.01	winter	Calcium	Total	3.56e+01
CRM	22	2.01	winter	Chromium	Total	3.00e-03
CRM	22	2.01	winter	Copper	Total	4.60e-03
CRM	22	2.01	winter	Iron	Total	3.11e-01
CRM	22	2.01	winter	Lead	Total	1.00e-03
CRM	22	2.01	winter	Magnesium	Total	9.55e+00
CRM	22	2.01	winter	Manganese	Total	3.14e-02
CRM	22	2.01	winter	Nickel	Total	1.07e-02
CRM	22	2.01	winter	Potassium	Total	1.57e+00
CRM	22	2.01	winter	Sodium	Total	7.36e+00
CRM	22	2.01	winter	Zinc	Total	1.34e-02
CRM	9	4.01	spring	Aluminum	Dissolved	1.70e-02
CRM	9	4.01	spring	Ammonium nitrogen	Dissolved	5.70e-02
CRM	9	4.01	spring	Antimony	Dissolved	2.44e-03
CRM	9	4.01	spring	Barium	Dissolved	1.94e-02
CRM	9	4.01	spring	Calcium	Dissolved	2.29e+01
CRM	9	4.01	spring	Chloride	Dissolved	2.70e+00
CRM	9	4.01	spring	Magnesium	Dissolved	7.00e+00
CRM	9	4.01	spring	Manganese	Dissolved	5.45e-03
CRM	9	4.01	spring	Nickel	Dissolved	2.74e-03
CRM	9	4.01	spring	Nitrate/nitrite	Dissolved	6.20e-01
CRM	9	4.01	spring	Potassium	Dissolved	1.41e+00
CRM	9	4.01	spring	Sodium	Dissolved	2.56e+00
CRM	9	4.01	spring	Sulfate	Dissolved	1.40e+01
CRM	9	4.01	summer	Antimony	Dissolved	3.50e-03
CRM	9	4.01	summer	Barium	Dissolved	2.44e-02
CRM	9	4.01	summer	Calcium	Dissolved	2.47e+01
CRM	9	4.01	summer	Chloride	Dissolved	4.10e+00
CRM	9	4.01	summer	Chromium	Dissolved	1.40e-03
CRM	9	4.01	summer	Copper	Dissolved	3.50e-03
CRM	9	4.01	summer	Iron	Dissolved	4.42e-01
CRM	9	4.01	summer	Magnesium	Dissolved	6.14e+00
CRM	9	4.01	summer	Manganese	Dissolved	1.70e-03
CRM	9	4.01	summer	Nickel	Dissolved	7.20e-03
CRM	9	4.01	summer	Nitrate/nitrite	Dissolved	4.20e-01
CRM	9	4.01	summer	Potassium	Dissolved	1.22e+00
CRM	9	4.01	summer	Selenium	Dissolved	3.90e-03
CRM	9	4.01	summer	Sodium	Dissolved	3.01e+00
CRM	9	4.01	summer	Sulfate	Dissolved	1.70e+01
CRM	9	4.01	summer	Zinc	Dissolved	5.80e-03

Table A27 (continued)

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
CRM	9	4.01	spring	Alkalinity as CaCO3	Total	1.60e+00
CRM	9	4.01	spring	Aluminum	Total	4.91e-01
CRM	9	4.01	spring	Barium	Total	2.58e-02
CRM	9	4.01	spring	Calcium	Total	2.41e+01
CRM	9	4.01	spring	Iron	Total	6.78e-01
CRM	9	4.01	spring	Lead	Total	1.60e-03
CRM	9	4.01	spring	Magnesium	Total	7.44e+00
CRM	9	4.01	spring	Manganese	Total	6.33e-02
CRM	9	4.01	spring	Mercury	Total	1.86e-05
CRM	9	4.01	spring	Nickel	Total	2.90e-03
CRM	9	4.01	spring	Potassium	Total	1.56e+00
CRM	9	4.01	spring	Sodium	Total	4.83e+00
CRM	9	4.01	spring	Vanadium	Total	1.20e-03
CRM	9	4.01	summer	Alkalinity as CaCO3	Total	1.80e+00
CRM	9	4.01	summer	Aluminum	Total	5.80e-02
CRM	9	4.01	summer	Barium	Total	2.62e-02
CRM	9	4.01	summer	Calcium	Total	2.58e+01
CRM	9	4.01	summer	Chromium	Total	1.60e-03
CRM	9	4.01	summer	Copper	Total	3.20e-03
CRM	9	4.01	summer	Iron	Total	5.18e-01
CRM	9	4.01	summer	Lead	Total	1.60e-03
CRM	9	4.01	summer	Magnesium	Total	6.34e+00
CRM	9	4.01	summer	Manganese	Total	3.23e-02
CRM	9	4.01	summer	Mercury	Total	1.19e-05
CRM	9	4.01	summer	Potassium	Total	1.31e+00
CRM	9	4.01	summer	Sodium	Total	3.14e+00
CRM	9	4.01	summer	Zinc	Total	5.70e-03
MBM	0.2	7.02	spring	Antimony	Dissolved	3.30e-03
MBM	0.2	7.02	spring	Barium	Dissolved	2.53e-02
MBM	0.2	7.02	spring	Calcium	Dissolved	2.91e+01
MBM	0.2	7.02	spring	Chloride	Dissolved	3.40e+00
MBM	0.2	7.02	spring	Copper	Dissolved	3.60e-03
MBM	0.2	7.02	spring	Fluoride	Dissolved	7.00e-02
MBM	0.2	7.02	spring	Iron	Dissolved	1.16e-02
MBM	0.2	7.02	spring	Magnesium	Dissolved	8.00e+00
MBM	0.2	7.02	spring	Nickel	Dissolved	2.00e-03
MBM	0.2	7.02	spring	Nitrate/nitrite	Dissolved	2.90e-01
MBM	0.2	7.02	spring	Potassium	Dissolved	1.44e+00
MBM	0.2	7.02	spring	Sodium	Dissolved	3.67e+00
MBM	0.2	7.02	spring	Sulfate	Dissolved	2.10e+01
MBM	0.2	7.02	spring	Zinc	Dissolved	5.50e-03
MBM	0.2	7.02	summer	Barium	Dissolved	2.64e-02
MBM	0.2	7.02	summer	Calcium	Dissolved	3.09e+01

Table A27 (continued)

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
MBM	0.2	7.02	summer	Chloride	Dissolved	2.80e+00
MBM	0.2	7.02	summer	Copper	Dissolved	2.50e-03
MBM	0.2	7.02	summer	Fluoride	Dissolved	7.00e-02
MBM	0.2	7.02	summer	Magnesium	Dissolved	8.53e+00
MBM	0.2	7.02	summer	Manganese	Dissolved	1.90e-03
MBM	0.2	7.02	summer	Nitrate/nitrite	Dissolved	2.10e-01
MBM	0.2	7.02	summer	Potassium	Dissolved	1.44e+00
MBM	0.2	7.02	summer	Sodium	Dissolved	3.22e+00
MBM	0.2	7.02	summer	Sulfate	Dissolved	1.60e+01
MBM	0.2	7.02	summer	Zinc	Dissolved	3.70e-03
MBM	0.2	7.02	spring	Alkalinity as CaCO3	Total	1.90e+00
MBM	0.2	7.02	spring	Aluminum	Total	8.37e-02
MBM	0.2	7.02	spring	Barium	Total	2.92e-02
MBM	0.2	7.02	spring	Calcium	Total	3.13e+01
MBM	0.2	7.02	spring	Chromium	Total	1.30e-03
MBM	0.2	7.02	spring	Copper	Total	4.30e-03
MBM	0.2	7.02	spring	Iron	Total	1.33e-01
MBM	0.2	7.02	spring	Lead	Total	1.30e-03
MBM	0.2	7.02	spring	Magnesium	Total	8.60e+00
MBM	0.2	7.02	spring	Manganese	Total	1.86e-02
MBM	0.2	7.02	spring	Nickel	Total	4.00e-03
MBM	0.2	7.02	spring	Potassium	Total	1.56e+00
MBM	0.2	7.02	spring	Sodium	Total	6.73e+00
MBM	0.2	7.02	spring	Uranium	Total	5.40e-03
MBM	0.2	7.02	spring	Zinc	Total	2.54e-02
MBM	0.2	7.02	summer	Alkalinity as CaCO3	Total	1.90e+00
MBM	0.2	7.02	summer	Aluminum	Total	1.80e-02
MBM	0.2	7.02	summer	Barium	Total	2.69e-02
MBM	0.2	7.02	summer	Boron	Total	1.74e-02
MBM	0.2	7.02	summer	Calcium	Total	3.03e+01
MBM	0.2	7.02	summer	Copper	Total	1.10e-03
MBM	0.2	7.02	summer	Iron	Total	3.90e-02
MBM	0.2	7.02	summer	Magnesium	Total	8.33e+00
MBM	0.2	7.02	summer	Manganese	Total	6.16e-02
MBM	0.2	7.02	summer	Potassium	Total	1.42e+00
MBM	0.2	7.02	summer	Sodium	Total	3.22e+00
MBM	0.2	7.02	summer	Zinc	Total	2.40e-03
MBM	0.4	7.01	spring	Ammonium nitrogen	Dissolved	9.80e-02
MBM	0.4	7.01	spring	Antimony	Dissolved	3.40e-03
MBM	0.4	7.01	spring	Arsenic	Dissolved	5.30e-03
MBM	0.4	7.01	spring	Barium	Dissolved	3.97e-02
MBM	0.4	7.01	spring	Boron	Dissolved	2.83e-02
MBM	0.4	7.01	spring	Calcium	Dissolved	3.15e+01

Table A27 (continued)

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
MBM	0.4	7.01	spring	Chloride	Dissolved	3.50e+00
MBM	0.4	7.01	spring	Copper	Dissolved	7.80e-03
MBM	0.4	7.01	spring	Fluoride	Dissolved	6.00e-02
MBM	0.4	7.01	spring	Iron	Dissolved	2.02e-02
MBM	0.4	7.01	spring	Magnesium	Dissolved	7.89e+00
MBM	0.4	7.01	spring	Manganese	Dissolved	2.40e-03
MBM	0.4	7.01	spring	Molybdenum	Dissolved	1.20e-03
MBM	0.4	7.01	spring	Nickel	Dissolved	3.00e-03
MBM	0.4	7.01	spring	Nitrate/nitrite	Dissolved	2.50e-01
MBM	0.4	7.01	spring	Potassium	Dissolved	1.56e+00
MBM	0.4	7.01	spring	Silver	Dissolved	1.60e-03
MBM	0.4	7.01	spring	Sodium	Dissolved	3.46e+00
MBM	0.4	7.01	spring	Sulfate	Dissolved	1.80e+01
MBM	0.4	7.01	spring	Vanadium	Dissolved	1.20e-03
MBM	0.4	7.01	spring	Zinc	Dissolved	8.50e-03
MBM	0.4	7.01	summer	Antimony	Dissolved	5.70e-03
MBM	0.4	7.01	summer	Arsenic	Dissolved	4.20e-03
MBM	0.4	7.01	summer	Barium	Dissolved	2.67e-02
MBM	0.4	7.01	summer	Calcium	Dissolved	3.20e+01
MBM	0.4	7.01	summer	Chloride	Dissolved	4.10e+00
MBM	0.4	7.01	summer	Copper	Dissolved	3.40e-03
MBM	0.4	7.01	summer	Fluoride	Dissolved	7.00e-02
MBM	0.4	7.01	summer	Magnesium	Dissolved	8.61e+00
MBM	0.4	7.01	summer	Manganese	Dissolved	1.20e-03
MBM	0.4	7.01	summer	Potassium	Dissolved	1.49e+00
MBM	0.4	7.01	summer	Sodium	Dissolved	3.10e+00
MBM	0.4	7.01	summer	Sulfate	Dissolved	1.60e+01
MBM	0.4	7.01	summer	Vanadium	Dissolved	1.30e-03
MBM	0.4	7.01	summer	Zinc	Dissolved	2.30e-03
MBM	0.4	7.01	spring	Alkalinity as CaCO3	Total	2.00e+00
MBM	0.4	7.01	spring	Aluminum	Total	1.34e-01
MBM	0.4	7.01	spring	Arsenic	Total	4.60e-03
MBM	0.4	7.01	spring	Barium	Total	3.98e-02
MBM	0.4	7.01	spring	Calcium	Total	3.20e+01
MBM	0.4	7.01	spring	Chromium	Total	1.00e-03
MBM	0.4	7.01	spring	Copper	Total	4.60e-03
MBM	0.4	7.01	spring	Iron	Total	2.87e-01
MBM	0.4	7.01	spring	Lead	Total	1.70e-03
MBM	0.4	7.01	spring	Magnesium	Total	8.25e+00
MBM	0.4	7.01	spring	Manganese	Total	4.30e-02
MBM	0.4	7.01	spring	Nickel	Total	2.60e-03
MBM	0.4	7.01	spring	Potassium	Total	1.64e+00
MBM	0.4	7.01	spring	Sodium	Total	6.77e+00

Table A27 (continued)

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
MBM	0.4	7.01	spring	Uranium	Total	2.10e-03
MBM	0.4	7.01	spring	Vanadium	Total	1.50e-03
MBM	0.4	7.01	spring	Zinc	Total	2.67e-02
MBM	0.4	7.01	summer	Alkalinity as CaCO3	Total	1.90e+00
MBM	0.4	7.01	summer	Aluminum	Total	3.44e-02
MBM	0.4	7.01	summer	Arsenic	Total	4.70e-03
MBM	0.4	7.01	summer	Barium	Total	3.04e-02
MBM	0.4	7.01	summer	Calcium	Total	3.26e+01
MBM	0.4	7.01	summer	Copper	Total	1.10e-03
MBM	0.4	7.01	summer	Iron	Total	7.00e-02
MBM	0.4	7.01	summer	Magnesium	Total	8.59e+00
MBM	0.4	7.01	summer	Manganese	Total	5.39e-02
MBM	0.4	7.01	summer	Potassium	Total	1.53e+00
MBM	0.4	7.01	summer	Sodium	Total	3.16e+00
MBM	0.4	7.01	summer	Vanadium	Total	1.40e-03
MBM	0.4	7.01	summer	Zinc	Total	4.10e-03
WBM	0.4	8	spring	Antimony	Dissolved	3.40e-03
WBM	0.4	8	spring	Barium	Dissolved	2.23e-02
WBM	0.4	8	spring	Calcium	Dissolved	2.53e+01
WBM	0.4	8	spring	Chloride	Dissolved	2.60e+00
WBM	0.4	8	spring	Copper	Dissolved	4.30e-03
WBM	0.4	8	spring	Fluoride	Dissolved	7.00e-02
WBM	0.4	8	spring	Iron	Dissolved	1.71e-02
WBM	0.4	8	spring	Magnesium	Dissolved	8.40e+00
WBM	0.4	8	spring	Nickel	Dissolved	5.20e-03
WBM	0.4	8	spring	Nitrate/nitrite	Dissolved	1.50e-01
WBM	0.4	8	spring	Potassium	Dissolved	1.45e+00
WBM	0.4	8	spring	Selenium	Dissolved	4.20e-03
WBM	0.4	8	spring	Sodium	Dissolved	3.43e+00
WBM	0.4	8	spring	Sulfate	Dissolved	1.70e+01
WBM	0.4	8	spring	Zinc	Dissolved	6.00e-03
WBM	0.4	8	summer	Aluminum	Dissolved	2.22e-02
WBM	0.4	8	summer	Barium	Dissolved	2.65e-02
WBM	0.4	8	summer	Boron	Dissolved	1.17e-02
WBM	0.4	8	summer	Calcium	Dissolved	3.13e+01
WBM	0.4	8	summer	Chloride	Dissolved	3.00e+00
WBM	0.4	8	summer	Fluoride	Dissolved	7.00e-02
WBM	0.4	8	summer	Iron	Dissolved	5.13e-02
WBM	0.4	8	summer	Magnesium	Dissolved	8.50e+00
WBM	0.4	8	summer	Manganese	Dissolved	7.10e-02
WBM	0.4	8	summer	Potassium	Dissolved	1.40e+00
WBM	0.4	8	summer	Sodium	Dissolved	3.24e+00
WBM	0.4	8	summer	Sulfate	Dissolved	1.60e+01

Table A27 (continued)

Site		Reach	Season	Analyte	Type	Concentration (mg/L)
WBM	0.4	8	spring	Alkalinity as CaCO3	Total	1.80e+00
WBM	0.4	8	spring	Aluminum	Total	9.43e-02
WBM	0.4	8	spring	Barium	Total	2.64e-02
WBM	0.4	8	spring	Calcium	Total	2.74e+01
WBM	0.4	8	spring	Chromium	Total	1.00e-03
WBM	0.4	8	spring	Copper	Total	1.87e-02
WBM	0.4	8	spring	Iron	Total	1.43e-01
WBM	0.4	8	spring	Lead	Total	2.30e-03
WBM	0.4	8	spring	Magnesium	Total	8.63e+00
WBM	0.4	8	spring	Manganese	Total	1.85e-02
WBM	0.4	8	spring	Nickel	Total	2.90e-03
WBM	0.4	8	spring	Potassium	Total	1.55e+00
WBM	0.4	8	spring	Sodium	Total	6.78e+00
WBM	0.4	8	spring	Zinc	Total	3.38e-02
WBM	0.4	8	summer	Alkalinity as CaCO3	Total	1.50e+00
WBM	0.4	8	summer	Aluminum	Total	3.25e-02
WBM	0.4	8	summer	Barium	Total	2.54e-02
WBM	0.4	8	summer	Calcium	Total	2.84e+01
WBM	0.4	8	summer	Iron	Total	6.40e-02
WBM	0.4	8	summer	Magnesium	Total	8.56e+00
WBM	0.4	8	summer	Manganese	Total	4.16e-02
WBM	0.4	8	summer	Mercury	Total	6.75e-06
WBM	0.4	8	summer	Potassium	Total	1.48e+00
WBM	0.4	8	summer	Sodium	Total	3.38e+00
WBM	0.4	8	summer	Zinc	Total	2.20e-03

Table A28. Filtered and total organic concentrations (ug/L) by season for the toxicity testing subtask

Sampling Date	River Mile		Reach	Season	Analyte	Process	Result
06JUN1994	MBM	0.4	7.01	spring	4-Chlorobenzenamine	Total	1.00E-03
20JUL1994	CRM	19	2.03	summer	Bis(2-ethylhexyl)phthalate	Filtered	2.00E-03
20JUL1994	CRM	22	2.01	summer	Bis(2-ethylhexyl)phthalate	Filtered	1.00E-03
20JUL1994	CRM	9	4.01	summer	Di-n-butylphthalate	Filtered	1.00E-03
20JUL1994	CRM	9	4.01	summer	Di-n-butylphthalate	Total	1.00E-03

Table A29. Values for radionuclides in water corresponding to sample collections for aqueous toxicity testing. One observation for each site and season.

Season	Subreach	Site	Analyte	Media	Result	Uncertainty	Detect. Limit	Unit
winter	2.01	CRM 22.0	Cesium-137	Dissolved	9.12E+00	3.39E+00	1.16E+01	pCi/L
winter	2.01	CRM 22.0	Cesium-137	Residue	-2.00E-01	2.30E-01	6.10E-01	pCi/L
winter	2.01	CRM 22.0	Cobalt-60	Dissolved	-8.30E-01	4.16E+00	8.94E+00	pCi/L
winter	2.01	CRM 22.0	Cobalt-60	Residue	2.90E-01	2.40E-01	7.00E-01	pCi/L
winter	2.01	CRM 22.0	Gross alpha activity	Total	2.60E-01	3.10E-01	1.05E+00	pCi/L
winter	2.01	CRM 22.0	Gross beta activity	Total	3.43E+00	5.80E-01	1.83E+00	pCi/L
winter	2.01	CRM 22.0	Particle associated Co-60[a]		1.32E+02	1.10E+02	3.19E+02	pCi/G
winter	2.01	CRM 22.0	Particle associated Cs-137		-8.90E+01	1.06E+02	2.76E+02	pCi/G
winter	2.01	CRM 22.0	Strontium-90	Total	0.00E+00	7.80E-01	2.66E+00	pCi/L
winter	2.01	CRM 22.0	Tritium	Total	0.00E+00	5.88E+01	1.95E+02	pCi/L
spring	2.01	CRM 22.0	Cesium-137	Dissolved	1.48E+01	3.79E+00	1.34E+01	pCi/L
spring	2.01	CRM 22.0	Cesium-137	Residue	2.00E-02	2.40E-01	6.80E-01	pCi/L
spring	2.01	CRM 22.0	Cobalt-60	Dissolved	1.60E+00	3.87E+00	1.06E+01	pCi/L
spring	2.01	CRM 22.0	Cobalt-60	Residue	-4.00E-02	3.10E-01	7.40E-01	pCi/L
spring	2.01	CRM 22.0	Gross alpha activity	Total	2.24E+00	5.70E-01	1.74E+00	pCi/L
spring	2.01	CRM 22.0	Gross beta activity	Total	6.51E+00	8.00E-01	2.31E+00	pCi/L
spring	2.01	CRM 22.0	Particle associated Co-60		-6.79E+00	5.38E+01	1.27E+02	pCi/G
spring	2.01	CRM 22.0	Particle associated Cs-137		3.61E+00	4.17E+01	1.17E+02	pCi/G
spring	2.01	CRM 22.0	Strontium-90	Total	2.30E-01	5.40E-01	2.47E+00	pCi/L
spring	2.01	CRM 22.0	Tritium	Total	0.00E+00	6.43E+01	2.15E+02	pCi/L
summer	2.01	CRM 22.0	Cesium-137	Dissolved	6.14E+00	3.83E+00	1.20E+01	pCi/L
summer	2.01	CRM 22.0	Cesium-137	Residue	1.40E-01	2.50E-01	7.40E-01	pCi/L
summer	2.01	CRM 22.0	Cobalt-60	Dissolved	-2.27E+00	4.94E+00	1.09E+01	pCi/L
summer	2.01	CRM 22.0	Cobalt-60	Residue	5.70E-01	2.50E-01	6.50E-01	pCi/L
summer	2.01	CRM 22.0	Gross alpha activity	Total	5.37E+00	4.50E-01	1.19E+00	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A29 (continued)

Season	Subreach	Site	Analyte	Media	Result	Uncertainty	Detect. Limit	Unit
summer	2.01	CRM 22.0	Gross beta activity	Total	4.00E+01	8.90E-01	2.02E+00	pCi/L
summer	2.01	CRM 22.0	Particle associated Co-60		1.43E+02	6.22E+01	1.63E+02	pCi/G
summer	2.01	CRM 22.0	Particle associated Cs-137		3.59E+01	6.33E+01	1.84E+02	pCi/G
summer	2.01	CRM 22.0	Strontium-90	Total	1.56E+01	1.06E+00	3.68E+00	pCi/L
summer	2.01	CRM 22.0	Tritium	Total	1.45E+04	1.03E+02	1.64E+02	pCi/L
winter	2.03	CRM 19.0	Cesium-137	Dissolved	7.18E+00	3.57E+00	1.16E+01	pCi/L
winter	2.03	CRM 19.0	Cesium-137	Residue	-2.00E-02	2.30E-01	6.40E-01	pCi/L
winter	2.03	CRM 19.0	Cobalt-60	Dissolved	9.30E-01	3.19E+00	8.94E+00	pCi/L
winter	2.03	CRM 19.0	Cobalt-60	Residue	-3.00E-01	2.90E-01	6.60E-01	pCi/L
winter	2.03	CRM 19.0	Gross alpha activity	Total	1.51E+00	3.90E-01	1.24E+00	pCi/L
winter	2.03	CRM 19.0	Gross beta activity	Total	9.72E+00	7.50E-01	2.27E+00	pCi/L
winter	2.03	CRM 19.0	Particle associated Co-60		-2.12E+02	2.10E+02	4.71E+02	pCi/G
winter	2.03	CRM 19.0	Particle associated Cs-137		-1.19E+01	1.64E+02	4.57E+02	pCi/G
winter	2.03	CRM 19.0	Strontium-90	Total	5.30E-01	8.10E-01	2.73E+00	pCi/L
winter	2.03	CRM 19.0	Tritium	Total	0.00E+00	5.98E+01	1.98E+02	pCi/L
spring	2.03	CRM 19.0	Cesium-137	Dissolved	1.06E+01	4.03E+00	1.32E+01	pCi/L
spring	2.03	CRM 19.0	Cesium-137	Residue	4.40E-01	1.30E-01	4.00E-01	pCi/L
spring	2.03	CRM 19.0	Cobalt-60	Dissolved	2.26E+00	3.14E+00	9.64E+00	pCi/L
spring	2.03	CRM 19.0	Cobalt-60	Residue	-1.00E-02	1.70E-01	4.00E-01	pCi/L
spring	2.03	CRM 19.0	Gross alpha activity	Total	1.05E+00	4.30E-01	1.54E+00	pCi/L
spring	2.03	CRM 19.0	Gross beta activity	Total	6.23E+00	8.20E-01	2.53E+00	pCi/L
spring	2.03	CRM 19.0	Particle associated Co-60		-7.40E-01	2.29E+01	5.33E+01	pCi/G
spring	2.03	CRM 19.0	Particle associated Cs-137		5.81E+01	1.66E+01	5.29E+01	pCi/G
spring	2.03	CRM 19.0	Strontium-90	Total	0.00E+00	5.60E-01	2.56E+00	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A29 (continued)

Season	Subreach	Site	Analyte	Media	Result	Uncertainty	Detect. Limit	Unit
spring	2.03	CRM 19.0	Tritium	Total	1.66E+02	6.53E+01	2.14E+02	pCi/L
summer	2.03	CRM 19.0	Cesium-137	Dissolved	5.89E+00	3.56E+00	1.13E+01	pCi/L
summer	2.03	CRM 19.0	Cesium-137	Residue	-9.00E-02	2.50E-01	6.60E-01	pCi/L
summer	2.03	CRM 19.0	Cobalt-60	Dissolved	-1.85E+00	4.96E+00	9.71E+00	pCi/L
summer	2.03	CRM 19.0	Cobalt-60	Residue	1.20E-01	2.20E-01	6.50E-01	pCi/L
summer	2.03	CRM 19.0	Gross alpha activity	Total	-3.00E-02	2.60E-01	1.10E+00	pCi/L
summer	2.03	CRM 19.0	Gross beta activity	Total	9.90E-01	5.60E-01	2.18E+00	pCi/L
summer	2.03	CRM 19.0	Particle associated Co-60		2.95E+01	5.56E+01	1.62E+02	pCi/G
summer	2.03	CRM 19.0	Particle associated Cs-137		-2.24E+01	6.14E+01	1.66E+02	pCi/G
summer	2.03	CRM 19.0	Strontium-90	Total	0.00E+00	5.30E-01	2.35E+00	pCi/L
summer	2.03	CRM 19.0	Tritium	Total	1.14E+03	5.56E+01	1.64E+02	pCi/L
spring	4.01	CRM 9.0	Cesium-137	Dissolved	-1.12E+00	1.77E+00	6.22E+00	pCi/L
spring	4.01	CRM 9.0	Cesium-137	Residue	2.10E-01	1.00E-01	3.10E-01	pCi/L
spring	4.01	CRM 9.0	Cobalt-60	Dissolved	9.00E-01	1.93E+00	4.57E+00	pCi/L
spring	4.01	CRM 9.0	Cobalt-60	Residue	6.00E-02	1.30E-01	3.00E-01	pCi/L
spring	4.01	CRM 9.0	Gross alpha activity	Total	1.56E+00	2.70E-01	8.40E-01	pCi/L
spring	4.01	CRM 9.0	Gross beta activity	Total	2.76E+00	4.20E-01	1.43E+00	pCi/L
spring	4.01	CRM 9.0	Particle associated Co-60		2.16E+00	4.94E+00	1.16E+01	pCi/G
spring	4.01	CRM 9.0	Particle associated Cs-137		8.24E+00	4.06E+00	1.19E+01	pCi/G
spring	4.01	CRM 9.0	Strontium-90	Total	9.00E-02	4.20E-01	1.88E+00	pCi/L
spring	4.01	CRM 9.0	Tritium	Total	7.42E+00	6.73E+01	2.23E+02	pCi/L
summer	4.01	CRM 9.0	Cesium-137	Dissolved	-2.56E+00	4.22E+00	1.12E+01	pCi/L
summer	4.01	CRM 9.0	Cesium-137	Residue	-6.00E-02	2.20E-01	6.00E-01	pCi/L
summer	4.01	CRM 9.0	Cobalt-60	Dissolved	4.01E+00	3.31E+00	1.05E+01	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A29 (continued)

Season	Subreach	Site	Analyte	Media	Result	Uncertainty	Detect. Limit	Unit
summer	4.01	CRM 9.0	Cobalt-60	Residue	-4.20E-01	3.30E-01	7.10E-01	pCi/L
summer	4.01	CRM 9.0	Gross alpha activity	Total	1.04E+00	3.10E-01	1.11E+00	pCi/L
summer	4.01	CRM 9.0	Gross beta activity	Total	8.31E+00	5.80E-01	1.83E+00	pCi/L
summer	4.01	CRM 9.0	Particle associated Co-60		-8.76E+01	6.91E+01	1.49E+02	pCi/G
summer	4.01	CRM 9.0	Particle associated Cs-137		-1.17E+01	4.56E+01	1.25E+02	pCi/G
summer	4.01	CRM 9.0	Strontium-90	Total	2.63E+00	4.50E-01	1.83E+00	pCi/L
summer	4.01	CRM 9.0	Tritium	Total	6.46E+01	4.97E+01	1.65E+02	pCi/L
spring	7.01	MBM 0.4	Cesium-137	Dissolved	-1.47E+00	2.90E+00	1.08E+01	pCi/L
spring	7.01	MBM 0.4	Cesium-137	Residue	-1.90E-01	2.40E-01	6.30E-01	pCi/L
spring	7.01	MBM 0.4	Cobalt-60	Dissolved	5.58E+00	3.34E+00	1.12E+01	pCi/L
spring	7.01	MBM 0.4	Cobalt-60	Residue	1.00E-01	2.60E-01	6.80E-01	pCi/L
spring	7.01	MBM 0.4	Gross alpha activity	Total	8.60E-01	2.50E-01	8.90E-01	pCi/L
spring	7.01	MBM 0.4	Gross beta activity	Total	3.35E+00	4.30E-01	1.51E+00	pCi/L
spring	7.01	MBM 0.4	Particle associated Co-60		1.06E+01	2.74E+01	7.25E+01	pCi/G
spring	7.01	MBM 0.4	Particle associated Cs-137		-2.00E+01	2.56E+01	6.69E+01	pCi/G
spring	7.01	MBM 0.4	Strontium-90	Total	0.00E+00	5.60E-01	2.23E+00	pCi/L
spring	7.01	MBM 0.4	Tritium	Total	7.24E+01	2.81E+01	9.19E+01	pCi/L
summer	7.01	MBM 0.4	Cesium-137	Dissolved	9.36E+00	3.20E+00	1.08E+01	pCi/L
summer	7.01	MBM 0.4	Cesium-137	Residue	-1.00E-02	2.50E-01	7.00E-01	pCi/L
summer	7.01	MBM 0.4	Cobalt-60	Dissolved	4.36E+00	3.33E+00	1.03E+01	pCi/L
summer	7.01	MBM 0.4	Cobalt-60	Residue	1.60E-01	2.60E-01	7.00E-01	pCi/L
summer	7.01	MBM 0.4	Gross alpha activity	Total	-5.51E+00	9.30E-01	3.25E+00	pCi/L
summer	7.01	MBM 0.4	Gross beta activity	Total	6.72E+00	1.35E+00	4.34E+00	pCi/L
summer	7.01	MBM 0.4	Particle associated Co-60		2.63E+01	4.21E+01	1.12E+02	pCi/G

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A29 (continued)

Season	Subreach	Site	Analyte	Media	Result	Uncertainty	Detect. Limit	Unit
summer	7.01	MBM 0.4	Particle associated Cs-137		-1.07E+00	4.04E+01	1.13E+02	pCi/G
summer	7.01	MBM 0.4	Strontium-90	Total	-1.10E+00	7.50E-01	2.52E+00	pCi/L
summer	7.01	MBM 0.4	Tritium	Total	-4.07E+01	7.96E+01	2.69E+02	pCi/L
spring	7.02	MBM 0.2	Cesium-137	Dissolved	1.27E+01	3.65E+00	1.28E+01	pCi/L
spring	7.02	MBM 0.2	Cesium-137	Residue	-2.90E-01	2.40E-01	6.10E-01	pCi/L
spring	7.02	MBM 0.2	Cobalt-60	Dissolved	-1.66E+00	4.12E+00	1.02E+01	pCi/L
spring	7.02	MBM 0.2	Cobalt-60	Residue	-5.00E-02	2.70E-01	6.40E-01	pCi/L
spring	7.02	MBM 0.2	Gross alpha activity	Total	2.50E-01	2.90E-01	1.15E+00	pCi/L
spring	7.02	MBM 0.2	Gross beta activity	Total	2.32E+00	5.20E-01	1.95E+00	pCi/L
spring	7.02	MBM 0.2	Particle associated Co-60		-7.79E+00	3.92E+01	9.48E+01	pCi/G
spring	7.02	MBM 0.2	Particle associated Cs-137		-4.33E+01	3.56E+01	8.93E+01	pCi/G
spring	7.02	MBM 0.2	Strontium-90	Total	1.60E+00	4.60E-01	1.68E+00	pCi/L
spring	7.02	MBM 0.2	Tritium	Total	0.00E+00	2.83E+01	9.46E+01	pCi/L
summer	7.02	MBM 0.2	Cesium-137	Dissolved	-8.20E-01	3.20E+00	8.61E+00	pCi/L
summer	7.02	MBM 0.2	Cesium-137	Residue	-3.00E-02	1.10E-01	3.00E-01	pCi/L
summer	7.02	MBM 0.2	Cobalt-60	Dissolved	3.16E+00	3.54E+00	9.78E+00	pCi/L
summer	7.02	MBM 0.2	Cobalt-60	Residue	-1.00E-02	1.30E-01	3.20E-01	pCi/L
summer	7.02	MBM 0.2	Gross alpha activity	Total	-6.22E+00	9.20E-01	3.23E+00	pCi/L
summer	7.02	MBM 0.2	Gross beta activity	Total	5.07E+00	1.35E+00	4.37E+00	pCi/L
summer	7.02	MBM 0.2	Particle associated Co-60		-1.51E+00	3.06E+01	7.57E+01	pCi/G
summer	7.02	MBM 0.2	Particle associated Cs-137		-6.44E+00	2.68E+01	7.16E+01	pCi/G
summer	7.02	MBM 0.2	Strontium-90	Total	-4.70E-01	8.80E-01	3.01E+00	pCi/L
summer	7.02	MBM 0.2	Tritium	Total	4.53E+01	8.06E+01	2.69E+02	pCi/L
spring	8	WBM 0.4	Cesium-137	Dissolved	8.53E+00	3.74E+00	1.22E+01	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A29 (continued)

Season	Subreach	Site	Analyte	Media	Result	Uncertainty	Detect. Limit	Unit
spring	8	WBM 0.4	Cesium-137	Residue	1.20E-01	1.00E-01	2.90E-01	pCi/L
spring	8	WBM 0.4	Cobalt-60	Dissolved	4.70E-01	3.98E+00	1.07E+01	pCi/L
spring	8	WBM 0.4	Cobalt-60	Residue	4.00E-02	1.20E-01	3.00E-01	pCi/L
spring	8	WBM 0.4	Gross alpha activity	Total	8.20E-01	2.80E-01	1.03E+00	pCi/L
spring	8	WBM 0.4	Gross beta activity	Total	2.04E+00	4.60E-01	1.73E+00	pCi/L
spring	8	WBM 0.4	Particle associated Co-60		6.77E+00	1.86E+01	4.72E+01	pCi/G
spring	8	WBM 0.4	Particle associated Cs-137		1.85E+01	1.62E+01	4.60E+01	pCi/G
spring	8	WBM 0.4	Strontium-90	Total	3.00E-02	4.80E-01	1.93E+00	pCi/L
spring	8	WBM 0.4	Tritium	Total	5.50E+01	2.80E+01	9.22E+01	pCi/L
summer	8	WBM 0.4	Cesium-137	Dissolved	4.62E+00	3.25E+00	1.00E+01	pCi/L
summer	8	WBM 0.4	Cesium-137	Residue	-1.00E-02	2.50E-01	7.00E-01	pCi/L
summer	8	WBM 0.4	Cobalt-60	Dissolved	3.80E-01	3.91E+00	8.86E+00	pCi/L
summer	8	WBM 0.4	Cobalt-60	Residue	6.00E-02	2.60E-01	7.00E-01	pCi/L
summer	8	WBM 0.4	Gross alpha activity	Total	-7.39E+00	9.00E-01	3.20E+00	pCi/L
summer	8	WBM 0.4	Gross beta activity	Total	7.75E+00	1.37E+00	4.41E+00	pCi/L
summer	8	WBM 0.4	Particle associated Co-60		8.12E+00	3.68E+01	9.97E+01	pCi/G
summer	8	WBM 0.4	Particle associated Cs-137		-9.60E-01	3.61E+01	1.01E+02	pCi/G
summer	8	WBM 0.4	Strontium-90	Total	1.47E+00	1.06E+00	3.36E+00	pCi/L
summer	8	WBM 0.4	Tritium	Total	-1.14E+01	8.00E+01	2.69E+02	pCi/L

[a] Particle associated radionuclides calculated by dividing residue portion of specific radionuclide by suspended solid load.

Table A30. Fathead minnow survival in the Clinch River, Poplar Creek, McCoy Branch and Walker Branch Test Sites

Test Date	Site ID[a]	Survival				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
4/22-29/93	Control	100.0	0.0	100	100	NA	NA	17.6	NA
	PCM 1.0	100.0	0.0	100	100	0.0	NA	17.6	NA
	PCM 2.9	97.5	5.0	90	100	-2.5	NA	14.7	NA
	PCM 4.3	90.0	0.0	90	90	-10.0	NA	5.9	NA
	PCM 5.1	80.0	18.3	60	100	-20.0	NA	-5.9	NA
	PCM 11.3	85.0	12.9	70	100	-15.0	NA	NA	NA
	CRM 9.0	100.0	0.0	100	100	0.0	NA	NA	NA
7/22-29/93	Control	90.0	14.1	70	100	NA	9.1	12.5	-10.0
	PCM 1.0	67.5	17.1	50	90	-25.0	-18.2	-15.6	NA
	PCM 2.9	72.5	15.0	60	90	-19.4	-12.1	-9.4	NA
	PCM 4.3	65.0	10.0	60	80	-27.8	-21.2	-18.8	NA
	PCM 5.1	80.0	0.0	80	80	-11.1	-3.0	0.0	NA
	PCM 6.0	82.5	9.6	70	90	-8.33	NA	3.1	NA
	PCM 11.3	80.0	21.6	50	100	-11.1	-3.0	NA	NA
	CRM 9.0	90.0	8.2	80	100	0.0	NA	NA	-10.0
	CRM 19.0	95.0	5.8	90	100	5.6	NA	NA	-5.0
	CRM 22.0	100.0	0.0	100	100	11.1	NA	NA	NA

Table A30 (continued)

Test Date	Site ID[a]	Survival				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
10/21-28/93	Control	87.5	12.6	70	100	NA	34.6	25.0	0.0
	PCM 1.0	60.0	14.1	50	80	-31.4	-7.7	-14.3	NA
	PCM 2.9	62.5	9.6	50	70	-28.6	-3.8	-10.7	NA
	PCM 4.3	87.5	9.6	80	100	0.0	34.6	25.0	NA
	PCM 5.1	65.0	12.9	50	80	-25.7	0.0	-7.1	NA
	PCM 6.0	65.0	17.3	40	80	-25.7	NA	-7.1	NA
	PCM 11.3	70.0	24.5	50	100	-20.0	7.7	NA	NA
	CRM 9.0	82.5	5.0	80	90	-5.7	NA	NA	-5.7
	CRM 19.0	77.5	26.3	40	100	-11.4	NA	NA	-11.4
	CRM 22.0	87.5	5.0	80	90	0.0	NA	NA	NA
1/25-2/1/94	Control	100.0	0.0	100	100	NA	60.0	21.2	2.6
	PCM 1.0	75.0	28.9	50	100	-25.0	20.0	-9.1	NA
	PCM 2.9	82.5	17.1	60	100	-17.5	32.0	0.0	NA
	PCM 4.3	75.0	31.1	30	100	-25.0	20.0	-9.1	NA
	PCM 5.1	77.5	26.3	40	100	-22.5	24.0	-6.1	NA
	PCM 6.0	62.5	27.5	30	90	-37.5	NA	-24.2	NA
	PCM 11.3	82.5	28.7	40	100	-17.5	32.0	NA	NA
	CRM 9.0	95.0	5.8	90	100	-5.0	NA	NA	-2.6
	CRM 19.0	95.0	5.8	90	100	-5.0	NA	NA	-2.6

Table A30 (continued)

Test Date	Site ID[a]	Survival				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	CRM 22.0	97.5	5.0	90	100	-2.5	NA	NA	NA
4/14-21/94	Control	97.5	5.0	90	100	NA	69.6	25.8	18.2
	PCM 1.0	45.0	17.3	20	60	-53.8	-21.7	-41.9	NA
	PCM 2.9	52.5	17.1	30	70	-46.2	-8.7	-32.3	NA
	PCM 4.3	42.5	9.6	30	50	-56.4	-26.1	-45.2	NA
	PCM 5.1	52.5	33.0	20	90	-46.2	-8.7	-32.3	NA
	PCM 6.0	57.5	15.0	40	70	-41.0	NA	-25.8	NA
	PCM 11.3	77.5	26.3	40	100	-20.5	34.8	NA	NA
	CRM 9.0	45.0	30.0	30	90	-53.8	NA	NA	-45.5
	CRM 19.0	75.0	5.8	70	80	-23.1	NA	NA	-9.1
	CRM 22.0	82.5	12.6	70	100	-15.4	NA	NA	NA
7/21-28/94	Control	80.0	14.1	60	90	NA	-17.9	-8.6	14.3
	PCM 1.0	90.0	11.5	80	100	12.5	-7.7	2.9	NA
	PCM 2.9	92.5	5.0	90	100	15.6	-5.1	5.7	NA
	PCM 4.3	90.0	8.2	80	100	12.5	-7.7	2.9	NA
	PCM 5.1	82.5	15.0	60	90	3.1	-15.4	-5.7	NA
	PCM 6.0	97.5	5.0	90	100	21.9	NA	11.4	NA
	PCM 11.3	87.5	5.0	80	90	9.4	-10.3	NA	NA
	CRM 9.0	72.5	23.6	40	90	-9.4	NA	NA	3.6

Table A30 (continued)

Test Date	Site ID[a]	Survival				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	CRM 19.0	95.0	5.8	90	100	18.8	NA	NA	35.7
	CRM 22.0	70.0	24.5	50	100	-12.5	NA	NA	NA

Test Date	Site ID[a]	Survival				Percent Difference	
		Mean	SD	Min.	Max.	Control	WBM 0.4[b]
6/2-9/94	Control	92.5	5.0	90	100	NA	-2.6
	MBM 0.2	92.5	5.0	90	100	0.0	-2.6
	MBM 0.4	92.5	5.0	90	100	0.0	-2.6
	WBM 0.4	95.0	10.0	80	100	2.7	NA
8/11-18/94	Control	95.0	5.8	90	100	NA	8.6
	MBM 0.2	75.0	23.8	40	90	-21.1	-14.3
	MBM 0.4	97.5	5.0	90	100	2.6	11.4
	WBM 0.4	87.5	9.6	80	100	-7.9	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile, MBM = McCoy Branch mile; WBM = Walker Branch mile
[b]Reference site
NA = Not Applicable

Table A31. Fathead minnow growth (per surviving larvae) in the Clinch River, Poplar Creek, McCoy Branch and Walker Branch Embayment Areas.

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
4/22-29/93	Control	0.42	0.06	0.35	0.47	NA	NA	10.53	NA
	PCM 1.0	0.40	0.02	0.37	0.43	-4.76	NA	5.26	NA
	PCM 2.9	0.41	0.04	0.36	0.45	-2.38	NA	7.89	NA
	PCM 4.3	0.39	0.02	0.36	0.41	-7.14	NA	2.63	NA
	PCM 5.1	0.43	0.04	0.38	0.48	2.38	NA	13.16	NA
	PCM 11.3	0.38	0.04	0.34	0.42	-9.52	NA	NA	NA
	CRM 9.0	0.38	0.03	0.34	0.41	-9.52	NA	NA	NA
7/22-29/93	Control	0.33	0.07	0.28	0.43	NA	6.45	3.13	-8.33
	PCM 1.0	0.42	0.10	0.31	0.55	27.27	35.48	31.25	NA
	PCM 2.9	0.37	0.06	0.33	0.45	12.12	19.35	15.63	NA
	PCM 4.3	0.36	0.08	0.25	0.43	9.09	16.13	12.50	NA
	PCM 5.1	0.38	0.04	0.32	0.41	15.15	22.58	18.75	NA
	PCM 6.0	0.31	0.05	0.25	0.37	-6.06	NA	-3.12	NA
	PCM 11.3	0.32	0.09	0.19	0.41	-3.03	3.23	NA	NA
	CRM 9.0	0.30	0.06	0.21	0.36	-9.09	NA	NA	-16.67

[a] PCM = Poplar Creek mile; CRM = Clinch River mile; MBM = McCoy Branch mile; WBM = Walker Branch mile
[b] Reference site
NA = Not Applicable

Table A31 (continued)

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	CRM 19.0	0.34	0.02	0.31	0.35	3.03	NA	NA	-5.56
	CRM 22.0	0.36	0.05	0.31	0.41	9.09	NA	NA	NA
10/21-28/93	Control	0.39	0.06	0.33	0.47	NA	-30.36	-27.78	-25.00
	PCM 1.0	0.39	0.08	0.33	0.51	0.00	-30.36	-27.78	NA
	PCM 2.9	0.51	0.10	0.39	0.63	30.77	-8.93	-5.56	NA
	PCM 4.3	0.46	0.05	0.39	0.51	17.95	-17.86	-14.81	NA
	PCM 5.1	0.42	0.09	0.29	0.49	7.69	-25.00	-22.22	NA
	PCM 6.0	0.56	0.12	0.41	0.66	43.59	NA	3.70	NA
	PCM 11.3	0.54	0.11	0.38	0.64	38.46	-3.57	NA	NA
	CRM 9.0	0.51	0.09	0.43	0.64	30.77	NA	NA	-1.92
	CRM 19.0	0.54	0.03	0.51	0.58	38.46	NA	NA	3.85
	CRM 22.0	0.52	0.02	0.48	0.53	33.33	NA	NA	NA
1/25-2/1/94	Control	0.41	0.05	0.35	0.46	NA	-25.45	-8.89	-10.87
	PCM 1.0	0.56	0.07	0.48	0.64	36.59	1.82	24.44	NA
	PCM 2.9	0.54	0.06	0.49	0.62	31.71	-1.82	20.00	NA
	PCM 4.3	0.56	0.09	0.46	0.67	36.59	1.82	24.44	NA

[a] PCM = Poplar Creek mile; CRM = Clinch River mile; MBM = McCoy Branch mile; WBM = Walker Branch mile
[b] Reference site
NA = Not Applicable

Table A31 (continued)

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	PCM 5.1	0.48	0.12	0.38	0.65	17.07	-12.73	6.67	NA
	PCM 6.0	0.55	0.12	0.46	0.72	34.15	NA	22.22	NA
	PCM 11.3	0.45	0.04	0.40	0.50	9.76	-18.18	NA	NA
	CRM 9.0	0.49	0.02	0.46	0.51	19.51	NA	NA	6.52
	CRM 19.0	0.49	0.10	0.42	0.64	19.51	NA	NA	6.52
	CRM 22.0	0.46	0.06	0.38	0.53	12.20	NA	NA	NA
4/14-21/94	Control	0.23	0.04	0.17	0.26	NA	-20.69	-14.81	-28.13
	PCM 1.0	0.28	0.05	0.20	0.32	21.74	-3.45	3.70	NA
	PCM 2.9	0.33	0.09	0.24	0.42	43.48	13.79	22.22	NA
	PCM 4.3	0.31	0.05	0.27	0.37	34.78	6.90	14.81	NA
	PCM 5.1	0.31	0.04	0.26	0.34	34.78	6.90	14.81	NA
	PCM 6.0	0.29	0.05	0.22	0.33	26.09	NA	7.41	NA
	PCM 11.3	0.27	0.09	0.19	0.39	17.39	-6.90	NA	NA
	CRM 9.0	0.39	0.04	0.34	0.44	69.57	NA	NA	21.88
	CRM 19.0	0.30	0.03	0.26	0.34	30.43	NA	NA	-6.25
	CRM 22.0	0.32	0.07	0.27	0.42	39.13	NA	NA	NA

[a] PCM = Poplar Creek mile; CRM = Clinch River mile; MBM = McCoy Branch mile; WBM = Walker Branch mile
[b] Reference site
NA = Not Applicable

Table A31 (continued)

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
7/21-28/94	Control	0.55	0.08	0.44	0.63	NA	-14.06	-12.70	1.85
	PCM 1.0	0.60	0.04	0.57	0.66	9.09	-6.25	-4.76	NA
	PCM 2.9	0.64	0.10	0.56	0.78	16.36	0.00	1.59	NA
	PCM 4.3	0.52	0.12	0.38	0.65	-5.45	-18.75	-17.46	NA
	PCM 5.1	0.60	0.06	0.53	0.66	9.09	-6.25	-4.76	NA
	PCM 6.0	0.64	0.08	0.53	0.70	16.36	NA	1.59	NA
	PCM 11.3	0.63	0.17	0.49	0.83	14.55	-1.56	NA	NA
	CRM 9.0	0.64	0.06	0.59	0.73	16.36	NA	NA	18.52
	CRM 19.0	0.57	0.05	0.52	0.62	3.64	NA	NA	5.56
	CRM 22.0	0.54	0.16	0.31	0.69	-1.82	NA	NA	NA

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference	
		Mean	SD	Min.	Max.	Control	WBM 0.4[b]
6/2-9/94	Control	0.43	0.06	0.36	0.48	NA	-18.87
	MBM 0.2	0.55	0.10	0.45	0.69	27.91	3.77
	MBM 0.4	0.57	0.05	0.51	0.64	32.56	7.55
	WBM 0.4	0.53	0.05	0.47	0.59	23.26	NA

[a] PCM = Poplar Creek mile; CRM = Clinch River mile; MBM = McCoy Branch mile; WBM = Walker Branch mile
[b] Reference site
NA = Not Applicable

Table A31 (continued)

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference	
		Mean	SD	Min.	Max.	Control	WBM 0.4[b]
8/11-18/94	Control	0.48	0.10	0.39	0.57	NA	-15.79
	MBM 0.2	0.46	0.18	0.19	0.57	-4.17	-19.30
	MBM 0.4	0.52	0.05	0.46	0.58	8.33	-8.77
	WBM 0.4	0.57	0.04	0.52	0.61	18.75	NA

[a] PCM = Poplar Creek mile; CRM = Clinch River mile; MBM = McCoy Branch mile; WBM = Walker Branch mile
[b] Reference site
NA = Not Applicable

Table A32. *Ceriodaphnia dubia* reproduction per surviving female in Clinch River, Poplar Creek, McCoy Branch and Walker Branch Embayment Areas

Test Date	Site ID[a]	Percent Survival	Reproduction				Percent Difference			
			Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
4/22-29/93	Control	90	27.1	6.8	14	37	NA	NA	3.0	NA
	PCM 1.0	100	26.8	4.7	21	38	-1.1	NA	1.9	NA
	PCM 2.9	80	26.5	9.5	7	37	-2.2	NA	0.8	NA
	PCM 4.3	90	30.6	7.0	20	42	12.9	NA	16.4	NA
	PCM 5.1	100	27.7	6.7	13	38	2.2	NA	5.3	NA
	PCM 11.3	100	26.3	7.5	17	40	-3.0	NA	NA	NA
	CRM 9.0	100	30.1	3.3	27	36	11.1	NA	NA	NA
7/22-29/93	Control	80	28.4	4.9	21	34	NA	-18.9	-7.8	-12.1
	PCM 1.0	100	31.7	6.1	21	43	11.6	-9.4	2.9	NA
	PCM 2.9	90	33.8	3.9	28	40	19.0	-3.4	9.7	NA
	PCM 4.3	80	33.3	5.3	27	44	17.3	-4.9	8.1	NA
	PCM 5.1	100	31.0	11.8	0	41	9.2	-11.4	0.7	NA
	PCM 6.0	100	35.0	4.3	27	42	23.2	NA	13.6	NA
	PCM 11.3	100	30.8	6.4	14	38	8.5	-12.0	NA	NA
	CRM 9.0	100	35.3	6.7	20	44	24.3	NA	NA	9.3
	CRM 19.0	100	28.4	9.8	10	38	0.0	NA	NA	-12.7

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; MBM = McCoy Branch mile; WMB = Walker Branch mile
[b]Reference site
NA = Not Applicable

Table A32 (continued)

Test Date	Site ID[a]	Percent Survival	Reproduction				Percent Difference			
			Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	CRM 22.0	100	32.3	6.5	19	42	13.7	NA	NA	NA
10/21-28/93	Control	100	29.4	1.6	27	32	NA	-10.1	-10.4	-8.1
	PCM 1.0	100	39.0	5.9	32	52	32.7	19.3	18.9	NA
	PCM 2.9	100	35.3	6.1	30	51	20.1	8.0	7.6	NA
	PCM 4.3	100	31.6	4.8	25	42	7.5	-3.4	-3.7	NA
	PCM 5.1	100	33.0	3.3	28	38	12.2	0.9	0.6	NA
	PCM 6.0	100	32.7	2.9	29	39	11.2	NA	-0.3	NA
	PCM 11.3	100	32.8	4.8	27	41	11.6	0.3	NA	NA
	CRM 9.0	100	31.2	4.2	22	36	6.1	NA	NA	-2.5
	CRM 19.0	100	31.2	3.2	25	35	6.1	NA	NA	-2.5
	CRM 22.0	90	32.0	4.8	27	40	8.8	NA	NA	NA
1/25-2/1/94	Control	100	18.4	3.4	13	25	NA	15.0	53.3	21.1
	PCM 1.0	100	18.6	3.6	12	25	1.1	16.3	55.0	NA
	PCM 2.9	90	17.3	4.0	9	21	-6.0	8.1	44.2	NA
	PCM 4.3	90	13.3	3.8	6	18	-27.7	-16.9	10.8	NA
	PCM 5.1	100	15.4	2.1	13	19	-16.3	-3.8	28.3	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; MBM = McCoy Branch mile; WMB = Walker Branch mile
[b]Reference site
NA = Not Applicable

Table A32 (continued)

Test Date	Site ID[a]	Percent Survival	Reproduction				Percent Difference			
			Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	PCM 6.0	100	16.0	2.7	10	19	-13.0	NA	33.3	NA
	PCM 11.3	90	12.0	4.7	4	18	-34.8	-25.0	NA	NA
	CRM 9.0	100	18.2	1.8	16	21	-1.1	NA	NA	19.7
	CRM 19.0	100	17.3	1.4	15	20	-6.0	NA	NA	13.8
	CRM 22.0	100	15.2	4.2	5	19	-17.4	NA	NA	NA
4/14-21/94	Control	100	18.7	3.2	16	26	NA	-15.4	11.3	3.9
	PCM 1.0	100	20.8	4.8	10	26	11.2	-5.9	23.8	NA
	PCM 2.9	100	20.7	2.6	18	27	10.7	-6.3	23.2	NA
	PCM 4.3	100	20.8	4.6	11	27	11.2	-5.9	23.8	NA
	PCM 5.1	100	22.6	3.4	18	31	20.9	2.3	34.5	NA
	PCM 6.0	100	22.1	3.0	17	26	18.2	NA	31.6	NA
	PCM 11.3	100	16.8	7.5	1	25	-10.2	-24.0	NA	NA
	CRM 9.0	90	16.6	4.7	9	23	-11.2	NA	NA	-7.8
	CRM 19.0	100	18.4	5.6	9	26	-1.6	NA	NA	2.2
	CRM 22.0	100	18.0	4.9	8	23	-3.7	NA	NA	NA
7/21-28/94	Control	90	24.4	5.8	14	36	NA	-12.9	-15.9	7.0
	PCM 1.0	100	28.1	3.4	23	33	15.2	0.4	-3.1	NA
	PCM 2.9	90	25.3	2.1	23	29	3.7	-9.6	-12.8	NA
	PCM 4.3	100	28.9	2.6	25	34	18.4	3.2	-0.3	NA
	PCM 5.1	100	28.0	6.8	13	36	14.8	0.0	-3.5	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; MBM = McCoy Branch mile; WMB = Walker Branch mile
[b]Reference site
NA = Not Applicable

Table A32 (continued)

Test Date	Site ID[a]	Percent Survival	Reproduction				Percent Difference			
			Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	PCM 6.0	100	28.0	3.9	22	35	14.8	NA	-3.5	NA
	PCM 11.3	90	29.0	5.5	20	37	18.9	3.6	NA	NA
	CRM 9.0	100	24.2	8.4	9	39	-0.8	NA	NA	6.1
	CRM 19.0	100	21.8	6.7	4	28	-10.7	NA	NA	-4.4
	CRM 22.0	80	22.8	6.2	11	31	-6.6	NA	NA	NA

Test Date	Site ID[a]	Percent Survival	Reproduction				Percent Difference	
			Mean	SD	Min.	Max.	Control	WBM 0.4[b]
6/2-8/94	Control	100	20.5	2.4	16	23	NA	-30.5
	MBM 0.2	90	26.4	5.0	19	34	28.8	-10.5
	MBM 0.4	100	24.9	2.8	20	30	21.5	-15.6
	WMB 0.4	100	29.5	3.3	26	35	43.9	NA
8/11-17/94	Control	100	20.3	4.6	13	28	NA	-13.3
	MBM 0.2	100	24.6	4.8	17	31	21.2	5.1
	MBM 0.4	100	9.7	4.0	3	16	-52.2	-58.6
	WBM 0.4	100	23.4	4.4	15	30	15.3	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; MBM = McCoy Branch mile; WMB = Walker Branch mile
[b]Reference site
NA = Not Applicable

Table A33. Results of Quarterly Medaka Embryo-larval Tests of Surface Water from the Clinch River and Poplar Creek Conducted for the CR-ERP between July 1993 andJuly 1994[a, b]

Date	Site[c]	Survival			Hatch			Developmental Abnormalities		
		Percent Survival	Decrease from Control (%)	Decrease from Reference (%)	Percent Hatch	Decrease from Control (%)	Decrease from Reference (%)	Percent Normal[d]	Decrease from Control (%)	Decrease from Reference (%)
7/21/93	Control	91	-	-	91	-	-	82	-	-
	CRM 22.0	96	-5	-	96	-5	-	100	-22	-
	CRM 19.0	86	5	10	81	11	16	81	1	19*
	CRM 9.0	100	-10	-4	87	4	9	87	-6	13*
	PCM 11.3	4	96*	-	4	96*	-	79	4	-
	PCM 6.0	5	95*	-25	5	95*	-25	67	18	15
	PCM 5.1	0	100*	100	0	100*	100	83	-1	-5
	PCM 4.3	4	96*	0	4	96*	0	57	30*	28
	PCM 2.9	9	90*	-125	9	90*	-125	74	10	6
	PCM 1.0	76	16	-1800	76	16	-1800	76	7	4

[a]n=21 - 25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River Mile; PCM = Poplar Creek Mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table A33 (continued)

Date	Site[c]	Survival			Hatch			Developmental Abnormalities		
		Percent Survival	Decrease from Control (%)	Decrease from Reference (%)	Percent Hatch	Decrease from Control (%)	Decrease from Reference (%)	Percent Normal[d]	Decrease from Control (%)	Decrease from Reference (%)
10/21/9	Control	83	-	-	74	-	-	79	-	-
	CRM 22.0	92	-11	-	92	-24	-	100	-27	-
	CRM 19.0	88	-6	4	88	-19	4	84	-6	16*
	CRM 9.0	83	0	10	78	-5	15	91	-15	9
	PCM 11.3	40	52*	-	40	46*	-	72	9	-
	PCM 6.0	8	90*	80*	8	89*	80*	37	53*	49*
	PCM 5.1	20	76*	50	20	73*	50	52	34*	28
	PCM 4.3	8	90*	80*	13	82*	68*	46	42*	36*
	PCM 2.9	20	76*	50	24	68*	40	76	4	-6
	PCM 1.0	13	84*	68*	13	82*	68*	58	27	19
1/25/94	Control	92	-	-	92	-	-	87	-	-

[a]n=21 - 25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River Mile; PCM = Poplar Creek Mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table A33 (continued)

Date	Site[c]	Survival			Hatch			Developmental Abnormalities		
		Percent Survival	Decrease from Control (%)	Decrease from Reference (%)	Percent Hatch	Decrease from Control (%)	Decrease from Reference (%)	Percent Normal[d]	Decrease from Control (%)	Decrease from Reference (%)
	CRM 22.0	92	-1050	-	83	-538	-	96	-10	-
	CRM 19.0	100	-1150	-9	92	-608	-11	96	-10	0
	CRM 9.0	88	-1000	4	79	-508	5	87	0	9
	PCM 11.3	100	-1150	-	92	-608	-	96	-10	-
	PCM 6.0	96	-1100	4	79	-508	14	96	-10	0
	PCM 5.1	92	-1050	8	76	-485	17	84	3	12
	PCM 4.3	83	-938	17*	83	-538	10	67	23*	30*
	PCM 2.9	63	-688	37*	63	32*	32*	58	33*	40*
	PCM 1.0	36	61*	64*	40	57*	57*	48	45*	50*
4/14/94	Control	96	-	-	64	-	-	100	-	-
	CRM 22.0	92	0	-	92	-21	-	96	4	-

[a]n=21 - 25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River Mile; PCM = Poplar Creek Mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table A33 (continued)

Date	Site[c]	Survival			Hatch			Developmental Abnormalities		
		Percent Survival	Decrease from Control (%)	Decrease from Reference (%)	Percent Hatch	Decrease from Control (%)	Decrease from Reference (%)	Percent Normal[d]	Decrease from Control (%)	Decrease from Reference (%)
	CRM 19.0	80	17*	13	80	-5	13	92	8	4
	CRM 9.0	92	0	0	92	-21	0	100	0	-4
	PCM 11.3	92	0	-	92	-21	-	100	0	-
	PCM 6.0	84	9	9	84	-11	9	96	4	4
	PCM 5.1	92	0	0	92	-21	0	96	4	4
	PCM 4.3	84	9	9	88	-16	4	92	8	8
	PCM 2.9	92	0	0	92	-21	0	100	0	0
	PCM 1.0	84	9	9	88	-16	4	96	4	4
7/21/94	Control	96	-	-	84	-	-	92	-	-
	CRM 22.0	36	63*	-	44	48*	-	68	26*	-
	CRM 19.0	16	83*	56	24	71*	45	68	26*	0

[a]n=21 - 25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River Mile; PCM = Poplar Creek Mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table A33 (continued)

Date	Site[c]	Survival			Hatch			Developmental Abnormalities		
		Percent Survival	Decrease from Control (%)	Decrease from Reference (%)	Percent Hatch	Decrease from Control (%)	Decrease from Reference (%)	Percent Normal[d]	Decrease from Control (%)	Decrease from Reference (%)
	CRM 9.0	79	18*	-119	83	10	-89	96	-4	-41
	PCM 11.3	71	26*	-	79	14	-	75	18	-
	PCM 6.0	84	9	-18	84	9	-6	84	9	-12
	PCM 5.1	52	46*	27	52	38*	34*	72	22*	4
	PCM 4.3	40	58*	44*	40	52*	49*	64	30*	15
	PCM 2.9	16	83*	77*	16	81*	80*	56	39*	25
	PCM 1.0	12	88*	83*	12	86*	85*	80	13	-7

[a]n=21 - 25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River Mile; PCM = Poplar Creek Mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table A34. Results of Medaka Embryo-larval Tests of Surface Water from the Clinch River and Poplar Creek Conducted for the K-25 Site Biological Monitoring and Abatement Program (BMAP) during October 1994 and January 1995[a,b]

Date	Site[c]	Survival			Hatch			Developmental Abnormalities		
		Percent Survival	Decrease from Control (%)	Decrease from Reference (%)	Percent Hatch	Decrease from Control (%)	Decrease from Reference (%)	Percent Normal[d]	Decrease from Control (%)	Decrease from Reference (%)
10/13/94	Control	96	--	--	83	--	--	96	--	--
	CRM 9.0	100	-4	--	96	??	--	100	-4	--
	PCM 11.3	32	67*	--	32	61*	--	56	42*	--
	PCM 5.1	13	86*	59	13	84*	??	21	78*	63*
	PCM 4.3	24	75*	25	24	71*	??	12	88*	79*
	PCM 2.9	24	75*	25	28	66*	??	8	92*	86*
	PCM 1.0	12	88*	63*	12	86*	63*	20	79*	64*
1/19/95	Control	85	--	--	85	--	--	85	--	--
	CRM 9.0	80	6	--	80	??	--	85	0	--
	PCM 11.3	90	-6	--	95	??	--	90	-6	--
	PCM 5.1	53	38*	41*	58	32*	39*	47	45*	48*
	PCM 4.3	50	41*	44*	50	41*	47*	35	59*	61*
	PCM 2.9	42	51*	53*	42	51*	56*	53	38*	41*
	PCM 1.0	25	71*	72*	30	65*	68*	10	88*	89*

[a] n=23 - 25 individually incubated embryos per site for 10/94 test; 19-20 embryos per site for 1/95 test
[b] Asterisks signify a significant difference in percent survival, hatch, or normal development between a site and a control or appropriate reference site (PCM 11.3 for Poplar Creek sites)
[c] CRM = Clinch River Mile; PCM = Poplar Creek Mile
[d] Percent of embryos not exhibiting any obvious developmental abnormality (other than delayed hatching) during the course of the test

Table A35. Results of Medaka Embryo-larval Tests of Surface Water from McCoy Branch and Walker Branch Conducted for the CR-ERP during June 1994 and August 1994[a,b]

Date	Site[c]	Survival			Hatch			Developmental Abnormalities		
		Percent Survival	Decrease from Control (%)	Decrease from Reference (%)	Percent Hatch	Decrease from Control (%)	Decrease from Reference (%)	Percent Normal[d]	Decrease from Control (%)	Decrease from Reference (%)
6/2/94	Control	100	-	-	88	-	-	92	-	-
	WBM 0.4	88	12*	-	88	0	-	96	9	-
	MBM 0.4	96	4	-9	96	-9	-9	96	9	0
	MBM 0.2	96	4	-9	100	-14	-14	96	9	0
8/11/94	Control	92	-	-	56	-	-	100	-	-
	WBM 0.4	100	-9	-	100	-79	-	100	0	-
	MBM 0.4	92	0	8	92	-64	8	98	4	4
	MBM 0.2	84	9	16*	88	-57	12*	96	8	8

[a] n = 24-25 individually incubated embryos per site per test.
[b] Asterisks signify a significant difference in % survival, hatch, or normal development between a site and either the control or the reference site (WBM 0.4)
[c] MBM = McCoy Branch Mile; WBM = Walker Branch Mile
[d] Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table A36. Comparison of Medaka and Redbreast Sunfish Embryo-larval Test of Surface Water from Selected Sites on the Clinch River and Poplar Creek.[a, b, c]

		Survival		Hatch		Developmental Abnormalities[e]	
Species	Site[d]	Percent Survival	Decrease From Reference (%)	Percent Hatch	Decrease From Reference (%)	Percent Normal	Decrease From Reference (%)
Medaka	CRM 22.0	80		85		90	-
	CRM 9.0	85	-6	85	0	80	11
	PCM 11.3	70		75		95	-
	PCM 6.0	45	36	50	33	70	26*
	PCM 4.3	11	84*	11	85*	50	47*
	PCM 1.0	11	84*	11	85*	42	56*
Sunfish	CRM 22.0	91		91		96	-
(Pair 1)	CRM 9.0	83	9	100	-10	92	4
	PCM 11.3	96		100		91	-
	PCM 6.0	80	17*	96	4	96	-6
	PCM 4.3	36	63*	96	4	84	8
	PCM 1.0	50	48*	100	0	92	-1
Sunfish	CRM 22.0	87		96		91	-
(Pair 2)	CRM 9.0	92	-6	100	-4	84	8
	PCM 11.3	96		100		91	-
	PCM 6.0	92	4	96	4	92	-1
	PCM 4.3	57	41*	100	0	95	-4
	PCM 1.0	88	8	100	0	100	-10
Sunfish	CRM 22.0	79		96		96	-
(Pair 3)	CRM 9.0	88	-11	96	0	100	4
	PCM 11.3	96		96		96	-
	PCM 6.0	78	19*	96	0	91	5
	PCM 4.3	63	34*	96	0	92	4
	PCM 1.0	72	25*	100	-4	96	0

[a] test initiated 7/28/94
[b] n= 18-20 embryos per site per test for medaka; n= 21-25 embryos per site per redbreast sunfish pairing.
[c] Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or appropriate reference site (PCM 11.3 for Poplar Creek sites)
[d] CRM = Clinch River Mile; PCM = Poplar Creek Mile
[e] Percent of embryos not exhibiting any developmental abnormality (other than delayed hatching) during the course of the test

Table A37. Summary of Individual Survival Statistics for Largemouth Bass Embryo-larval Tests of Surface Water from the Clinch River and Poplar Creek Conducted for the CR-ERP during April 1994 [a,b]

	Pair 1			Pair 2			Pair 3			Pair 4			Pair 5		
Site[c]	%	Control	Ref	%	Control	Ref	%	Control	Ref	%	Control	Ref	%	Control	Ref
Control	90			88			80			86			94		
CRM 22.0	85	6		92	-5		94	-18		94	-9		92	2	
CRM 19.0	88	2	-4	98	-11	-7	96	-20	-2	94	-9	0	94	0	-2
CRM 9.0	76	16*	11	96	-9	-4	96	-20	-2	96	-12	-2	78	17*	15*
TRM 547	90	0	-6	94	-7	-2	90	-13	4	92	-7	2	88	6	4
PCM 11.3	90	0		94	-7		90	-13		80	7		72	23*	
PCM 6.0	88	2	2	96	-9	-2	88	-10	2	62	28*	23*	64	32*	11
PCM 5.1	74	18*	18*	98	-11	-4	84	-5	7	64	26*	20*	90	4	-25
PCM 4.3	86	4	4	96	-9	-2	92	-15	-2	66	23*	18	94	0	-31
PCM 2.9	94	-4	-4	96	-9	-2	88	-10	2	72	16*	10	82	13*	-14
PCM 1.0	94	-4	-4	98	-11	-4	96	-20	-7	76	12	5	90	4	-25

[a]Test initiated 4/21/94; expressed as percent decrease from control or appropriate reference (PCM 11.3 for Poplar Creek sites, CRM 22.0 for Clinch River and Tenness River sites) in the % survival of an initial 50 embryos per site per each of five different largemouth bass pairings; eggs were fertilized in vitrowith sperm derived from testes minced in a saline solution

[b]Asterisks signify a significant difference in % survival between a site and the control or appropriate reference site

[c]CRM = Clinch River Mile, TRM = Tennessee River Mile, and PCM = Poplar Creek Mile

Table A38. Summary of Developmental Abnormality Statistics for Largemouth Bass Embryo-larval Tests of Surface Water from the Clinch River and Poplar Creek Conducted for the CR-ERP during April 1994 [a,b]

	Pair 1			Pair 2			Pair 3			Pair 4			Pair5		
Site[c]	%[d]	Control	Ref	%[d]	Control	Ref	%[d]	Control	Ref	%[d]	Control	Ref	%[d]	Control	Ref
Control	94	–	–	78	–	–	95	–	–	92	–	–	100	–	–
CRM 22.0	96	-2	–	98	-26	–	96	-1	–	90	2	–	96	4	–
CRM 19.0	92	2	4	100	-28	-2	98	-3	-2	100	-9	-11	96	4	0
CRM 9.0	96	-2	0	98	-26	0	94	1	2	94	-2	-4	89	11*	7
TRM 547	98	-4	-2	94	-20	4	96	-1	0	96	-4	-7	88	12*	8
PCM 11.3	100	-6	–	96	-23	–	98	-3	–	88	4	–	92	8*	–
PCM 6.0	100	-6	0	100	-28	-4	96	-1	0	96	-4	-9	90	10*	2
PCM 5.1	92	2	8*	96	-23	0	98	-3	-2	88	4	0	92	8*	0
PCM 4.3	98	-4	2	86	-10	10*	90	5	6	92	0	-4	90	10*	2
PCM 2.9	94	0	6*	96	-23	0	96	-1	0	96	-4	-9	86	14*	6
PCM 1.0	98	-4	2	96	-23	0	100	-5	-4	86	6	2	90	10*	2

[a]Test initiated 4/21/94; expressed as percent decrease from control or appropriate reference (PCM 11.3 for Poplar Creek sites, CRM 22.0 for Clinch River and Tenness River sites) in the % normal embryos of an initial 50 embryos per site per each of five different largemouth bass pairings; eggs were fertilized in vitrowith sperm derived from testes minced in a saline solution

[b]Asterisks signify a significant difference in % normal between a site and the control or appropriate reference site

[c]CRM = Clinch River Mile, TRM = Tennessee River Mile, and PCM = Poplar Creek Mile

[d]Percent of embryos that did not exhibit any obvious developmental abnormality (other than delayed hatching) during the course of the test

Table A39. Organic compounds that were not detected in any Phase 2 water sample

Parameter name		
1,2,4-Trichlorobenzene	Benzo(ghi)perylene	N-Nitrosodiphenylamine
2-Chloronaphthalene	Benzo(k)fluoranthene	PCB-1016
2-Chlorophenol	Benzyl alcohol	PCB-1221
2-Methyl-4,6-dinitrophenol	beta-BHC	PCB-1232
2-Methylnaphthalene	Bis(2-chloroethoxy)methane	PCB-1232
2-Methylphenol	Bis(2-chloroethyl) ether	PCB-1242
2-Nitroaniline	Carbazole	PCB-1248
2-Nitrophenol	Chrysene	Pentachlorophenol
2,2'-oxybis(1-Chloropropanol)	delta-BHC	Phenanthrene
2,4-Dichlorophenol	Dibenzofuran	Phenol
2,4-Dimethylphenol	Dibenz(a,h)anthracene	Pyrene
2,4-Dinitrophenol	Dieldrin	Toxaphene
2,4-Dinitrotoluene	Dimethylphthalate	
2,4,5-Trichlorophenol	Endosulfan I	
2,4,6-Trichlorophenol	Endosulfan II	
2,6-Dinitrotoluene	Endosulfan sulfate	
3-Nitroaniline	Endrin	
3,3'-Dichlorobenzidine	Endrin aldehyde	
4-Bromophenyl phenyl ethene	Endrin ketone	
4-Chloro-3-methylphenol	Fluoranthene	
4-Chlorophenylphenyl ethene	Fluorene	
4-Methylphenol	gamma-Chlordane	
4-Nitroaniline	Heptachlor	
4-Nitrophenol	Heptachlor epoxide	
4,4'-DDD	Hexachlorobenzene	
4,4'-DDE	Hexachlorobutadiene	
4,4'-DDT	Hexachlorocyclopentadiene	
Acenaphthene	Hexachloroethane	
Acenaphthylene	Indeno(1,2,3-cd)pyrene	
Aldrin	Isophorone	
alpha-Chlordane	Lindane	
Anthracene	Methoxychlor	
Benzo(a)anthracene	Naphthalene	
Benzo(a)pyrene	Nitrobenzene	
Benzo(b)fluoranthene	N-Nitroso-di-n-propylamine	

Appendix B

SEDIMENT CHARACTERIZATION

Table B1. Selected metals concentrations in surface sediment, TVA Instream Contaminant Study.

Parameter (ppm)[1]	East Fork Poplar Creek			Bear Creek			White Oak Creek			Poplar Creek		
	Max	Min (n-16)	Mean	Max	Min (n-3)	Mean	Max	Min (n-4)	Mean	Max	Min (n-3)	Mean
Mercury	165.0	11.0	40.0	0.7	<0.1	0.3	6.0	2.2	3.3	5.9	0.1	3.4
Arsenic	14.0	3.8	6.9	11.0	4.8	6.5	12.0	5.0	8.7	11.0	7.4	8.9
Cadmium	8.2	<0.5	1.6	8.6	<0.5	8.6	2.4	0.6	1.4	3.5	2.1	2.9
Chromium	58.0	24.0	37.0	35.0	16.0	22.0	290.0	66.0	163.0	38.0	19.0	27.0
Lead	170.0	36.0	80.0	85.0	35.0	52.0	51.0	33.0	40.0	38.0	23.0	32.0
Nickel	74.0	20.0	37.0	155.0	28.0	67.0	30.0	24.0	26.0	65.0	43.0	56.0
Silver	45.0	2.0	8.0	<1.0	<1.0	<1.0	10.0	2.0	6.0	2.0	<1.0	2.0
Zirconium	590.0	350.0	448.0	500.0	430.0	500.0	480.0	260.0	365.0	470.0	220.0	340.0

Parameter (ppm)[1]	Clinch River (Watts Bar)			Background Stations					
				Clinch River (Melton Hill)			Norris Reservoir[2]		
	Max	Min (n-4)	Mean	Max	Min (n-1)	Mean	Max	Min (n-3)	Mean
Mercury	2.8	0.3	0.8	<0.1	<0.1	<0.1	0.1	0.1	0.1
Arsenic	11.0	5.1	8.1	17.0	17.0	17.0	26.0	16.0	22.0
Cadmium	4.2	0.7	1.8	0.5	0.5	0.5	<0.5	<0.5	<0.5
Chromium	25.0	9.0	16.0	25.0	25.0	25.0	23.0	21.0	22.0
Lead	38.0	14.0	30.0	28.0	28.0	28.0	77.0	58.0	67.0
Nickel	38.0	14.0	21.0	36.0	36.0	36.0	28.0	24.0	26.0
Silver	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zirconium	890.0	400.0	650.0	230.0	230.0	230.0	270.0	180.0	220.0

[1] ppm is equivalent to mg/kg.
[2] Values for Norris Reservoir include Clinch River Miles 85.3 and 94.1 and Powell River Mile 6.0.

Table B2. TVA Instream contaminant study - Task 2. Maximum concentrations (pCi/g) reported for significant radioisotopes in fine-particle surface sediment (TVA 1985a).

Control Station	Clinch River	East Fork Poplar Creek	Bear Creek	White Oak Creek	Poplar Creek	Norris Reservoir: Clinch River Upstream	Norris Reservoir: Powell River	Comparison Data: Tennessee River[2]	Comparison Data: Clinch River[3]
ANALYSIS/ISOTOPE									
Gross Alpha	11	160	32	3	11	4	3	15	100
Gross Beta	398	110	150	6,600	60	42	37	65	91
Uranium[1] 7	90	200	4.1	14	5.9	2.3	—[4]	2.0	
Sr-89	4	.7	.5	0	1	4	1	14	12.1
Sr-90	1.8	.1	.1	900	.2	.4	.5	.6	0.6
GAMMA SPECTRAL ANALYSIS[5]									
Co-60	1.2	—	—	184	—	—	—	.6	2.7
Cs-134	—	—	—	1.2	—	—	—	.13	.01
Cs-137	167	8.6	.2	12,100	1.9	.9	.7	5.5	83
K-40	27	21	18	25	16	27	16	27	84
Ra-226	.7	—	—	—	—	—	—	2.3	1.4
Th-234	4	23	63	—	3.8	—	—	—	—
Eu-152	—	—	—	8	—	—	—	—	—
Eu-154	—	—	—	7	—	—	—	—	—
Am-241	—	—	—	4	—	—	—	—	—
Ac-228	2.2	2	1.8	4	1.1	2.2	1.8	2.7	2.1
Pa-234	—	—	—	—	—	—	—	4.6	4.8
TRANSURANICS									
Pu-239	.73	.10	.001	1.08	.02	—[4]	—[4]	—[4]	—[4]
Pu-238	.03	.02	.001	.007	<.0002	—[4]	—[4]	—[4]	—[4]
Am-241	.51	.05	.04	.46	.02	—[4]	—[4]	—[4]	—[4]
Cm-244	.02	.01	.009	.01	<.0008	—[4]	—[4]	—[4]	—[4]

[1] Uranium reported in units of $\mu g/g$, dry weight.
[2] Maximum concentrations reported by TVA in surface sediment samples collected from the Tennessee River from 1981-83.
[3] Maximum concentrations reported by TVA in surface sediment samples collected from the Clinch River from 1974-83.
[4] Analysis not performed.
[5] Dash indicates isotope not identified in gamma spectral analysis.
NOTE: The lower limits of detection for all isotopes are typically 1 pCi/g, dry weight.

Table B3. Concentrations of ^{137}Cs and selected metals in sediment at recreation area beaches and at water intakes in the Clinch River. All units mg/Kg unless otherwise noted. Data from TVA (1991).

	LOCATION			
Analyte	Emory River Mile 2 - Kingston Steam Plant Intake	Clinch River Mile 13 - K-25 Intake	Clinch River Mile 17 - Campground Beach	Upstream (maximum of all upstream sites)
^{137}Cs (pCi/g)	2.05	23.74	0.19	0.18 - CRM 36 and 52.5
Arsenic	19	15	3.8	20 - CRM 36
Chromium	28	22	56	87 - CRM 120
Copper	18	13	17	25 - CRM 120
Lead	30	29	35	150 - CRM 87.5
Mercury	0.5	0.45	<0.1	0.16 - CRM 36
Nickel	17	29	42	61 - CRM 36
Phenanthrene	ND	1.1	ND	0.44 - CRM 52.5
Pyrene	ND	0.96	ND	0.48 - CRM 52.5
Bis (2-ethyl-hexyl) phthalate	ND	0.42	ND	1.8 - CRM 41.5
Benzo(a) anthracene	ND	0.44	ND	ND
Flouranthene	ND	ND	ND	0.63 - CRM 52.5

Table B4. Number of samples within each subreach from the Phase 1, Phase 2, and the near-shore sediment sampling tasks.

Subreach	Phase 1 (sediment cores)	Phase 2 (sediment cores and pore-water)	Near-shore study (surface grabs only)
0	-	5	-
1	2	-	21
2.01	-	1	-
2.02	1	-	50
2.03	-	1	79
2.04	1	7	30
Total Reach 2	2	9	159
3.01	-	2	-
3.02	1	8	1
3.03	-	9	-
3.04	1	6	3
Total Reach 3	2	25	4
4.01	1	9	51
4.02	-	6	26
4.03	-	7	48
4.04	1	11	25
Total Reach 4	2	33	150
6.0	-	-	62
7.01	-	1	-
7.02	-	1	-
8.0	-	1	-
10	1	-	7
13	-	5	-
18	-	3	23

Table B5. Summary statistics for surface sediment (0-15 cm) inorganic concentrations (mg/kg) by reach. Mercury data includes results from Brooks Rand (BR) laboratory.

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach 0								
Aluminum	5	5	1.7E+03	6.8E+03	5.0E+03	910.89	6.9E+03	5.7E+03
Antimony	4	2	2.3E-01	6.9E-01	6.8E-01	0.01	6.9E-01	6.7E-01
Arsenic	5	5	1.4E+00	5.1E+00	3.4E+00	0.64	4.7E+00	3.8E+00
Barium	5	5	2.2E+01	7.4E+01	5.7E+01	9.14	7.7E+01	6.6E+01
Beryllium	5	5	1.6E-01	5.7E-01	4.6E-01	0.08	6.3E-01	5.2E-01
Boron	5	3	1.2E+00	2.6E+00	1.6E+00	0.32	2.3E+00	1.2E+00
Cadmium	5	5	1.5E-01	2.9E-01	2.5E-01	0.03	3.0E-01	2.7E-01
Calcium	5	5	1.0E+03	5.3E+03	2.9E+03	730.67	4.4E+03	2.5E+03
Chromium	5	5	1.0E+01	1.3E+01	1.1E+01	0.5	1.2E+01	1.0E+01
Cobalt	5	5	3.7E+00	1.8E+01	9.9E+00	2.29	1.5E+01	9.2E+00
Copper	5	5	2.4E+00	1.0E+01	7.5E+00	1.52	1.1E+01	9.0E+00
Iron	5	5	5.4E+03	1.5E+04	1.2E+04	1774.1	1.6E+04	1.4E+04
Kjeldahl Nitrogen	5	5	4.2E+02	3.5E+04	7.5E+03	6921.61	2.2E+04	6.7E+02
Lead	5	5	7.8E+00	2.6E+01	1.9E+01	3.16	2.6E+01	2.2E+01
Magnesium	5	5	5.7E+02	2.5E+03	1.6E+03	339.62	2.3E+03	1.6E+03
Manganese	5	5	3.0E+02	2.1E+03	1.2E+03	338.76	1.9E+03	1.1E+03
Mercury (BR)	5	5	1.7E-02	6.9E-02	4.2E-02	0.009735	6.3E-02	4.9E-02
Methyl Mercury (BR)	5	5	7.2E-05	2.5E-04	1.7E-04	0.0000395	2.6E-04	2.1E-04
Nickel	5	5	8.2E+00	1.5E+01	1.2E+01	1.32	1.5E+01	1.4E+01
Potassium	5	5	1.9E+02	7.1E+02	5.4E+02	96.46	7.5E+02	6.6E+02
Selenium	5	5	2.2E-01	4.2E-01	3.3E-01	0.03	4.0E-01	3.4E-01
Silver	5	4	2.0E-02	7.4E-01	1.8E-01	0.14	4.9E-01	5.2E-02
Sodium	5	4	1.6E+01	3.7E+01	2.6E+01	5.53	3.7E+01	2.6E+01
Uranium	5	5	1.8E-01	7.7E-01	4.0E-01	0.11	6.2E-01	4.1E-01
Vanadium	5	5	4.2E+00	1.4E+01	1.1E+01	1.8	1.4E+01	1.3E+01
Zinc	5	5	3.1E+01	8.9E+01	5.9E+01	10.57	8.1E+01	6.4E+01
Reach 1								
Arsenic	2	2	4.5E+00	1.0E+01	7.4E+00	2.9168	2.6E+01	7.4E+00
Beryllium	2	2	4.7E-01	9.3E-01	7.0E-01	0.2258	2.1E+00	7.0E-01
Cadmium	2	2	5.9E-01	8.1E-01	7.0E-01	0.1126	1.4E+00	7.0E-01
Chromium	2	2	8.8E+00	1.6E+01	1.3E+01	3.7341	3.6E+01	1.3E+01
Copper	2	2	3.4E+01	3.5E+01	3.4E+01	0.3333	3.7E+01	3.4E+01
Lead	2	2	2.5E+01	3.8E+01	3.1E+01	6.5534	7.3E+01	3.1E+01
Mercury	2	2	5.2E-02	1.5E-01	1.0E-01	0.0513	4.3E-01	1.0E-01
Nickel	2	2	1.2E+01	2.0E+01	1.6E+01	4.0584	4.2E+01	1.6E+01
Selenium	2	2	3.4E-01	7.8E-01	5.6E-01	0.2213	2.0E+00	5.6E-01

Table B5. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Silver	2	2	2.3E-01	3.3E-01	2.8E-01	0.0515	6.0E-01	2.8E-01
Zinc	2	2	6.1E+01	1.1E+02	8.4E+01	23.5046	2.3E+02	8.4E+01
Reach 2								
Aluminum	9	9	2.0E+03	1.8E+04	9.1E+03	1474.68	1.2E+04	8.7E+03
Arsenic	11	11	1.8E+00	1.0E+01	5.0E+00	0.85	6.6E+00	3.8E+00
Barium	9	9	4.3E+01	1.9E+02	1.0E+02	15.11	1.3E+02	8.9E+01
Beryllium	11	10	2.3E-01	1.3E+00	6.5E-01	0.08	7.9E-01	6.4E-01
Boron	9	7	2.3E+00	4.9E+00	3.6E+00	0.35	4.2E+00	3.3E+00
Cadmium	11	10	7.0E-02	5.1E-01	2.6E-01	0.04	3.4E-01	2.2E-01
Calcium	9	9	8.4E+02	1.4E+04	4.0E+03	1385.95	6.6E+03	2.4E+03
Chromium	11	11	6.9E+00	2.1E+01	1.3E+01	1.14	1.5E+01	1.3E+01
Cobalt	9	9	4.9E+00	1.6E+01	1.1E+01	1.32	1.3E+01	9.2E+00
Copper	11	11	2.8E+00	1.2E+01	8.7E+00	0.96	1.0E+01	9.3E+00
Iron	9	9	8.4E+03	2.6E+04	1.6E+04	1915.87	2.0E+04	1.5E+04
Kjeldahl Nitrogen	9	9	1.7E+02	8.8E+03	2.0E+03	969.39	3.8E+03	7.2E+02
Lead	11	11	5.4E+00	6.5E+01	2.2E+01	5.18	3.2E+01	1.6E+01
Magnesium	9	9	4.2E+02	6.2E+03	2.2E+03	548.42	3.2E+03	1.8E+03
Manganese	9	9	2.7E+02	4.5E+03	1.6E+03	466.18	2.5E+03	9.6E+02
Mercury	3	2	3.0E-02	6.2E-01	2.4E-01	0.21900	8.8E-01	5.0E-02
Mercury (BR)	9	9	2.6E-02	2.5E-01	1.2E-01	0.02838	1.7E-01	9.3E-02
Methyl Mercury (BR)	9	9	1.4E-05	6.5E-04	2.3E-04	0.000071	3.6E-04	1.8E-04
Nickel	11	11	4.7E+00	2.5E+01	1.3E+01	1.67	1.6E+01	1.4E+01
Potassium	9	9	2.6E+02	2.0E+03	1.0E+03	157.08	1.3E+03	1.0E+03
Selenium	8	1	1.6E-01	2.7E+00	3.5E-01	.	.	3.5E-01
Silver	11	9	1.9E-02	6.0E-01	1.2E-01	0.05	2.2E-01	5.4E-02
Sodium	9	7	2.6E+01	4.4E+01	3.4E+01	2.16	3.8E+01	3.6E+01
Uranium	9	9	8.0E-02	9.6E-01	4.4E-01	0.09	6.0E-01	3.3E-01
Vanadium	9	9	6.7E+00	2.1E+01	1.4E+01	1.61	1.7E+01	1.4E+01
Zinc	11	11	2.4E+01	8.2E+01	5.4E+01	5.5	6.4E+01	5.3E+01
Reach 3								
Aluminum	25	25	4.6E+03	2.0E+04	1.1E+04	731.1	1.2E+04	1.1E+04
Antimony	24	2	3.0E-01	6.4E-01	3.0E-01	0.00	3.0E-01	3.0E-01
Arsenic	27	27	1.6E+00	6.4E+01	9.8E+00	2.92	1.5E+01	4.2E+00
Barium	25	25	4.8E+01	2.1E+02	1.0E+02	8.08	1.1E+02	9.4E+01
Beryllium	27	27	3.1E-01	1.3E+00	7.1E-01	0.04	7.9E-01	7.0E-01
Boron	25	18	8.9E-01	2.0E+01	6.4E+00	1.01	8.2E+00	3.8E+00
Cadmium	27	27	1.2E-01	5.6E+00	1.5E+00	0.27	2.0E+00	1.0E+00

Table B5. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Calcium	25	25	8.6E+02	4.2E+04	3.8E+03	1618.94	6.6E+03	1.9E+03
Chromium	27	27	1.2E+01	2.3E+02	4.0E+01	8.69	5.5E+01	2.6E+01
Cobalt	25	25	9.3E+00	2.4E+01	1.5E+01	0.78	1.7E+01	1.6E+01
Copper	27	27	5.5E+00	1.4E+02	3.5E+01	6.13	4.6E+01	2.6E+01
Iron	25	25	1.1E+04	3.3E+04	1.9E+04	1015.39	2.1E+04	1.9E+04
Kjeldahl Nitrogen	25	25	1.2E+02	1.6E+03	6.4E+02	83.34	7.9E+02	5.7E+02
Lead	27	27	7.0E+00	5.3E+01	2.2E+01	2.07	2.6E+01	2.0E+01
Magnesium	25	25	9.2E+02	2.9E+03	1.5E+03	102.06	1.7E+03	1.5E+03
Manganese	25	25	3.4E+02	1.4E+03	6.3E+02	52.93	7.2E+02	5.9E+02
Mercury	3	3	2.8E+00	2.1E+01	8.7E+00	5.93	2.6E+01	2.8E+00
Mercury (BR)	25	25	3.1E-02	1.4E+02	1.5E+01	5.74986	2.5E+01	5.1E+00
Methyl Mercury (BR)	25	25	9.1E-05	1.2E-02	4.1E-03	0.00065	5.2E-03	3.0E-03
Nickel	27	27	9.7E+00	2.3E+02	5.4E+01	9.78	7.0E+01	3.7E+01
Potassium	25	25	5.7E+02	2.3E+03	1.2E+03	79.44	1.3E+03	1.1E+03
Selenium	25	6	1.6E-01	2.9E+00	4.5E-01	0.127	6.7E-01	2.5E-01
Silver	26	26	3.0E-02	5.6E+00	1.0E+00	0.26	1.5E+00	5.4E-01
Sodium	25	25	2.3E+01	1.7E+02	5.7E+01	6.48	6.8E+01	5.0E+01
Thallium	27	3	1.4E-01	7.3E-01	3.5E-01	0.022	3.9E-01	3.2E-01
Uranium	25	25	4.3E-01	5.2E+01	9.8E+00	2.38507	1.4E+01	6.5E+00
Vanadium	25	25	7.9E+00	3.4E+01	1.8E+01	1.36167	2.0E+01	1.7E+01
Zinc	27	27	3.4E+01	2.4E+02	9.8E+01	9.2262	1.1E+02	8.1E+01
Reach 4								
Aluminum	33	33	3.1E+03	2.1E+04	9.4E+03	725.57	1.1E+04	8.8E+03
Antimony	31	1	3.0E-01	9.3E-01	5.0E-01	.	.	5.0E-01
Arsenic	35	35	2.0E+00	1.7E+01	6.6E+00	0.61	7.6E+00	6.2E+00
Barium	33	33	3.3E+01	1.7E+02	8.2E+01	6.02	9.3E+01	7.8E+01
Beryllium	35	35	2.5E-01	1.5E+00	7.2E-01	0.05	8.1E-01	6.8E-01
Boron	33	32	1.2E+00	8.0E+00	3.8E+00	0.29	4.3E+00	3.8E+00
Cadmium	35	35	1.3E-01	1.3E+00	3.8E-01	0.03	4.4E-01	3.8E-01
Calcium	33	33	8.2E+02	5.0E+03	2.4E+03	172.82	2.7E+03	2.5E+03
Chromium	35	35	8.5E+00	5.1E+01	2.0E+01	1.48	2.2E+01	1.8E+01
Cobalt	33	33	5.4E+00	2.9E+01	1.2E+01	0.92	1.4E+01	1.1E+01
Copper	35	35	4.0E+00	6.1E+01	2.1E+01	2.54	2.5E+01	1.8E+01
Iron	33	33	8.6E+03	3.2E+04	1.7E+04	1079.24	1.9E+04	1.6E+04
Kjeldahl Nitrogen	33	31	9.8E+00	2.1E+03	8.7E+02	120.37	1.1E+03	5.3E+02
Lead	35	35	9.1E+00	7.1E+01	2.5E+01	2.39	2.9E+01	2.2E+01
Magnesium	33	33	6.3E+02	2.7E+03	1.6E+03	98.47	1.8E+03	1.5E+03
Manganese	33	33	3.4E+02	2.0E+03	9.2E+02	88.7	1.1E+03	7.9E+02

Table B5. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Mercury	12	12	1.0E+00	5.1E+00	2.0E+00	0.30056	2.5E+00	1.7E+00
Mercury (BR)	23	23	2.9E-03	6.9E+00	1.9E+00	0.43055	2.6E+00	1.2E+00
Methyl Mercury (BR)	22	22	1.1E-04	3.6E-03	1.0E-03	0.00019	1.4E-03	7.7E-04
Molybdenum	33	3	3.1E-01	1.6E+00	9.9E-01	0.02	1.0E+00	9.7E-01
Nickel	35	35	8.1E+00	4.4E+01	2.1E+01	1.56	2.4E+01	2.1E+01
Potassium	33	33	3.9E+02	1.8E+03	9.4E+02	57.45	1.0E+03	9.4E+02
Selenium	34	11	1.6E-01	2.1E+00	3.2E-01	0.05	4.0E-01	2.0E-01
Silver	33	33	3.0E-02	2.7E+00	2.5E-01	0.08	3.9E-01	1.8E-01
Sodium	33	33	1.9E+01	9.0E+01	4.2E+01	3.14	4.7E+01	3.5E+01
Uranium	33	33	1.5E-01	2.1E+00	9.1E-01	0.08	1.0E+00	8.8E-01
Vanadium	33	33	6.2E+00	3.7E+01	1.7E+01	1.24	1.9E+01	1.7E+01
Zinc	35	35	2.8E+01	1.7E+02	7.9E+01	6.49	9.0E+01	7.1E+01
Reach 5								
Antimony	3	1	4.3E-01	1.5E+00	1.5E+00			1.5E+00
Arsenic	4	4	9.3E+00	1.1E+01	1.0E+01	0.43307	1.1E+01	1.0E+01
Beryllium	4	4	1.2E+00	1.8E+00	1.4E+00	0.13519	1.7E+00	1.4E+00
Cadmium	4	4	1.0E+00	7.0E+00	2.7E+00	1.4609	6.1E+00	1.3E+00
Chromium	4	4	2.6E+01	3.2E+01	2.9E+01	1.32221	3.3E+01	3.0E+01
Copper	4	4	2.9E+01	4.3E+01	3.7E+01	3.4446	4.5E+01	3.9E+01
Lead	4	4	3.5E+01	4.7E+01	4.1E+01	2.90594	4.8E+01	4.1E+01
Mercury	4	4	4.6E-01	1.3E+00	7.0E-01	0.18915	1.1E+00	5.3E-01
Nickel	4	4	2.1E+01	3.2E+01	2.5E+01	2.62898	3.1E+01	2.3E+01
Silver	4	4	1.6E-01	9.1E-01	4.1E-01	0.1754	8.2E-01	2.8E-01
Zinc	4	4	1.8E+02	2.7E+02	2.2E+02	20.3905	2.7E+02	2.1E+02
Reach 7								
Aluminum	2	2	1.7E+04	1.9E+04	1.8E+04	1013.49	2.5E+04	1.8E+04
Antimony	10	3	2.0E-01	9.5E-01	2.6E-01	0.04	3.3E-01	2.0E-01
Arsenic	10	10	4.3E+00	9.7E+01	2.1E+01	8.6	3.7E+01	1.3E+01
Barium	2	2	1.6E+02	1.6E+02	1.6E+02	1.36	1.7E+02	1.6E+02
Beryllium	10	10	7.5E-01	1.5E+00	1.1E+00	0.08	1.2E+00	1.0E+00
Boron	2	2	5.7E+00	7.2E+00	6.5E+00	0.77	1.1E+01	6.5E+00
Cadmium	10	3	3.1E-01	9.4E-01	4.4E-01	0.07	5.6E-01	3.6E-01
Calcium	2	2	8.4E+03	9.6E+03	9.0E+03	639.77	1.3E+04	9.0E+03
Chromium	10	10	1.9E+01	5.9E+01	2.9E+01	4.07	3.6E+01	2.3E+01
Cobalt	2	2	1.4E+01	1.6E+01	1.5E+01	0.93	2.1E+01	1.5E+01
Copper	10	10	1.5E+01	4.3E+01	2.8E+01	3.14	3.4E+01	2.7E+01
Iron	2	2	3.0E+04	3.1E+04	3.1E+04	181.11	3.2E+04	3.1E+04

Table B5. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Kjeldahl Nitrogen	2	2	1.2E+03	2.7E+03	1.9E+03	775	6.8E+03	1.9E+03
Lead	10	10	1.4E+01	3.3E+01	2.0E+01	1.98	2.4E+01	1.8E+01
Magnesium	2	2	2.9E+03	3.2E+03	3.0E+03	118.77	3.8E+03	3.0E+03
Manganese	2	2	1.6E+03	2.9E+03	2.3E+03	648.47	6.4E+03	2.3E+03
Mercury (BR)	2	2	1.1E-01	1.6E-01	1.3E-01	0.0255	3.0E-01	1.3E-01
Methyl Mercury (BR)	2	2	2.8E-04	3.2E-04	3.0E-04	0.000022	4.4E-04	3.0E-04
Nickel	10	10	1.8E+01	4.1E+01	2.6E+01	1.96	3.0E+01	2.6E+01
Potassium	2	2	2.0E+03	2.1E+03	2.1E+03	27.27	2.2E+03	2.1E+03
Selenium	10	8	2.7E-01	8.4E+00	1.7E+00	0.78	3.1E+00	9.2E-01
Silver	10	6	2.5E-02	2.6E-01	9.2E-02	0.02	1.3E-01	6.3E-02
Sodium	2	2	6.2E+01	6.6E+01	6.4E+01	1.99	7.7E+01	6.4E+01
Thallium	10	1	2.5E-01	6.9E-01	6.9E-01	.	.	6.9E-01
Uranium	2	2	5.5E-01	7.6E-01	6.6E-01	0.1	1.3E+00	6.6E-01
Vanadium	2	2	3.5E+01	5.2E+01	4.4E+01	8.45	9.7E+01	4.4E+01
Zinc	10	10	4.6E+01	1.1E+02	8.0E+01	6.77	9.2E+01	7.8E+01
Reach 8								
Aluminum	1	1	.	.	1.7E+04	.	.	1.7E+04
Arsenic	1	1	.	.	7.9E+00	.	.	7.9E+00
Barium	1	1	.	.	1.2E+02	.	.	1.2E+02
Beryllium	1	1	.	.	1.1E+00	.	.	1.1E+00
Boron	1	1	.	.	4.2E+00	.	.	4.2E+00
Cadmium	1	1	.	.	2.8E-01	.	.	2.8E-01
Calcium	1	1	.	.	6.0E+03	.	.	6.0E+03
Chromium	1	1	.	.	2.1E+01	.	.	2.1E+01
Cobalt	1	1	.	.	1.5E+01	.	.	1.5E+01
Copper	1	1	.	.	2.3E+01	.	.	2.3E+01
Iron	1	1	.	.	2.9E+04	.	.	2.9E+04
Kjeldahl Nitrogen	1	1	.	.	1.5E+03	.	.	1.5E+03
Lead	1	1	.	.	2.8E+01	.	.	2.8E+01
Magnesium	1	1	.	.	2.9E+03	.	.	2.9E+03
Manganese	1	1	.	.	2.0E+03	.	.	2.0E+03
Mercury (BR)	1	1	.	.	7.6E-01	.	.	.
Methyl Mercury (BR)	1	1	.	.	4.6E-04	.	.	.
Nickel	1	1	.	.	2.4E+01	.	.	2.4E+01
Potassium	1	1	.	.	1.8E+03	.	.	1.8E+03
Silver	1	1	.	.	8.0E-02	.	.	8.0E-02
Sodium	1	1	.	.	5.2E+01	.	.	5.2E+01
Uranium	1	1	.	.	7.4E-01	.	.	7.4E-01

Table B5. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Vanadium	1	1	.	.	3.2E+01	.	.	3.2E+01
Zinc	1	1	.	.	9.2E+01	.	.	9.2E+01
Reach 10								
Arsenic	1	1	.	.	6.9E+00	.	.	6.9E+00
Beryllium	1	1	.	.	1.3E+00	.	.	1.3E+00
Chromium	1	1	.	.	2.6E+01	.	.	2.6E+01
Copper	1	1	.	.	4.5E+01	.	.	4.5E+01
Lead	1	1	.	.	3.8E+01	.	.	3.8E+01
Mercury	1	1	.	.	7.0E-02	.	.	7.0E-02
Nickel	1	1	.	.	2.3E+01	.	.	2.3E+01
Zinc	1	1	.	.	9.9E+01	.	.	9.9E+01
Reach 13								
Aluminum	5	5	3.7E+03	1.3E+04	9.4E+03	1589.32	1.3E+04	1.0E+04
Arsenic	5	5	3.3E+00	4.1E+00	3.8E+00	0.13	4.0E+00	3.8E+00
Barium	5	5	7.4E+01	1.2E+02	9.0E+01	8.48	1.1E+02	8.5E+01
Boron	5	5	1.5E+00	1.3E+01	8.8E+00	1.96	1.3E+01	9.2E+00
Beryllium	5	5	4.5E-01	7.9E-01	6.4E-01	0.06	7.7E-01	6.8E-01
Cadmium	5	5	8.0E-02	4.3E-01	2.5E-01	0.07	4.0E-01	1.8E-01
Calcium	5	5	1.0E+03	1.6E+03	1.2E+03	107.4	1.5E+03	1.2E+03
Chromium	5	5	1.1E+01	1.7E+01	1.4E+01	1.1	1.7E+01	1.5E+01
Cobalt	5	5	9.0E+00	1.9E+01	1.4E+01	1.75	1.8E+01	1.5E+01
Copper	5	5	8.0E+00	1.5E+01	1.1E+01	1.16	1.4E+01	1.0E+01
Iron	5	5	1.1E+04	1.8E+04	1.5E+04	1393.05	1.8E+04	1.6E+04
Kjeldahl Nitrogen	5	5	4.3E+02	1.1E+03	6.1E+02	116.61	8.6E+02	5.5E+02
Lead	5	5	1.2E+01	1.8E+01	1.5E+01	0.97	1.7E+01	1.5E+01
Magnesium	5	5	8.5E+02	1.7E+03	1.4E+03	156.842	1.8E+03	1.6E+03
Manganese	5	5	2.4E+02	8.1E+02	4.9E+02	98.492	7.0E+02	4.2E+02
Mercury (BR)	5	5	5.2E-02	1.2E+00	3.5E-01	0.21765	8.2E-01	1.9E-01
Methyl Mercury (BR)	5	5	2.4E-04	2.7E-03	1.1E-03	0.00043	2.0E-03	8.7E-04
Nickel	5	5	1.5E+01	2.9E+01	2.2E+01	2.785	2.8E+01	1.9E+01
Potassium	5	5	6.5E+02	1.3E+03	1.1E+03	127.334	1.4E+03	1.3E+03
Selenium	5	1	2.0E-01	2.4E+00	5.2E-01	.	.	5.2E-01
Silver	5	4	3.0E-02	1.6E-01	7.8E-02	0.02	1.3E-01	5.0E-02
Sodium	5	5	3.2E+01	6.3E+01	5.1E+01	5.44	6.2E+01	5.3E+01
Uranium	5	5	7.3E-01	2.8E+00	1.2E+00	0.383	2.1E+00	9.3E-01
Vanadium	5	5	1.5E+01	2.1E+01	1.7E+01	1.254	2.0E+01	1.6E+01
Zinc	5	5	3.6E+01	9.2E+01	6.5E+01	11.002	8.8E+01	5.7E+01

Table B5. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach 18								
Aluminum	3	3	8.7E+03	1.4E+04	1.2E+04	1511.77	1.6E+04	1.3E+04
Arsenic	3	3	3.5E+00	5.4E+00	4.6E+00	0.56	6.2E+00	4.9E+00
Barium	3	3	8.3E+01	1.2E+02	1.1E+02	12.72	1.4E+02	1.2E+02
Beryllium	3	3	5.4E-01	7.7E-01	6.8E-01	0.07	8.9E-01	7.3E-01
Boron	3	3	3.6E+00	6.5E+00	4.8E+00	0.89	7.4E+00	4.3E+00
Cadmium	3	3	3.7E-01	4.5E-01	4.2E-01	0.03	5.0E-01	4.5E-01
Calcium	3	3	2.0E+03	2.4E+03	2.3E+03	141.18	2.7E+03	2.4E+03
Chromium	3	3	1.3E+01	1.8E+01	1.6E+01	1.4	2.0E+01	1.7E+01
Cobalt	3	3	7.7E+00	1.1E+01	9.5E+00	0.92	1.2E+01	1.0E+01
Copper	3	3	1.2E+01	2.0E+01	1.6E+01	2.46	2.3E+01	1.7E+01
Iron	3	3	1.4E+04	2.0E+04	1.8E+04	1978.31	2.3E+04	1.9E+04
Kjeldahl Nitrogen	3	3	7.9E+02	1.2E+03	9.9E+02	131.91	1.4E+03	9.4E+02
Lead	3	3	2.0E+01	2.7E+01	2.3E+01	2.07	2.9E+01	2.3E+01
Magnesium	3	3	2.1E+03	2.8E+03	2.4E+03	200.34	3.0E+03	2.4E+03
Manganese	3	3	1.3E+03	2.0E+03	1.7E+03	214.55	2.4E+03	1.9E+03
Mercury (BR)	3	3	6.4E-02	1.1E-01	9.1E-02	0.014097	1.3E-01	9.8E-02
Nickel	3	3	8.8E+00	1.4E+01	1.2E+01	1.55	1.6E+01	1.3E+01
Potassium	3	3	1.3E+03	1.5E+03	1.4E+03	66.17	1.6E+03	1.4E+03
Silver	3	3	8.0E-02	1.9E-01	1.4E-01	0.03	2.3E-01	1.4E-01
Sodium	3	3	4.1E+01	5.5E+01	5.0E+01	4.65	6.4E+01	5.5E+01
Uranium	3	3	7.6E-01	7.9E-01	7.8E-01	0.01	8.1E-01	7.8E-01
Vanadium	3	3	1.6E+01	2.4E+01	2.1E+01	2.37	2.8E+01	2.3E+01
Zinc	3	3	1.1E+02	1.3E+02	1.2E+02	6.82	1.4E+02	1.3E+02
Reach 22								
Arsenic	1	1	.	.	3.9E+00	.	.	3.9E+00
Beryllium	1	1	.	.	2.7E+00	.	.	2.7E+00
Cadmium	1	1	.	.	3.5E+00	.	.	3.5E+00
Chromium	1	1	.	.	9.8E+01	.	.	9.8E+01
Copper	1	1	.	.	4.1E+01	.	.	4.1E+01
Lead	1	1	.	.	1.2E+02	.	.	1.2E+02
Mercury	1	1	.	.	1.1E+02	.	.	1.1E+02
Nickel	1	1	.	.	2.4E+01	.	.	2.4E+01
Silver	1	1	.	.	1.7E+01	.	.	1.7E+01
Zinc	1	1	.	.	1.1E+02	.	.	1.1E+02

Table B6. Summary statistics for surface sediment (0-15 cm) inorganic concentrations (mg/kg) by subreach. Mercury data includes results from Brooks Rand (BR) laboratory.

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Subreach 0								
Aluminum	5	5	1.7E+03	6.8E+03	5.0E+03	910.89	6.9E+03	5.7E+03
Antimony	4	2	2.3E-01	6.9E-01	6.8E-01	0.01	6.9E-01	6.7E-01
Arsenic	5	5	1.4E+00	5.1E+00	3.4E+00	0.64	4.7E+00	3.8E+00
Barium	5	5	2.2E+01	7.4E+01	5.7E+01	9.14	7.7E+01	6.6E+01
Beryllium	5	5	1.6E-01	5.7E-01	4.6E-01	0.08	6.3E-01	5.2E-01
Boron	5	3	1.2E+00	2.6E+00	1.6E+00	0.32	2.3E+00	1.2E+00
Cadmium	5	5	1.5E-01	2.9E-01	2.5E-01	0.03	3.0E-01	2.7E-01
Calcium	5	5	1.0E+03	5.3E+03	2.9E+03	730.67	4.4E+03	2.5E+03
Chromium	5	5	1.0E+01	1.3E+01	1.1E+01	0.5	1.2E+01	1.0E+01
Cobalt	5	5	3.7E+00	1.8E+01	9.9E+00	2.29	1.5E+01	9.2E+00
Copper	5	5	2.4E+00	1.0E+01	7.5E+00	1.52	1.1E+01	9.0E+00
Iron	5	5	5.4E+03	1.5E+04	1.2E+04	1774.1	1.6E+04	1.4E+04
Kjeldahl Nitrogen	5	5	4.2E+02	3.5E+04	7.5E+03	6921.61	2.2E+04	6.7E+02
Lead	5	5	7.8E+00	2.6E+01	1.9E+01	3.16	2.6E+01	2.2E+01
Magnesium	5	5	5.7E+02	2.5E+03	1.6E+03	339.62	2.3E+03	1.6E+03
Manganese	5	5	3.0E+02	2.1E+03	1.2E+03	338.76	1.9E+03	1.1E+03
Mercury (BR)	5	5	1.7E-02	6.9E-02	4.2E-02	0.009735	6.3E-02	4.9E-02
Methyl Mercury (BR)	5	5	7.2E-05	2.5E-04	1.7E-04	0.0000395	2.6E-04	2.1E-04
Nickel	5	5	8.2E+00	1.5E+01	1.2E+01	1.32	1.5E+01	1.4E+01
Potassium	5	5	1.9E+02	7.1E+02	5.4E+02	96.46	7.5E+02	6.6E+02
Silver	5	4	2.0E-02	7.4E-01	1.8E-01	0.14	4.9E-01	5.2E-02
Sodium	5	4	1.6E+01	3.7E+01	2.6E+01	5.53	3.7E+01	2.6E+01
Uranium	5	5	1.8E-01	7.7E-01	4.0E-01	0.11	6.2E-01	4.1E-01
Vanadium	5	5	4.2E+00	1.4E+01	1.1E+01	1.8	1.4E+01	1.3E+01
Zinc	5	5	3.1E+01	8.9E+01	5.9E+01	10.57	8.1E+01	6.4E+01
Subreach 1								
Arsenic	2	2	4.5E+00	1.0E+01	7.4E+00	2.9168	2.6E+01	7.4E+00
Beryllium	2	2	4.7E-01	9.3E-01	7.0E-01	0.2258	2.1E+00	7.0E-01
Cadmium	2	2	5.9E-01	8.1E-01	7.0E-01	0.1126	1.4E+00	7.0E-01
Chromium	2	2	8.8E+00	1.6E+01	1.3E+01	3.7341	3.6E+01	1.3E+01
Copper	2	2	3.4E+01	3.5E+01	3.4E+01	0.3333	3.7E+01	3.4E+01
Lead	2	2	2.5E+01	3.8E+01	3.1E+01	6.5534	7.3E+01	3.1E+01
Mercury	2	2	5.2E-02	1.5E-01	1.0E-01	0.0513	4.3E-01	1.0E-01
Nickel	2	2	1.2E+01	2.0E+01	1.6E+01	4.0584	4.2E+01	1.6E+01
Selenium	2	2	3.4E-01	7.8E-01	5.6E-01	0.2213	2.0E+00	5.6E-01
Silver	2	2	2.3E-01	3.3E-01	2.8E-01	0.0515	6.0E-01	2.8E-01

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Zinc	2	2	6.1E+01	1.1E+02	8.4E+01	23.5046	2.3E+02	8.4E+01
Subreach 2.01								
Aluminum	1	1	.	.	4.1E+03	.	.	4.1E+03
Arsenic	1	1	.	.	1.8E+00	.	.	1.8E+00
Barium	1	1	.	.	4.3E+01	.	.	4.3E+01
Beryllium	1	1	.	.	4.0E-01	.	.	4.0E-01
Cadmium	1	1	.	.	1.1E-01	.	.	1.1E-01
Calcium	1	1	.	.	9.3E+02	.	.	9.3E+02
Chromium	1	1	.	.	7.8E+00	.	.	7.8E+00
Cobalt	1	1	.	.	4.9E+00	.	.	4.9E+00
Copper	1	1	.	.	4.2E+00	.	.	4.2E+00
Iron	1	1	.	.	8.4E+03	.	.	8.4E+03
Kjeldahl Nitrogen	1	1	.	.	4.7E+03	.	.	4.7E+03
Lead	1	1	.	.	5.4E+00	.	.	5.4E+00
Magnesium	1	1	.	.	8.2E+02	.	.	8.2E+02
Manganese	1	1	.	.	2.7E+02	.	.	2.7E+02
Mercury (BR)	1	1	.	.	2.4E-01	.	.	2.4E-01
Methyl Mercury (BR)	1	1	.	.	4.2E-05	.	.	4.2E-05
Nickel	1	1	.	.	9.7E+00	.	.	9.7E+00
Potassium	1	1	.	.	5.9E+02	.	.	5.9E+02
Silver	1	1	.	.	3.0E-02	.	.	3.0E-02
Uranium	1	1	.	.	8.0E-02	.	.	8.0E-02
Vanadium	1	1	.	.	6.7E+00	.	.	6.7E+00
Zinc	1	1	.	.	3.0E+01	.	.	3.0E+01
Subreach 2.02								
Arsenic	1	1	.	.	3.1E+00	.	.	3.1E+00
Chromium	1	1	.	.	6.9E+00	.	.	6.9E+00
Copper	1	1	.	.	9.1E+00	.	.	9.1E+00
Lead	1	1	.	.	9.7E+00	.	.	9.7E+00
Nickel	1	1	.	.	4.7E+00	.	.	4.7E+00
Zinc	1	1	.	.	4.0E+01	.	.	4.0E+01
Subreach 2.03								
Aluminum	1	1	.	.	8.2E+03	.	.	8.2E+03
Antimony	1	1	.	.	2.4E-01	.	.	2.4E-01
Arsenic	1	1	.	.	2.0E+00	.	.	2.0E+00

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Barium	1	1	.	.	8.9E+01	.	.	8.9E+01
Beryllium	1	1	.	.	6.8E-01	.	.	6.8E-01
Cadmium	1	1	.	.	1.9E-01	.	.	1.9E-01
Calcium	1	1	.	.	1.9E+03	.	.	1.9E+03
Chromium	1	1	.	.	1.3E+01	.	.	1.3E+01
Cobalt	1	1	.	.	7.9E+00	.	.	7.9E+00
Copper	1	1	.	.	7.7E+00	.	.	7.7E+00
Iron	1	1	.	.	1.5E+04	.	.	1.5E+04
Kjeldahl Nitrogen	1	1	.	.	8.8E+03	.	.	8.8E+03
Lead	1	1	.	.	8.6E+00	.	.	8.6E+00
Magnesium	1	1	.	.	1.7E+03	.	.	1.7E+03
Manganese	1	1	.	.	5.5E+02	.	.	5.5E+02
Mercury (BR)	1	1	.	.	2.6E-02	.	.	2.6E-02
Methyl Mercury (BR)	1	1	.	.	1.4E-05	.	.	1.4E-05
Nickel	1	1	.	.	1.8E+01	.	.	1.8E+01
Potassium	1	1	.	.	7.7E+02	.	.	7.7E+02
Silver	1	1	.	.	5.4E-02	.	.	5.4E-02
Uranium	1	1	.	.	2.7E-01	.	.	2.7E-01
Vanadium	1	1	.	.	1.1E+01	.	.	1.1E+01
Zinc	1	1	.	.	5.3E+01	.	.	5.3E+01
Subreach 2.04								
Aluminum	7	7	2.0E+03	1.8E+04	9.9E+03	1737.97	1.3E+04	1.1E+04
Arsenic	8	8	3.6E+00	1.0E+01	6.1E+00	0.93	7.8E+00	5.2E+00
Barium	7	7	6.5E+01	1.9E+02	1.1E+02	16.79	1.5E+02	1.3E+02
Beryllium	8	8	3.5E-01	1.3E+00	7.1E-01	0.1	9.0E-01	7.0E-01
Boron	7	7	2.3E+00	4.9E+00	3.7E+00	0.39	4.5E+00	3.5E+00
Cadmium	8	8	7.0E-02	5.1E-01	3.0E-01	0.05	4.1E-01	2.9E-01
Calcium	7	7	8.4E+02	1.4E+04	4.8E+03	1691.06	8.1E+03	3.5E+03
Chromium	8	8	1.2E+01	2.1E+01	1.5E+01	0.98	1.7E+01	1.4E+01
Cobalt	7	7	8.3E+00	1.6E+01	1.2E+01	1.33	1.4E+01	9.9E+00
Copper	8	8	2.8E+00	1.2E+01	9.4E+00	1.18	1.2E+01	1.1E+01
Iron	7	7	9.2E+03	2.6E+04	1.7E+04	2146.66	2.2E+04	1.8E+04
Kjeldahl Nitrogen	7	7	1.7E+02	1.4E+03	6.2E+02	184.14	9.7E+02	3.7E+02
Lead	8	8	1.3E+01	6.5E+01	2.7E+01	6.13	3.9E+01	2.0E+01
Magnesium	7	7	4.2E+02	6.2E+03	2.5E+03	671.51	3.8E+03	2.4E+03
Manganese	7	7	9.3E+02	4.5E+03	2.0E+03	529.62	3.0E+03	1.3E+03
Mercury	2	2	5.0E-02	6.2E-01	3.3E-01	0.28449	2.1E+00	3.3E-01
Mercury (BR)	7	7	2.9E-02	2.5E-01	1.1E-01	0.02891	1.7E-01	9.3E-02

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Arsenic	9	9	2.5E+00	1.8E+01	5.7E+00	1.6	8.7E+00	3.6E+00
Barium	8	8	6.3E+01	1.9E+02	1.1E+02	13.89	1.3E+02	9.9E+01
Beryllium	9	9	3.3E-01	1.0E+00	6.8E-01	0.07	8.1E-01	6.9E-01
Boron	8	6	8.9E-01	1.6E+01	5.5E+00	1.72	8.7E+00	3.7E+00
Cadmium	9	9	2.5E-01	5.3E+00	1.6E+00	0.53	2.5E+00	7.8E-01
Calcium	8	8	1.5E+03	4.2E+04	7.5E+03	4998.53	1.7E+04	2.2E+03
Chromium	9	9	1.8E+01	2.3E+02	5.2E+01	23.17	9.5E+01	2.6E+01
Cobalt	8	8	1.1E+01	2.1E+01	1.7E+01	1.28	1.9E+01	1.7E+01
Copper	9	9	1.3E+01	1.4E+02	4.5E+01	15.14	7.3E+01	2.9E+01
Iron	8	8	1.3E+04	2.4E+04	1.9E+04	1339.11	2.2E+04	1.9E+04
Kjeldahl Nitrogen	8	8	1.3E+02	1.6E+03	6.6E+02	186.05	1.0E+03	4.0E+02
Lead	9	9	1.2E+01	5.3E+01	2.5E+01	4.77	3.3E+01	1.8E+01
Magnesium	8	8	1.2E+03	2.9E+03	1.8E+03	227.13	2.2E+03	1.7E+03
Manganese	8	8	3.4E+02	1.1E+03	6.2E+02	87.76	7.9E+02	5.8E+02
Mercury	1	1	2.8E+00	2.8E+00	2.8E+00	.	.	2.8E+00
Mercury (BR)	8	8	6.3E-01	3.7E+01	1.3E+01	4.66965	2.2E+01	8.8E+00
Methyl Mercury (BR)	8	8	9.8E-04	1.2E-02	5.6E-03	0.00128	8.0E-03	5.2E-03
Nickel	9	9	2.5E+01	2.3E+02	8.2E+01	25.77	1.3E+02	4.8E+01
Po .um	8	8	9.5E+02	2.3E+03	1.4E+03	154.53	1.7E+03	1.2E+03
Selenium	8	1	3.0E-01	1.4E+00	3.0E-01	.	.	3.0E-01
Silver	9	9	9.0E-02	5.6E+00	1.1E+00	0.58	2.2E+00	4.3E-01
Sodium	8	8	2.7E+01	7.2E+01	5.4E+01	5.1312	6.4E+01	5.4E+01
Uranium	8	8	1.4E+00	5.2E+01	1.5E+01	6.0973	2.7E+01	7.6E+00
Vanadium	8	8	1.1E+01	2.2E+01	1.8E+01	1.409	2.0E+01	1.8E+01
Zinc	9	9	6.8E+01	2.4E+02	1.2E+02	21.4114	1.6E+02	8.1E+01
Subreach 3.03								
Aluminum	9	9	4.8E+03	1.6E+04	1.0E+04	1261.16	1.3E+04	1.1E+04
Arsenic	9	9	1.9E+00	1.1E+01	4.4E+00	0.85	6.0E+00	4.3E+00
Barium	9	9	5.1E+01	1.3E+02	8.8E+01	8.61	1.0E+02	9.3E+01
Beryllium	9	9	3.1E-01	9.3E-01	6.5E-01	0.06	7.7E-01	7.0E-01
Boron	9	5	9.0E-01	1.1E+01	4.2E+00	1.07	6.2E+00	2.5E+00
Cadmium	9	9	3.9E-01	3.5E+00	1.5E+00	0.36	2.1E+00	1.0E+00
Calcium	9	9	1.3E+03	3.3E+03	2.1E+03	261.48	2.5E+03	1.9E+03
Chromium	9	9	1.5E+01	1.2E+02	4.1E+01	11.46	6.2E+01	3.0E+01
Cobalt	9	9	9.9E+00	2.4E+01	1.5E+01	1.35	1.8E+01	1.6E+01
Copper	9	9	8.8E+00	5.9E+01	2.8E+01	6.14	4.0E+01	2.4E+01
Iron	9	9	1.1E+04	3.3E+04	1.9E+04	2210.22	2.3E+04	1.9E+04
Kjeldahl Nitrogen	9	9	1.2E+02	1.2E+03	6.9E+02	105.61	8.9E+02	7.0E+02

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Methyl Mercury (BR)	7	7	5.3E-05	6.5E-04	2.8E-04	0.000078	4.3E-04	2.2E-04
Nickel	8	8	6.4E+00	2.5E+01	1.4E+01	1.85	1.8E+01	1.4E+01
Potassium	7	7	2.6E+02	2.0E+03	1.1E+03	188.73	1.5E+03	1.1E+03
Selenium	5	1	3.5E-01	2.7E+00	3.5E-01	.	.	3.5E-01
Silver	8	7	1.9E-02	6.0E-01	1.6E-01	0.07	2.9E-01	6.6E-02
Sodium	7	7	2.6E+01	4.4E+01	3.5E+01	2.35	3.9E+01	3.6E+01
Uranium	7	7	2.8E-01	9.6E-01	5.1E-01	0.1	7.0E-01	3.9E-01
Vanadium	7	7	9.3E+00	2.1E+01	1.6E+01	1.57	1.9E+01	1.5E+01
Zinc	8	8	2.4E+01	8.2E+01	5.8E+01	6.56	7.1E+01	6.0E+01
Subreach 3.01								
Aluminum	2	2	9.1E+03	1.1E+04	1.0E+04	1150	1.8E+04	1.0E+04
Arsenic	2	2	1.6E+00	4.1E+00	2.9E+00	1.25	1.1E+01	2.9E+00
Barium	2	2	7.8E+01	8.6E+01	8.2E+01	4.1	1.1E+02	8.2E+01
Beryllium	2	2	6.6E-01	7.0E-01	6.8E-01	0.02	8.1E-01	6.8E-01
Boron	2	1	1.2E+00	3.8E+00	3.8E+00	.	.	3.8E+00
Cadmium	2	2	1.3E-01	2.1E+00	1.1E+00	0.99	7.3E+00	1.1E+00
Calcium	2	2	8.6E+02	1.9E+03	1.4E+03	497	4.5E+03	1.4E+03
Chromium	2	2	1.2E+01	2.1E+01	1.6E+01	4.3	4.3E+01	1.6E+01
Cobalt	2	2	1.1E+01	2.0E+01	1.6E+01	4.3	4.3E+01	1.6E+01
Copper	2	2	6.3E+00	2.6E+01	1.6E+01	10.05	8.0E+01	1.6E+01
Iron	2	2	1.4E+04	1.8E+04	1.6E+04	2100	2.9E+04	1.6E+04
Kjeldahl Nitrogen	2	2	1.8E+02	1.5E+03	8.2E+02	636.5	4.8E+03	8.2E+02
Lead	2	2	9.4E+00	1.9E+01	1.4E+01	4.75	4.4E+01	1.4E+01
Magnesium	2	2	1.2E+03	1.5E+03	1.3E+03	155	2.3E+03	1.3E+03
Manganese	2	2	3.8E+02	6.1E+02	5.0E+02	114	1.2E+03	5.0E+02
Mercury (BR)	2	2	3.1E-02	4.6E+00	2.3E+00	2.2877	1.7E+01	2.3E+00
Methyl Mercury (BR)	2	2	9.1E-05	2.8E-03	1.4E-03	0.00133	9.9E-03	1.4E-03
Nickel	2	2	1.2E+01	2.9E+01	2.0E+01	8.45	7.4E+01	2.0E+01
Potassium	2	2	8.0E+02	1.4E+03	1.1E+03	313.5	3.1E+03	1.1E+03
Silver	2	2	4.0E-02	5.0E-01	2.7E-01	0.23	1.7E+00	2.7E-01
Sodium	2	2	2.6E+01	5.1E+01	3.9E+01	12.3	1.2E+02	3.9E+01
Uranium	2	2	7.6E-01	3.3E+00	2.0E+00	1.26	9.9E+00	2.0E+00
Vanadium	2	2	1.4E+01	1.8E+01	1.6E+01	2	2.9E+01	1.6E+01
Zinc	2	2	3.4E+01	7.7E+01	5.5E+01	21.65	1.9E+02	5.5E+01
Subreach 3.02								
Aluminum	8	8	7.6E+03	2.0E+04	1.2E+04	1440.28	1.4E+04	1.0E+04
Antimony	8	1	3.0E-01	6.4E-01	3.0E-01	.	.	3.0E-01

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Lead	9	9	7.0E+00	3.8E+01	2.3E+01	3.35	2.9E+01	2.3E+01
Magnesium	9	9	9.2E+02	2.4E+03	1.5E+03	152.55	1.8E+03	1.5E+03
Manganese	9	9	3.6E+02	1.4E+03	6.8E+02	119.4	9.0E+02	6.2E+02
Mercury (BR)	9	9	2.0E+00	1.2E+01	5.6E+00	1.01704	7.4E+00	5.0E+00
Methyl Mercury (BR)	9	9	9.3E-04	5.5E-03	2.5E-03	0.00047	3.4E-03	2.6E-03
Nickel	9	9	1.7E+01	8.6E+01	4.3E+01	7.84	5.8E+01	4.4E+01
Potassium	9	9	6.6E+02	1.9E+03	1.1E+03	116.57	1.3E+03	1.0E+03
Silver	9	9	1.4E-01	4.9E+00	1.1E+00	0.5	2.1E+00	5.8E-01
Sodium	9	9	2.3E+01	1.0E+02	4.4E+01	8.73	6.1E+01	3.4E+01
Uranium	9	9	9.2E-01	3.3E+01	8.9E+00	3.23	1.5E+01	6.5E+00
Vanadium	9	9	7.9E+00	3.3E+01	1.6E+01	2.47	2.1E+01	1.6E+01
Zinc	9	9	5.6E+01	1.5E+02	1.0E+02	13.03	1.3E+02	8.3E+01
Subreach 3.04								
Aluminum	6	6	4.6E+03	1.4E+04	1.0E+04	1607.41	1.3E+04	1.0E+04
Antimony	7	1	3.0E-01	5.5E-01	3.0E-01	.	.	3.0E-01
Arsenic	7	7	3.1E+00	6.4E+01	2.4E+01	9.57	4.2E+01	1.2E+01
Barium	6	6	4.8E+01	2.1E+02	1.2E+02	24.86	1.7E+02	1.1E+02
Beryllium	7	7	3.3E-01	1.3E+00	8.4E-01	0.12	1.1E+00	8.3E-01
Boron	6	6	8.4E+00	2.0E+01	1.2E+01	1.76	1.6E+01	1.1E+01
Cadmium	7	7	1.2E-01	5.6E+00	1.7E+00	0.7	3.0E+00	1.2E+00
Calcium	6	6	1.2E+03	4.3E+03	2.4E+03	477.32	3.4E+03	2.0E+03
Chromium	7	7	1.3E+01	5.6E+01	3.0E+01	6.16	4.1E+01	2.6E+01
Cobalt	6	6	9.3E+00	1.9E+01	1.4E+01	1.66	1.7E+01	1.5E+01
Copper	7	7	5.5E+00	9.0E+01	3.7E+01	10.81	5.8E+01	3.8E+01
Iron	6	6	1.1E+04	2.4E+04	1.9E+04	2111.76	2.3E+04	2.0E+04
Kjeldahl Nitrogen	6	6	1.2E+02	9.3E+02	4.9E+02	112.93	7.1E+02	5.2E+02
Lead	7	7	1.0E+01	3.1E+01	2.0E+01	2.76	2.6E+01	2.0E+01
Magnesium	6	6	9.6E+02	1.9E+03	1.4E+03	162	1.7E+03	1.4E+03
Manganese	6	6	3.8E+02	8.4E+02	6.0E+02	66.02	7.3E+02	6.2E+02
Mercury	2	2	2.8E+00	2.1E+01	1.2E+01	8.91	6.8E+01	1.2E+01
Mercury (BR)	6	6	2.1E+00	1.4E+02	3.5E+01	22.4112	8.0E+01	5.1E+00
Methyl Mercury (BR)	6	6	1.1E-03	1.2E-02	5.3E-03	0.0017	8.7E-03	4.2E-03
Nickel	7	7	9.7E+00	7.0E+01	4.1E+01	8.89	5.8E+01	3.7E+01
Potassium	6	6	5.7E+02	1.6E+03	1.1E+03	168.52	1.4E+03	1.1E+03
Selenium	7	5	1.6E-01	2.9E+00	8.5E-01	0.381	1.6E+00	2.7E-01
Silver	6	6	3.0E-02	1.6E+00	8.2E-01	0.25	1.3E+00	9.5E-01
Sodium	6	6	3.8E+01	1.7E+02	8.4E+01	19.45	1.2E+02	6.9E+01
Thallium	7	3	1.8E-01	7.3E-01	4.3E-01	0.076	5.8E-01	3.2E-01

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Uranium	6	6	4.3E-01	1.4E+01	6.7E+00	2.38	1.1E+01	5.5E+00
Vanadium	6	6	8.4E+00	3.4E+01	2.1E+01	4	2.9E+01	1.9E+01
Zinc	7	7	3.6E+01	1.1E+02	8.1E+01	10.58	1.0E+02	8.5E+01
Subreach 4.01								
Aluminum	9	9	3.1E+03	1.2E+04	6.7E+03	967.1	8.5E+03	6.1E+03
Arsenic	10	10	2.2E+00	6.2E+00	3.7E+00	0.43	4.5E+00	3.4E+00
Barium	9	9	3.3E+01	1.2E+02	6.1E+01	8.02	7.6E+01	5.4E+01
Beryllium	10	10	2.5E-01	1.0E+00	4.9E-01	0.07	6.1E-01	4.1E-01
Boron	9	8	1.4E+00	4.8E+00	3.4E+00	0.33	4.0E+00	3.7E+00
Cadmium	10	10	1.3E-01	5.5E-01	3.0E-01	0.05	3.8E-01	2.5E-01
Calcium	9	9	8.5E+02	2.8E+03	1.9E+03	223.7	2.3E+03	2.1E+03
Chromium	10	10	8.5E+00	2.1E+01	1.5E+01	1.38	1.8E+01	1.7E+01
Cobalt	9	9	5.4E+00	1.1E+01	7.9E+00	0.73	9.2E+00	7.4E+00
Copper	10	10	4.0E+00	1.8E+01	8.7E+00	1.34	1.1E+01	7.8E+00
Iron	9	9	8.6E+03	2.0E+04	1.2E+04	1186.75	1.4E+04	1.1E+04
Kjeldahl Nitrogen	9	7	9.8E+00	4.8E+02	1.7E+02	59.04	2.8E+02	1.5E+02
Lead	10	10	9.1E+00	4.8E+01	1.6E+01	3.64	2.3E+01	1.3E+01
Magnesium	9	9	6.3E+02	2.0E+03	1.4E+03	157.24	1.7E+03	1.5E+03
Manganese	9	9	3.5E+02	8.0E+02	6.0E+02	54.5	7.0E+02	5.5E+02
Mercury	1	1	.	.	5.1E+00	.	.	5.1E+00
Mercury (BR)	9	9	6.6E-02	6.9E+00	2.2E+00	0.9591	4.0E+00	5.3E-01
Methyl Mercury (BR)	9	9	1.9E-04	3.6E-03	1.4E-03	0.00039	2.2E-03	1.5E-03
Nickel	10	10	8.1E+00	2.6E+01	1.5E+01	1.9	1.8E+01	1.3E+01
Potassium	9	9	3.9E+02	1.3E+03	8.3E+02	101.07	1.0E+03	7.8E+02
Selenium	9	4	1.6E-01	1.5E+00	3.5E-01	0.16	6.4E-01	2.0E-01
Silver	9	9	5.0E-02	3.1E-01	1.4E-01	0.03	2.0E-01	9.0E-02
Sodium	9	9	2.4E+01	4.8E+01	3.2E+01	2.37	3.7E+01	3.3E+01
Uranium	9	9	1.5E-01	2.1E+00	8.2E-01	0.22	1.2E+00	5.3E-01
Vanadium	9	9	6.2E+00	1.7E+01	1.1E+01	1.15	1.3E+01	1.1E+01
Zinc	10	10	2.8E+01	6.7E+01	4.7E+01	4.02	5.4E+01	4.5E+01
Subreach 4.02								
Aluminum	6	6	4.7E+03	1.0E+04	7.2E+03	867.77	8.9E+03	6.9E+03
Arsenic	6	6	2.0E+00	1.1E+01	4.7E+00	1.43	7.5E+00	3.8E+00
Barium	6	6	4.8E+01	1.1E+02	7.0E+01	9.22	8.8E+01	6.7E+01
Beryllium	6	6	3.1E-01	7.8E-01	5.4E-01	0.08	7.0E-01	5.7E-01
Boron	6	6	1.2E+00	5.1E+00	2.5E+00	0.62	3.7E+00	1.7E+00
Cadmium	6	6	1.5E-01	5.1E-01	2.4E-01	0.06	3.6E-01	1.8E-01

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Calcium	6	6	1.0E+03	4.4E+03	2.2E+03	541.44	3.3E+03	1.8E+03
Chromium	6	6	1.1E+01	1.9E+01	1.5E+01	1.25	1.8E+01	1.5E+01
Cobalt	6	6	7.8E+00	1.1E+01	9.2E+00	0.49	1.0E+01	9.2E+00
Copper	6	6	4.4E+00	1.7E+01	8.9E+00	1.79	1.3E+01	7.5E+00
Iron	6	6	9.6E+03	1.6E+04	1.3E+04	1118.94	1.5E+04	1.3E+04
Kjeldahl Nitrogen	6	6	2.8E+02	1.3E+03	5.9E+02	167.85	9.3E+02	4.0E+02
Lead	6	6	9.7E+00	3.3E+01	1.9E+01	3.23	2.6E+01	1.8E+01
Magnesium	6	6	8.9E+02	2.5E+03	1.4E+03	234.57	1.9E+03	1.3E+03
Manganese	6	6	3.4E+02	1.2E+03	5.7E+02	142.77	8.6E+02	4.0E+02
Mercury	3	3	1.3E-01	1.9E+00	9.2E-01	0.52	2.4E+00	7.3E-01
Mercury (BR)	6	6	2.9E-03	2.9E+00	1.2E+00	0.4920	2.1E+00	9.5E-01
Methyl Mercury (BR)	6	6	1.1E-04	2.2E-03	7.6E-04	0.00032	1.4E-03	5.2E-04
Nickel	6	6	1.0E+01	2.1E+01	1.4E+01	1.64	1.7E+01	1.3E+01
Potassium	6	6	5.9E+02	1.1E+03	7.9E+02	66.31	9.2E+02	7.8E+02
Silver	6	6	3.0E-02	1.8E-01	8.4E-02	0.03	1.4E-01	5.3E-02
Sodium	6	6	1.9E+01	3.4E+01	2.5E+01	2.13	2.9E+01	2.4E+01
Uranium	6	6	2.6E-01	1.4E+00	6.4E-01	0.18	9.9E-01	5.1E-01
Vanadium	6	6	8.2E+00	1.7E+01	1.3E+01	1.42	1.6E+01	1.3E+01
Zinc	6	6	3.5E+01	8.0E+01	5.4E+01	7.09	6.9E+01	4.8E+01
Subreach 4.03								
Aluminum	7	7	6.7E+03	1.3E+04	9.3E+03	901.29	1.1E+04	9.5E+03
Antimony	6	1	3.3E-01	5.0E-01	5.0E-01	.	.	5.0E-01
Arsenic	7	7	4.3E+00	1.3E+01	7.7E+00	1.1	9.8E+00	8.2E+00
Barium	7	7	4.0E+01	1.2E+02	7.5E+01	11.86	9.8E+01	6.5E+01
Beryllium	7	7	4.2E-01	1.1E+00	6.9E-01	0.08	8.4E-01	6.4E-01
Boron	7	7	2.3E+00	4.2E+00	3.2E+00	0.27	3.8E+00	3.1E+00
Cadmium	7	7	2.6E-01	5.6E-01	4.2E-01	0.04	5.0E-01	4.4E-01
Calcium	7	7	8.2E+02	5.0E+03	2.5E+03	529.76	3.5E+03	2.0E+03
Chromium	7	7	2.0E+01	5.1E+01	3.1E+01	4.17	3.9E+01	2.9E+01
Cobalt	7	7	6.6E+00	1.8E+01	1.3E+01	1.43	1.6E+01	1.3E+01
Copper	7	7	1.4E+01	3.9E+01	2.5E+01	3.37	3.2E+01	2.3E+01
Iron	7	7	1.1E+04	2.4E+04	1.8E+04	1714.04	2.2E+04	1.8E+04
Kjeldahl Nitrogen	7	7	4.1E+02	1.5E+03	7.4E+02	145.96	1.0E+03	5.3E+02
Lead	7	7	1.4E+01	7.1E+01	3.3E+01	6.83	4.7E+01	3.1E+01
Magnesium	7	7	7.1E+02	2.6E+03	1.6E+03	276.42	2.2E+03	1.4E+03
Manganese	7	7	4.2E+02	2.0E+03	1.0E+03	207.82	1.4E+03	8.3E+02
Mercury	2	2	2.1E+00	4.5E+00	3.3E+00	1.2	1.1E+01	3.3E+00
Mercury (BR)	7	7	7.3E-01	5.3E+00	2.3E+00	0.58366	3.4E+00	1.8E+00

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Methyl Mercury (BR)	7	7	2.9E-04	1.2E-03	7.7E-04	0.0001	9.7E-04	8.2E-04
Nickel	7	7	1.5E+01	4.4E+01	2.6E+01	3.68	3.3E+01	2.8E+01
Potassium	7	7	5.7E+02	1.2E+03	9.2E+02	103.07	1.1E+03	9.5E+02
Selenium	7	1	2.9E-01	2.1E+00	3.9E-01	0.584	3.4E+00	1.8E+00
Silver	7	7	7.0E-02	3.6E-01	2.2E-01	0.04972	3.2E-01	2.1E-01
Sodium	7	7	2.6E+01	4.7E+01	3.6E+01	2.97064	4.2E+01	3.5E+01
Uranium	7	7	4.8E-01	2.1E+00	1.1E+00	0.20089	1.5E+00	1.0E+00
Vanadium	7	7	1.3E+01	2.5E+01	1.9E+01	1.50215	2.2E+01	2.0E+01
Zinc	7	7	4.9E+01	1.1E+02	7.3E+01	7.70996	8.8E+01	7.7E+01
Subreach 4.04								
Aluminum	11	11	7.4E+03	2.1E+04	1.3E+04	1340.8	1.5E+04	1.2E+04
Arsenic	12	12	4.4E+00	1.7E+01	9.3E+00	0.92	1.1E+01	8.2E+00
Barium	11	11	6.5E+01	1.7E+02	1.1E+02	9.73	1.3E+02	1.0E+02
Beryllium	12	12	7.3E-01	1.5E+00	1.0E+00	0.06	1.1E+00	1.0E+00
Boron	11	11	3.8E+00	8.0E+00	5.4E+00	0.39	6.1E+00	5.4E+00
Cadmium	12	12	3.3E-01	1.3E+00	5.1E-01	0.07	6.4E-01	4.6E-01
Calcium	11	11	1.9E+03	3.5E+03	2.9E+03	135.66	3.1E+03	2.9E+03
Chromium	12	12	1.1E+01	3.1E+01	1.9E+01	1.78	2.2E+01	1.8E+01
Cobalt	11	11	9.8E+00	2.9E+01	1.7E+01	1.6	2.0E+01	1.7E+01
Copper	12	12	1.9E+01	6.1E+01	3.5E+01	4.1	4.2E+01	3.0E+01
Iron	11	11	1.3E+04	3.2E+04	2.2E+04	1964.19	2.5E+04	2.1E+04
Kjeldahl Nitrogen	11	11	9.1E+02	2.1E+03	1.7E+03	109.74	1.9E+03	1.8E+03
Lead	12	12	1.5E+01	6.0E+01	2.9E+01	3.47	3.5E+01	2.5E+01
Magnesium	11	11	1.3E+03	2.7E+03	1.9E+03	136.23	2.1E+03	1.9E+03
Manganese	11	11	6.2E+02	2.0E+03	1.3E+03	141.83	1.6E+03	1.3E+03
Mercury	11	11	1.0E+00	2.2E+00	1.7E+00	0.1	1.9E+00	1.7E+00
Mercury (BR)	1	1	.	.	1.1E+00	.	.	1.1E+00
Nickel	12	12	1.7E+01	4.2E+01	2.7E+01	2.09	3.1E+01	2.6E+01
Potassium	11	11	4.8E+02	1.8E+03	1.1E+03	119.2	1.3E+03	1.1E+03
Selenium	12	6	2.6E-01	9.0E-01	4.3E-01	0.06	5.3E-01	3.1E-01
Silver	11	11	1.8E-01	2.7E+00	4.6E-01	0.22	8.7E-01	2.3E-01
Sodium	11	11	4.1E+01	9.0E+01	6.2E+01	4.27	7.0E+01	6.3E+01
Uranium	11	11	7.0E-01	1.6E+00	1.0E+00	0.07	1.1E+00	9.2E-01
Vanadium	11	11	1.6E+01	3.7E+01	2.3E+01	2.08	2.7E+01	2.1E+01
Zinc	12	12	8.0E+01	1.7E+02	1.2E+02	8.47	1.4E+02	1.2E+02
Subreach 5								
Antimony	3	1	4.3E-01	1.5E+00	1.5E+00	.	.	1.5E+00

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Arsenic	4	4	9.3E+00	1.1E+01	1.0E+01	0.43307	1.1E+01	1.0E+01
Beryllium	4	4	1.2E+00	1.8E+00	1.4E+00	0.13519	1.7E+00	1.4E+00
Cadmium	4	4	1.0E+00	7.0E+00	2.7E+00	1.4609	6.1E+00	1.3E+00
Chromium	4	4	2.6E+01	3.2E+01	2.9E+01	1.32221	3.3E+01	3.0E+01
Copper	4	4	2.9E+01	4.3E+01	3.7E+01	3.4446	4.5E+01	3.9E+01
Lead	4	4	3.5E+01	4.7E+01	4.1E+01	2.90594	4.8E+01	4.1E+01
Mercury	4	4	4.6E-01	1.3E+00	7.0E-01	0.18915	1.1E+00	5.3E-01
Nickel	4	4	2.1E+01	3.2E+01	2.5E+01	2.629	3.1E+01	2.3E+01
Silver	4	4	1.6E-01	9.1E-01	4.1E-01	0.1754	8.2E-01	2.8E-01
Zinc	4	4	1.8E+02	2.7E+02	2.2E+02	20.3905	2.7E+02	2.1E+02
Subreach 7.01								
Aluminum	1	1	.	.	1.9E+04	.	.	1.9E+04
Arsenic	1	1	.	.	9.7E+01	.	.	9.7E+01
Barium	1	1	.	.	1.6E+02	.	.	1.6E+02
Beryllium	1	1	.	.	1.4E+00	.	.	1.4E+00
Boron	1	1	.	.	7.2E+00	.	.	7.2E+00
Cadmium	1	1	.	.	5.0E-01	.	.	5.0E-01
Calcium	1	1	.	.	9.6E+03	.	.	9.6E+03
Chromium	1	1	.	.	2.5E+01	.	.	2.5E+01
Cobalt	1	1	.	.	1.4E+01	.	.	1.4E+01
Copper	1	1	.	.	2.6E+01	.	.	2.6E+01
Iron	1	1	.	.	3.1E+04	.	.	3.1E+04
Kjeldahl Nitrogen	1	1	.	.	2.7E+03	.	.	2.7E+03
Lead	1	1	.	.	1.6E+01	.	.	1.6E+01
Magnesium	1	1	.	.	3.2E+03	.	.	3.2E+03
Manganese	1	1	.	.	1.6E+03	.	.	1.6E+03
Mercury (BR)	1	1	.	.	1.6E-01	.	.	1.6E-01
Methyl Mercury (BR)	1	1	.	.	3.2E-04	.	.	3.2E-04
Nickel	1	1	.	.	2.7E+01	.	.	2.7E+01
Potassium	1	1	.	.	2.1E+03	.	.	2.1E+03
Selenium	1	1	.	.	8.4E+00	.	.	8.4E+00
Sodium	1	1	.	.	6.6E+01	.	.	6.6E+01
Uranium	1	1	.	.	5.5E-01	.	.	5.5E-01
Vanadium	1	1	.	.	5.2E+01	.	.	5.2E+01
Zinc	1	1	.	.	9.7E+01	.	.	9.7E+01
Subreach 7.02								
Aluminum	1	1	.	.	1.7E+04	.	.	1.7E+04

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Antimony	9	3	2.0E-01	8.3E-01	2.6E-01	0.04300	3.4E-01	2.0E-01
Arsenic	9	9	4.3E+00	2.1E+01	1.2E+01	1.62381	1.5E+01	1.3E+01
Barium	1	1	.	.	1.6E+02	.	.	1.6E+02
Beryllium	9	9	7.5E-01	1.5E+00	1.0E+00	0.08431	1.2E+00	1.0E+00
Boron	1	1	.	.	5.7E+00	.	.	5.7E+00
Cadmium	9	2	3.1E-01	9.4E-01	4.2E-01	0.08535	5.8E-01	3.6E-01
Calcium	1	1	.	.	8.4E+03	.	.	8.4E+03
Chromium	9	9	1.9E+01	5.9E+01	2.9E+01	4.53416	3.8E+01	2.3E+01
Cobalt	1	1	.	.	1.6E+01	.	.	1.6E+01
Copper	9	9	1.5E+01	4.3E+01	2.8E+01	3.50445	3.4E+01	2.8E+01
Iron	1	1	.	.	3.0E+04	.	.	3.0E+04
Kjeldahl Nitrogen	1	1	.	.	1.2E+03	.	.	1.2E+03
Lead	9	9	1.4E+01	3.3E+01	2.1E+01	2.15588	2.5E+01	1.9E+01
Magnesium	1	1	.	.	2.9E+03	.	.	2.9E+03
Manganese	1	1	.	.	2.9E+03	.	.	2.9E+03
Mercury (BR)	1	1	.	.	1.1E-01	.	.	1.1E-01
Methyl Mercury (BR)	1	1	.	.	2.8E-04	.	.	2.8E-04
Nickel	9	9	1.8E+01	4.1E+01	2.6E+01	2.18718	3.1E+01	2.5E+01
Potassium	1	1	.	.	2.0E+03	.	.	2.0E+03
Selenium	9	8	2.7E-01	2.3E+00	9.9E-01	0.20574	1.4E+00	8.0E-01
Silver	9	6	2.5E-02	2.6E-01	9.6E-02	0.02378	1.4E-01	7.7E-02
Sodium	1	1	.	.	6.2E+01	.	.	6.2E+01
Thallium	9	1	2.5E-01	6.9E-01	6.9E-01	.	.	6.9E-01
Uranium	1	1	.	.	7.6E-01	.	.	7.6E-01
Vanadium	1	1	.	.	3.5E+01	.	.	3.5E+01
Zinc	9	9	4.6E+01	1.1E+02	7.8E+01	7.23991	9.1E+01	7.2E+01
Subreach 8								
Aluminum	1	1	.	.	1.7E+04	.	.	1.7E+04
Arsenic	1	1	.	.	7.9E+00	.	.	7.9E+00
Barium	1	1	.	.	1.2E+02	.	.	1.2E+02
Beryllium	1	1	.	.	1.1E+00	.	.	1.1E+00
Boron	1	1	.	.	4.2E+00	.	.	4.2E+00
Cadmium	1	1	.	.	2.8E-01	.	.	2.8E-01
Calcium	1	1	.	.	6.0E+03	.	.	6.0E+03
Chromium	1	1	.	.	2.1E+01	.	.	2.1E+01
Cobalt	1	1	.	.	1.5E+01	.	.	1.5E+01
Copper	1	1	.	.	2.3E+01	.	.	2.3E+01
Iron	1	1	.	.	2.9E+04	.	.	2.9E+04

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Kjeldahl Nitrogen	1	1	.	.	1.5E+03	.	.	1.5E+03
Lead	1	1	.	.	2.8E+01	.	.	2.8E+01
Magnesium	1	1	.	.	2.9E+03	.	.	2.9E+03
Manganese	1	1	.	.	2.0E+03	.	.	2.0E+03
Mercury (BR)	1	1	.	.	7.6E-01	.	.	7.6E-01
Methyl Mercury (BR)	1	1	.	.	4.6E-04	.	.	4.6E-04
Nickel	1	1	.	.	2.4E+01	.	.	2.4E+01
Potassium	1	1	.	.	1.8E+03	.	.	1.8E+03
Silver	1	1	.	.	8.0E-02	.	.	8.0E-02
Sodium	1	1	.	.	5.2E+01	.	.	5.2E+01
Uranium	1	1	.	.	7.4E-01	.	.	7.4E-01
Vanadium	1	1	.	.	3.2E+01	.	.	3.2E+01
Zinc	1	1	.	.	9.2E+01	.	.	9.2E+01
Subreach 10								
Arsenic	1	1	.	.	6.9E+00	.	.	6.9E+00
Beryllium	1	1	.	.	1.3E+00	.	.	1.3E+00
Chromium	1	1	.	.	2.6E+01	.	.	2.6E+01
Copper	1	1	.	.	4.5E+01	.	.	4.5E+01
Lead	1	1	.	.	3.8E+01	.	.	3.8E+01
Mercury	1	1	.	.	7.0E-02	.	.	7.0E-02
Nickel	1	1	.	.	2.3E+01	.	.	2.3E+01
Zinc	1	1	.	.	9.9E+01	.	.	9.9E+01
Subreach 13								
Aluminum	5	5	3.7E+03	1.3E+04	9.4E+03	1589.32	1.3E+04	1.0E+04
Arsenic	5	5	3.3E+00	4.1E+00	3.8E+00	0.13	4.0E+00	3.8E+00
Barium	5	5	7.4E+01	1.2E+02	9.0E+01	8.48	1.1E+02	8.5E+01
Beryllium	5	5	4.5E-01	7.9E-01	6.4E-01	0.06	7.7E-01	6.8E-01
Boron	5	5	1.5E+00	1.3E+01	8.8E+00	1.96	1.3E+01	9.2E+00
Cadmium	5	5	8.0E-02	4.3E-01	2.5E-01	0.07	4.0E-01	1.8E-01
Calcium	5	5	1.0E+03	1.6E+03	1.2E+03	107.4	1.5E+03	1.2E+03
Chromium	5	5	1.1E+01	1.7E+01	1.4E+01	1.1	1.7E+01	1.5E+01
Cobalt	5	5	9.0E+00	1.9E+01	1.4E+01	1.75	1.8E+01	1.5E+01
Copper	5	5	8.0E+00	1.5E+01	1.1E+01	1.16	1.4E+01	1.0E+01
Iron	5	5	1.1E+04	1.8E+04	1.5E+04	1393.05	1.8E+04	1.6E+04
Kjeldahl Nitrogen	5	5	4.3E+02	1.1E+03	6.1E+02	116.61	8.6E+02	5.5E+02
Lead	5	5	1.2E+01	1.8E+01	1.5E+01	0.97	1.7E+01	1.5E+01
Magnesium	5	5	8.5E+02	1.7E+03	1.4E+03	156.84	1.8E+03	1.6E+03

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Manganese	5	5	2.4E+02	8.1E+02	4.9E+02	98.49	7.0E+02	4.2E+02
Mercury (BR)	5	5	5.2E-02	1.2E+00	3.5E-01	0.21765	8.2E-01	1.9E-01
Methyl Mercury (BR)	5	5	2.4E-04	2.7E-03	1.1E-03	0.00043	2.0E-03	8.7E-04
Nickel	5	5	1.5E+01	2.9E+01	2.2E+01	2.79	2.8E+01	1.9E+01
Potassium	5	5	6.5E+02	1.3E+03	1.1E+03	127.33	1.4E+03	1.3E+03
Selenium	5	1	2.0E-01	2.4E+00	5.2E-01	.	.	.
Silver	5	4	3.0E-02	1.6E-01	7.8E-02	0.02	1.3E-01	5.0E-02
Sodium	5	5	3.2E+01	6.3E+01	5.1E+01	5.44	6.2E+01	5.3E+01
Uranium	5	5	7.3E-01	2.8E+00	1.2E+00	0.38	2.1E+00	9.3E-01
Vanadium	5	5	1.5E+01	2.1E+01	1.7E+01	1.25	2.0E+01	1.6E+01
Zinc	5	5	3.6E+01	9.2E+01	6.5E+01	11	8.8E+01	5.7E+01
Subreach 18								
Aluminum	3	3	8.7E+03	1.4E+04	1.2E+04	1511.77	1.6E+04	1.3E+04
Arsenic	3	3	3.5E+00	5.4E+00	4.6E+00	0.56	6.2E+00	4.9E+00
Barium	3	3	8.3E+01	1.2E+02	1.1E+02	12.72	1.4E+02	1.2E+02
Beryllium	3	3	5.4E-01	7.7E-01	6.8E-01	0.07	8.9E-01	7.3E-01
Boron	3	3	3.6E+00	6.5E+00	4.8E+00	0.89	7.4E+00	4.3E+00
Cadmium	3	3	3.7E-01	4.5E-01	4.2E-01	0.03	5.0E-01	4.5E-01
Calcium	3	3	2.0E+03	2.4E+03	2.3E+03	141.18	2.7E+03	2.4E+03
Chromium	3	3	1.3E+01	1.8E+01	1.6E+01	1.4	2.0E+01	1.7E+01
Cobalt	3	3	7.7E+00	1.1E+01	9.5E+00	0.92	1.2E+01	1.0E+01
Copper	3	3	1.2E+01	2.0E+01	1.6E+01	2.46	2.3E+01	1.7E+01
Iron	3	3	1.4E+04	2.0E+04	1.8E+04	1978.31	2.3E+04	1.9E+04
Kjeldahl Nitrogen	3	3	7.9E+02	1.2E+03	9.9E+02	131.91	1.4E+03	9.4E+02
Lead	3	3	2.0E+01	2.7E+01	2.3E+01	2.07	2.9E+01	2.3E+01
Magnesium	3	3	2.1E+03	2.8E+03	2.4E+03	200.34	3.0E+03	2.4E+03
Manganese	3	3	1.3E+03	2.0E+03	1.7E+03	214.55	2.4E+03	1.9E+03
Mercury (BR)	3	3	6.4E-02	1.1E-01	9.1E-02	0.014097	1.3E-01	9.8E-02
Nickel	3	3	8.8E+00	1.4E+01	1.2E+01	1.55	1.6E+01	1.3E+01
Potassium	3	3	1.3E+03	1.5E+03	1.4E+03	66.17	1.6E+03	1.4E+03
Silver	3	3	8.0E-02	1.9E-01	1.4E-01	0.03	2.3E-01	1.4E-01
Sodium	3	3	4.1E+01	5.5E+01	5.0E+01	4.65	6.4E+01	5.5E+01
Uranium	3	3	7.6E-01	7.9E-01	7.8E-01	0.010	8.1E-01	7.8E-01
Vanadium	3	3	1.6E+01	2.4E+01	2.1E+01	2.37	2.8E+01	2.3E+01
Zinc	3	3	1.1E+02	1.3E+02	1.2E+02	6.82	1.4E+02	1.3E+02
Subreach 22								
Arsenic	1	1	.	.	3.9E+00	.	.	3.9E+00

Table B6. (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Beryllium	1	1	.	.	2.7E+00	.	.	2.7E+00
Cadmium	1	1	.	.	3.5E+00	.	.	3.5E+00
Chromium	1	1	.	.	9.8E+01	.	.	9.8E+01
Copper	1	1	.	.	4.1E+01	.	.	4.1E+01
Lead	1	1	.	.	1.2E+02	.	.	1.2E+02
Mercury	1	1	.	.	1.1E+02	.	.	1.1E+02
Nickel	1	1	.	.	2.4E+01	.	.	2.4E+01
Silver	1	1	.	.	1.7E+01	.	.	1.7E+01
Zinc	1	1	.	.	1.1E+02	.	.	1.1E+02

Table B7. Summary statistics for deep sediment (core weighted) inorganic concentrations (mg/kg) by reach.

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach 0								
Aluminum	5	5	2.1E+03	8.3E+03	5.5E+03	1076.67	7.8E+03	6.2E+03
Antimony	5	2	2.3E-01	6.7E-01	5.4E-01	0.04	6.3E-01	5.0E-01
Arsenic	5	5	1.5E+00	6.9E+00	3.8E+00	0.92	5.8E+00	3.8E+00
Barium	5	5	2.5E+01	9.3E+01	6.5E+01	11.35	8.9E+01	7.4E+01
Beryllium	5	5	2.1E-01	6.0E-01	4.9E-01	0.07	6.5E-01	5.7E-01
Boron	5	3	1.2E+00	2.5E+00	1.8E+00	0.30	2.5E+00	1.4E+00
Cadmium	5	5	1.5E-01	3.4E-01	2.6E-01	0.03	3.3E-01	2.7E-01
Calcium	5	5	1.1E+03	4.9E+03	2.9E+03	716.3	4.5E+03	2.5E+03
Chromium	5	5	1.0E+01	2.0E+01	1.3E+01	1.93	1.7E+01	1.1E+01
Cobalt	5	5	4.2E+00	1.6E+01	1.0E+01	2.08	1.5E+01	9.2E+00
Copper	5	5	3.0E+00	1.2E+01	8.0E+00	1.65	1.2E+01	9.5E+00
Iron	5	5	6.3E+03	2.0E+04	1.3E+04	2258.87	1.8E+04	1.4E+04
Kjeldahl Nitrogen	5	5	4.2E+02	3.5E+04	7.7E+03	6887.66	2.2E+04	7.3E+02
Lead	5	5	1.0E+01	4.2E+01	2.3E+01	5.21	3.4E+01	2.2E+01
Magnesium	5	5	6.4E+02	2.5E+03	1.7E+03	347.2	2.4E+03	1.6E+03
Manganese	5	5	2.9E+02	4.3E+03	1.6E+03	703.61	3.1E+03	1.1E+03
Mercury	5	5	3.5E-02	1.4E-01	7.5E-02	0.02	1.1E-01	6.9E-02
Nickel	5	5	7.7E+00	2.2E+01	1.4E+01	2.56	1.9E+01	1.4E+01
Potassium	5	5	2.2E+02	8.6E+02	5.9E+02	109.7	8.2E+02	6.8E+02
Silver	5	4	2.0E-02	4.9E-01	1.4E-01	0.09	3.3E-01	5.2E-02
Sodium	5	4	1.5E+01	4.0E+01	2.5E+01	5.87	3.8E+01	1.7E+01
Uranium	5	5	2.1E-01	7.7E-01	4.5E-01	0.11	6.7E-01	4.9E-01
Vanadium	5	5	4.9E+00	1.7E+01	1.2E+01	2.17	1.6E+01	1.3E+01
Zinc	5	5	3.0E+01	8.4E+01	6.1E+01	10.87	8.4E+01	7.1E+01
Reach 1								
Arsenic	2	2	5.0E+00	1.1E+01	8.0E+00	3.0141	2.7E+01	8.0E+00
Beryllium	2	2	5.9E-01	8.1E-01	7.0E-01	0.1072	1.4E+00	7.0E-01
Cadmium	2	2	4.2E-01	7.3E-01	5.7E-01	0.1547	1.5E+00	5.7E-01
Chromium	2	2	9.9E+00	2.0E+01	1.5E+01	4.8691	4.5E+01	1.5E+01
Copper	2	2	2.6E+01	2.9E+01	2.8E+01	1.3587	3.6E+01	2.8E+01
Lead	2	2	3.0E+01	3.9E+01	3.5E+01	4.5584	6.3E+01	3.5E+01
Mercury	2	2	5.9E-02	1.2E-01	9.2E-02	0.0322	3.0E-01	9.2E-02
Nickel	2	2	1.4E+01	2.3E+01	1.8E+01	4.8722	4.9E+01	1.8E+01
Selenium	2	2	4.2E-01	6.9E-01	5.6E-01	0.1376	1.4E+00	5.6E-01
Silver	2	2	2.0E-01	3.3E-01	2.7E-01	0.0624	6.6E-01	2.7E-01
Zinc	2	2	7.0E+01	1.2E+02	9.6E+01	26.2773	2.6E+02	9.6E+01

Table B7 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach 2								
Aluminum	8	8	4.0E+03	1.8E+04	9.6E+03	1356.05	1.2E+04	9.1E+03
Antimony	7	1	7.0E-01	7.0E-01	7.0E-01	.	.	7.0E-01
Arsenic	10	10	1.6E+00	1.0E+01	4.9E+00	0.8	6.4E+00	4.3E+00
Barium	8	8	4.7E+01	1.9E+02	1.0E+02	16.2	1.4E+02	1.0E+02
Beryllium	10	10	4.1E-01	1.3E+00	7.1E-01	0.08	8.6E-01	7.0E-01
Boron	8	6	2.2E+00	4.9E+00	3.5E+00	0.25	4.0E+00	3.1E-01
Cadmium	10	10	1.3E-01	4.8E-01	3.0E-01	0.04	3.7E-01	3.1E-01
Calcium	8	8	1.2E+03	9.1E+03	3.8E+03	933.91	5.6E+03	2.9E+03
Chromium	10	10	7.7E+00	2.1E+01	1.4E+01	1.05	1.6E+01	1.4E+01
Cobalt	8	8	5.3E+00	2.1E+01	1.2E+01	1.78	1.6E+01	1.1E+01
Copper	10	10	4.1E+00	1.5E+01	9.7E+00	1.05	1.2E+01	9.8E+00
Iron	8	8	8.9E+03	2.6E+04	1.7E+04	1873.22	2.0E+04	1.7E+04
Kjeldahl Nitrogen	8	8	2.2E+02	6.5E+03	2.1E+03	897.36	3.8E+03	9.1E+02
Lead	10	10	5.8E+00	6.5E+01	2.7E+01	5.15	3.6E+01	2.5E+01
Magnesium	8	8	8.5E+02	4.1E+03	2.2E+03	339.75	2.8E+03	2.0E+03
Manganese	8	8	2.0E+02	4.5E+03	1.6E+03	504.15	2.6E+03	1.1E+03
Mercury	10	8	3.2E-02	2.5E-01	1.0E-01	0.02	1.4E-01	7.4E-02
Nickel	10	10	8.4E+00	2.5E+01	1.5E+01	1.41	1.7E+01	1.4E+01
Potassium	8	8	4.8E+02	2.0E+03	1.0E+03	149.6	1.3E+03	9.5E+02
Selenium	8	2	1.8E-01	2.4E+00	3.2E-01	0.00	3.2E-01	3.2E-01
Silver	10	9	1.9E-02	5.5E-01	1.5E-01	0.05	2.5E-01	7.8E-02
Sodium	8	6	2.6E+01	4.4E+01	3.2E+01	2.29	3.7E+01	3.3E+01
Uranium	8	8	1.1E-01	1.0E+00	5.3E-01	0.12	7.5E-01	4.3E-01
Vanadium	8	8	6.0E+00	2.1E+01	1.5E+01	1.68	1.8E+01	1.5E+01
Zinc	10	10	3.0E+01	8.2E+01	5.9E+01	4.74	6.7E+01	5.7E+01
Reach 3								
Aluminum	25	25	6.5E+03	2.0E+04	1.3E+04	774.55	1.4E+04	1.3E+04
Antimony	25	2	2.8E-01	6.1E-01	3.0E-01	0.00	3.1E-01	3.0E-01
Arsenic	28	28	1.3E+00	1.4E+02	1.5E+01	5.71	2.5E+01	5.0E+00
Barium	25	25	5.9E+01	2.9E+02	1.2E+02	10.21	1.3E+02	1.0E+02
Beryllium	28	28	3.0E-01	1.7E+00	8.1E-01	0.06	9.2E-01	7.5E-01
Boron	25	18	9.0E-01	4.4E+01	7.7E+00	1.78	1.1E+01	5.0E+00
Cadmium	28	28	9.2E-02	5.6E+00	1.7E+00	0.28	2.2E+00	1.2E+00
Calcium	25	25	5.0E+02	1.4E+04	3.0E+03	547.3	3.9E+03	2.2E+03
Chromium	28	28	9.3E+00	1.1E+02	3.8E+01	4.94	4.7E+01	3.1E+01
Cobalt	25	25	9.5E+00	2.5E+01	1.6E+01	0.88	1.8E+01	1.6E+01

Table B7 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Copper	28	28	5.4E+00	1.7E+02	3.8E+01	6.41	4.9E+01	3.4E+01
Iron	25	25	1.1E+04	3.6E+04	2.1E+04	1170.5	2.3E+04	2.0E+04
Kjeldahl Nitrogen	25	25	7.7E+01	2.1E+03	6.5E+02	94.74	8.1E+02	5.3E+02
Lead	28	28	7.4E+00	5.8E+01	2.2E+01	1.97	2.6E+01	2.1E+01
Magnesium	25	25	9.5E+02	2.7E+03	1.7E+03	94.78	1.8E+03	1.7E+03
Manganese	25	25	2.7E+02	1.1E+03	6.1E+02	39.75	6.8E+02	5.9E+02
Mercury	28	28	2.5E-02	1.1E+02	1.3E+01	4.4	2.1E+01	5.2E+00
Nickel	28	28	7.8E+00	3.3E+02	5.5E+01	12.07	7.5E+01	4.0E+01
Potassium	25	25	6.1E+02	2.4E+03	1.3E+03	99.67	1.5E+03	1.3E+03
Selenium	26	8	1.7E-01	3.3E+00	4.6E-01	0.1430	7.1E-01	1.7E-01
Silver	28	28	2.2E-02	3.8E+00	9.5E-01	0.18	1.3E+00	8.9E-01
Sodium	25	25	2.3E+01	3.0E+02	6.9E+01	12.4154	9.0E+01	5.0E+01
Thallium	28	11	1.3E-01	1.6E+00	2.7E-01	0.0576	3.7E-01	2.1E-01
Uranium	25	25	4.6E-01	1.1E+02	1.3E+01	4.3664	2.0E+01	6.5E+00
Vanadium	25	25	1.1E+01	5.9E+01	2.2E+01	2.0728	2.5E+01	1.8E+01
Zinc	28	28	2.8E+01	2.1E+02	9.5E+01	8.7618	1.1E+02	9.0E+01
Reach 4								
Aluminum	33	33	4.7E+03	2.0E+04	1.1E+04	684.05	1.2E+04	1.1E+04
Antimony	35	2	2.5E-01	7.8E-01	4.1E-01	0.002	4.1E-01	4.1E-01
Arsenic	35	35	2.2E+00	1.2E+01	6.9E+00	0.5	7.7E+00	7.7E+00
Barium	33	33	4.5E+01	1.5E+02	9.5E+01	5.44	1.0E+02	8.5E+01
Beryllium	35	35	3.4E-01	1.4E+00	8.3E-01	0.05	9.1E-01	7.7E-01
Boron	33	33	1.4E+00	7.5E+00	4.2E+00	0.29	4.7E+00	4.2E+00
Cadmium	35	35	1.4E-01	1.4E+00	4.3E-01	0.05	5.1E-01	4.5E-01
Calcium	33	33	7.1E+02	4.4E+03	2.4E+03	160.31	2.7E+03	2.5E+03
Chromium	35	35	1.1E+01	3.7E+01	2.1E+01	1.18	2.3E+01	2.0E+01
Cobalt	33	33	7.0E+00	2.6E+01	1.4E+01	0.99	1.5E+01	1.2E+01
Copper	35	35	4.4E+00	5.3E+01	2.2E+01	2.45	2.6E+01	1.9E+01
Iron	33	33	9.6E+03	3.1E+04	1.9E+04	1032.1	2.0E+04	1.8E+04
Kjeldahl Nitrogen	33	31	9.9E+00	2.1E+03	8.9E+02	119.29	1.1E+03	6.3E+02
Lead	35	35	9.7E+00	5.0E+01	2.5E+01	1.61	2.8E+01	2.5E+01
Magnesium	33	33	5.6E+02	2.7E+03	1.7E+03	97.65	1.9E+03	1.8E+03
Manganese	33	33	2.7E+02	2.0E+03	1.0E+03	92.95	1.2E+03	9.2E+02
Mercury	35	35	8.5E-02	1.2E+01	2.4E+00	0.4	3.1E+00	2.0E+00
Nickel	35	35	9.6E+00	4.0E+01	2.3E+01	1.62	2.6E+01	2.2E+01
Potassium	33	33	4.5E+02	1.7E+03	1.0E+03	58.14	1.1E+03	1.1E+03
Selenium	35	13	1.6E-01	1.4E+00	3.9E-01	0.06	5.0E-01	2.1E-01
Silver	34	34	3.0E-02	1.8E+00	2.8E-01	0.06	3.7E-01	2.0E-01

Table B7 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Sodium	33	33	1.9E+01	7.6E+01	4.3E+01	2.9	4.8E+01	4.0E+01
Uranium	33	33	3.1E-01	2.2E+00	1.2E+00	0.1	1.3E+00	1.2E+00
Vanadium	33	33	8.2E+00	3.3E+01	2.0E+01	1.12	2.2E+01	1.8E+01
Zinc	35	35	3.5E+01	1.6E+02	8.5E+01	6.45	9.6E+01	7.0E+01
Rèach 5								
Antimony	3	1	4.0E-01	4.8E-01	4.6E-01			4.6E-01
Arsenic	4	4	7.5E+00	9.2E+00	8.6E+00	0.38009	9.4E+00	8.8E+00
Beryllium	4	4	1.0E+00	1.5E+00	1.2E+00	0.09752	1.5E+00	1.2E+00
Cadmium	4	4	1.1E+00	5.2E+00	2.3E+00	0.98322	4.6E+00	1.4E+00
Chromium	4	4	2.8E+01	3.5E+01	3.2E+01	1.79194	3.6E+01	3.3E+01
Copper	4	4	2.9E+01	3.9E+01	3.5E+01	2.195	4.0E+01	3.6E+01
Lead	4	4	3.9E+01	4.6E+01	4.4E+01	1.65588	4.7E+01	4.5E+01
Mercury	4	4	9.9E-01	3.1E+00	1.9E+00	0.46841	3.0E+00	1.7E+00
Nickel	4	4	1.9E+01	3.0E+01	2.3E+01	2.25762	2.9E+01	2.2E+01
Silver	4	4	1.6E-01	7.4E-01	3.6E-01	0.13372	6.7E-01	2.6E-01
Zinc	4	4	2.3E+02	2.7E+02	2.5E+02	8.03156	2.7E+02	2.5E+02
Reach 7								
Aluminum	2	2	1.5E+04	1.6E+04	1.5E+04	938.86	2.1E+04	1.5E+04
Antimony	10	4	2.0E-01	6.8E-01	2.7E-01	0.038	3.4E-01	2.0E-01
Arsenic	10	10	4.3E+00	6.4E+01	1.7E+01	5.37	2.7E+01	1.3E+01
Barium	2	2	1.3E+02	1.6E+02	1.4E+02	15.92	2.4E+02	1.4E+02
Beryllium	10	10	7.5E-01	1.5E+00	1.1E+00	0.06	1.2E+00	1.1E+00
Boron	2	2	4.8E+00	5.8E+00	5.3E+00	0.49	8.4E+00	5.3E+00
Cadmium	10	5	2.6E-01	8.2E-01	4.0E-01	0.07	5.3E-01	3.1E-01
Calcium	2	2	4.6E+03	6.5E+03	5.5E+03	956.75	1.2E+04	5.5E+03
Chromium	10	10	1.9E+01	5.9E+01	3.0E+01	3.94	3.7E+01	2.5E+01
Cobalt	2	2	1.3E+01	1.3E+01	1.3E+01	0.11	1.4E+01	1.3E+01
Copper	10	10	1.5E+01	3.7E+01	2.4E+01	2.4	2.8E+01	2.3E+01
Iron	2	2	2.4E+04	2.9E+04	2.7E+04	2320.46	4.1E+04	2.7E+04
Kjeldahl Nitrogen	2	2	1.0E+03	1.4E+03	1.2E+03	221.28	2.6E+03	1.2E+03
Lead	10	10	1.4E+01	3.0E+01	2.1E+01	1.87	2.4E+01	1.9E+01
Magnesium	2	2	2.3E+03	2.7E+03	2.5E+03	186.65	3.7E+03	2.5E+03
Manganese	2	2	1.0E+03	1.6E+03	1.3E+03	282.74	3.1E+03	1.3E+03
Mercury	10	2	5.0E-02	2.3E-01	1.2E-01	0.01	1.4E-01	1.2E-01
Nickel	10	10	1.8E+01	4.1E+01	2.6E+01	1.96	3.0E+01	2.6E+01
Potassium	2	2	1.4E+03	2.0E+03	1.7E+03	296.9	3.6E+03	1.7E+03
Selenium	10	8	2.7E-01	9.5E+00	2.0E+00	0.90	3.7E+00	9.3E-01

Table B7 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Silver	10	7	2.5E-02	2.6E-01	9.6E-02	0.02	1.4E-01	5.5E-02
Sodium	2	2	4.7E+01	5.4E+01	5.1E+01	3.46	7.3E+01	5.1E+01
Thallium	10	1	2.5E-01	5.7E-01	5.7E-01	.	.	5.7E-01
Uranium	2	2	7.3E-01	7.8E-01	7.6E-01	0.02	8.9E-01	7.6E-01
Vanadium	2	2	3.1E+01	4.3E+01	3.7E+01	5.9	7.4E+01	3.7E+01
Zinc	10	10	4.6E+01	1.0E+02	7.7E+01	6.22	8.8E+01	7.7E+01
Reach 8								
Aluminum	1	1	.	.	1.6E+04	.	.	1.6E+04
Arsenic	1	1	.	.	5.5E+00	.	.	5.5E+00
Barium	1	1	.	.	1.2E+02	.	.	1.2E+02
Beryllium	1	1	.	.	1.1E+00	.	.	1.1E+00
Boron	1	1	.	.	4.4E+00	.	.	4.4E+00
Cadmium	1	1	.	.	2.5E-01	.	.	2.5E-01
Calcium	1	1	.	.	4.1E+03	.	.	4.1E+03
Chromium	1	1	.	.	2.0E+01	.	.	2.0E+01
Cobalt	1	1	.	.	3.0E+01	.	.	3.0E+01
Copper	1	1	.	.	1.8E+01	.	.	1.8E+01
Iron	1	1	.	.	2.7E+04	.	.	2.7E+04
Kjeldahl Nitrogen	1	1	.	.	1.5E+03	.	.	1.5E+03
Lead	1	1	.	.	5.2E+01	.	.	5.2E+01
Magnesium	1	1	.	.	2.4E+03	.	.	2.4E+03
Manganese	1	1	.	.	1.2E+03	.	.	1.2E+03
Mercury	1	1	.	.	3.4E-01	.	.	3.4E-01
Nickel	1	1	.	.	2.2E+01	.	.	2.2E+01
Potassium	1	1	.	.	1.6E+03	.	.	1.6E+03
Silver	1	1	.	.	7.3E-02	.	.	7.3E-02
Sodium	1	1	.	.	4.6E+01	.	.	4.6E+01
Uranium	1	1	.	.	7.0E-01	.	.	7.0E-01
Vanadium	1	1	.	.	2.8E+01	.	.	2.8E+01
Zinc	1	1	.	.	8.2E+01	.	.	8.2E+01
Reach 10								
Antimony	1	1	.	.	4.1E-01	.	.	4.1E-01
Arsenic	1	1	.	.	5.2E+00	.	.	5.2E+00
Beryllium	1	1	.	.	1.3E+00	.	.	1.3E+00
Cadmium	1	1	.	.	6.4E-01	.	.	6.4E-01
Chromium	1	1	.	.	2.2E+01	.	.	2.2E+01
Copper	1	1	.	.	1.9E+01	.	.	1.9E+01

Table B7 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Lead	1	1	.	.	3.3E+01	.	.	3.3E+01
Mercury	1	1	.	.	8.2E-02	.	.	8.2E-02
Nickel	1	1	.	.	2.1E+01	.	.	2.1E+01
Zinc	1	1	.	.	8.7E+01	.	.	8.7E+01
Reach 13								
Aluminum	5	5	9.6E+03	1.3E+04	1.1E+04	674.973	1.3E+04	1.0E+04
Arsenic	5	5	2.6E+00	4.0E+00	3.2E+00	0.261	3.8E+00	3.2E+00
Barium	5	5	8.3E+01	1.2E+02	9.8E+01	6.67	1.1E+02	9.6E+01
Beryllium	5	5	6.0E-01	8.3E-01	7.0E-01	0.04	7.8E-01	6.9E-01
Boron	5	5	2.1E+00	9.1E+00	7.1E+00	1.29	9.9E+00	8.1E+00
Cadmium	5	5	8.0E-02	3.8E-01	2.0E-01	0.055	3.2E-01	1.6E-01
Calcium	5	5	1.0E+03	1.2E+03	1.1E+03	47.455	1.2E+03	1.2E+03
Chromium	5	5	1.4E+01	1.8E+01	1.6E+01	0.664	1.7E+01	1.7E+01
Cobalt	5	5	1.1E+01	1.8E+01	1.5E+01	1.208	1.7E+01	1.5E+01
Copper	5	5	8.9E+00	1.4E+01	1.1E+01	0.923	1.3E+01	1.1E+01
Iron	5	5	1.5E+04	1.9E+04	1.7E+04	814.655	1.9E+04	1.6E+04
Kjeldahl Nitrogen	5	5	3.8E+02	1.1E+03	6.2E+02	113.868	8.7E+02	5.5E+02
Lead	5	5	1.4E+01	1.6E+01	1.5E+01	0.445	1.6E+01	1.6E+01
Magnesium	5	5	1.4E+03	1.7E+03	1.6E+03	56.404	1.7E+03	1.5E+03
Manganese	5	5	2.4E+02	9.1E+02	5.8E+02	122.288	8.5E+02	5.5E+02
Mercury	5	5	3.7E-02	4.4E+00	9.4E-01	0.856	2.8E+00	8.7E-02
Nickel	5	5	1.8E+01	4.0E+01	2.4E+01	4.241	3.3E+01	1.9E+01
Potassium	5	5	1.1E+03	1.4E+03	1.3E+03	53.924	1.4E+03	1.3E+03
Selenium	5	1	2.0E-01	2.4E+00	3.2E-01	.	.	3.2E-01
Silver	5	5	3.7E-02	9.4E-02	5.8E-02	0.011	8.2E-02	4.8E-02
Sodium	5	5	2.9E+01	5.5E+01	4.7E+01	4.7	5.7E+01	4.8E+01
Uranium	5	5	7.1E-01	2.7E+00	1.2E+00	0.387	2.0E+00	7.7E-01
Vanadium	5	5	1.6E+01	2.0E+01	1.8E+01	0.754	1.9E+01	1.7E+01
Zinc	5	5	4.5E+01	8.5E+01	6.2E+01	7.481	7.8E+01	5.8E+01
Reach 18								
Aluminum	3	3	8.8E+03	1.4E+04	1.2E+04	1694.82	1.7E+04	1.3E+04
Arsenic	3	3	4.9E+00	5.3E+00	5.1E+00	0.11	5.4E+00	5.0E+00
Barium	3	3	8.4E+01	1.2E+02	1.1E+02	12.33	1.4E+02	1.2E+02
Beryllium	3	3	5.6E-01	7.8E-01	7.0E-01	0.07	9.0E-01	7.5E-01
Boron	3	3	3.5E+00	5.1E+00	4.3E+00	0.46	5.7E+00	4.5E+00
Cadmium	3	3	4.6E-01	5.0E-01	4.8E-01	0.01	5.2E-01	4.9E-01
Calcium	3	3	2.0E+03	2.3E+03	2.1E+03	83.73	2.4E+03	2.0E+03

Table B7 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Chromium	3	3	1.4E+01	1.9E+01	1.7E+01	1.56	2.1E+01	1.8E+01
Cobalt	3	3	9.1E+00	1.2E+01	1.1E+01	0.78	1.3E+01	1.1E+01
Copper	3	3	1.4E+01	2.0E+01	1.7E+01	1.77	2.2E+01	1.8E+01
Iron	3	3	1.5E+04	2.1E+04	1.8E+04	1863.98	2.4E+04	2.0E+04
Kjeldahl Nitrogen	3	3	6.4E+02	1.2E+03	9.6E+02	162.29	1.4E+03	1.0E+03
Lead	3	3	2.0E+01	2.7E+01	2.4E+01	1.76	2.9E+01	2.4E+01
Magnesium	3	3	2.1E+03	2.6E+03	2.3E+03	146.14	2.8E+03	2.3E+03
Manganese	3	3	1.2E+03	2.1E+03	1.7E+03	280.09	2.5E+03	1.9E+03
Mercury	3	3	1.2E-01	1.3E-01	1.2E-01	0	1.3E-01	1.2E-01
Nickel	3	3	8.9E+00	1.4E+01	1.2E+01	1.55	1.6E+01	1.3E+01
Potassium	3	3	1.2E+03	1.4E+03	1.3E+03	76.61	1.6E+03	1.4E+03
Silver	3	3	9.6E-02	2.1E-01	1.5E-01	0.03	2.5E-01	1.5E-01
Sodium	3	3	4.6E+01	5.3E+01	4.9E+01	2.03	5.5E+01	4.8E+01
Uranium	3	3	9.4E-01	1.0E-01	9.8E-01	0.019	1.0E+00	9.8E-01
Vanadium	3	3	1.7E+01	2.4E+01	2.1E+01	2.31	2.8E+01	2.3E+01
Zinc	3	3	1.3E+02	1.4E+02	1.4E+02	3.73	1.5E+02	1.3E+02
Reach 22								
Antimony	1	1	.	.	9.6E+00	.	.	9.6E+00
Arsenic	1	1	.	.	4.4E+00	.	.	4.4E+00
Beryllium	1	1	.	.	1.5E+00	.	.	1.5E+00
Cadmium	1	1	.	.	2.4E+00	.	.	2.4E+00
Chromium	1	1	.	.	5.3E+01	.	.	5.3E+01
Copper	1	1	.	.	2.4E+01	.	.	2.4E+01
Lead	1	1	.	.	6.1E+01	.	.	6.1E+01
Mercury	1	1	.	.	7.4E+01	.	.	7.4E+01
Nickel	1	1	.	.	2.3E+01	.	.	2.3E+01
Silver	1	1	.	.	7.6E+00	.	.	7.6E+00
Thallium	1	1	.	.	6.6E-01	.	.	6.6E-01
Zinc	1	1	.	.	7.7E+01	.	.	7.7E+01

Table B8. Summary statistics for deep sediment (core weighted) inorganic concentrations (mg/kg) by subreach.

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Subreach 0								
Aluminum	5	5	2.1E+03	8.3E+03	5.5E+03	1076.67	7.8E+03	6.2E+03
Antimony	5	2	2.3E-01	6.7E-01	5.4E-01	0.04	6.3E-01	5.0E-01
Arsenic	5	5	1.5E+00	6.9E+00	3.8E+00	0.92	5.8E+00	3.8E+00
Barium	5	5	2.5E+01	9.3E+01	6.5E+01	11.35	8.9E+01	7.4E+01
Beryllium	5	5	2.1E-01	6.0E-01	4.9E-01	0.07	6.5E-01	5.7E-01
Boron	5	3	1.2E+00	2.5E+00	1.8E+00	0.30	2.5E+00	1.4E+00
Cadmium	5	5	1.5E-01	3.4E-01	2.6E-01	0.03	3.3E-01	2.7E-01
Calcium	5	5	1.1E+03	4.9E+03	2.9E+03	716.3	4.5E+03	2.5E+03
Chromium	5	5	1.0E+01	2.0E+01	1.3E+01	1.93	1.7E+01	1.1E+01
Cobalt	5	5	4.2E+00	1.6E+01	1.0E+01	2.08	1.5E+01	9.2E+00
Copper	5	5	3.0E+00	1.2E+01	8.0E+00	1.65	1.2E+01	9.5E+00
Iron	5	5	6.3E+03	2.0E+04	1.3E+04	2258.87	1.8E+04	1.4E+04
Kjeldahl Nitrogen	5	5	4.2E+02	3.5E+04	7.7E+03	6887.66	2.2E+04	7.3E+02
Lead	5	5	1.0E+01	4.2E+01	2.3E+01	5.21	3.4E+01	2.2E+01
Magnesium	5	5	6.4E+02	2.5E+03	1.7E+03	347.2	2.4E+03	1.6E+03
Manganese	5	5	2.9E+02	4.3E+03	1.6E+03	703.61	3.1E+03	1.1E+03
Mercury	5	5	3.5E-02	1.4E-01	7.5E-02	0.02	1.1E-01	6.9E-02
Nickel	5	5	7.7E+00	2.2E+01	1.4E+01	2.56	1.9E+01	1.4E+01
Potassium	5	5	2.2E+02	8.6E+02	5.9E+02	109.7	8.2E+02	6.8E+02
Silver	5	4	2.0E-02	4.9E-01	1.4E-01	0.09	3.3E-01	5.2E-02
Sodium	5	4	1.5E+01	4.0E+01	2.5E+01	5.87	3.8E+01	1.7E+01
Uranium	5	5	2.1E-01	7.7E-01	4.5E-01	0.11	6.7E-01	4.9E-01
Vanadium	5	5	4.9E+00	1.7E+01	1.2E+01	2.17	1.6E+01	1.3E+01
Zinc	5	5	3.0E+01	8.4E+01	6.1E+01	10.87	8.4E+01	7.1E+01
Subreach 1								
Arsenic	2	2	5.0E+00	1.1E+01	8.0E+00	3.0141	2.7E+01	8.0E+00
Beryllium	2	2	5.9E-01	8.1E-01	7.0E-01	0.1072	1.4E+00	7.0E-01
Cadmium	2	2	4.2E-01	7.3E-01	5.7E-01	0.1547	1.5E+00	5.7E-01
Chromium	2	2	9.9E+00	2.0E+01	1.5E+01	4.8691	4.5E+01	1.5E+01
Copper	2	2	2.6E+01	2.9E+01	2.8E+01	1.3587	3.6E+01	2.8E+01
Lead	2	2	3.0E+01	3.9E+01	3.5E+01	4.5584	6.3E+01	3.5E+01
Mercury	2	2	5.9E-02	1.2E-01	9.2E-02	0.0322	3.0E-01	9.2E-02
Nickel	2	2	1.4E+01	2.3E+01	1.8E+01	4.8722	4.9E+01	1.8E+01
Selenium	2	2	4.2E-01	6.9E-01	5.6E-01	0.1376	1.4E+00	5.6E-01
Silver	2	2	2.0E-01	3.3E-01	2.7E-01	0.0624	6.6E-01	2.7E-01
Zinc	2	2	7.0E+01	1.2E+02	9.6E+01	26.2773	2.6E+02	9.6E+01

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Subreach 2.01								
Aluminum	1	1	.	.	4.0E+03	.	.	4.0E+03
Arsenic	1	1	.	.	1.6E+00	.	.	1.6E+00
Barium	1	1	.	.	4.7E+01	.	.	4.7E+01
Beryllium	1	1	.	.	4.1E-01	.	.	4.1E-01
Cadmium	1	1	.	.	1.3E-01	.	.	1.3E-01
Calcium	1	1	.	.	1.2E+03	.	.	1.2E+03
Chromium	1	1	.	.	7.7E+00	.	.	7.7E+00
Cobalt	1	1	.	.	5.3E+00	.	.	5.3E+00
Copper	1	1	.	.	4.1E+00	.	.	4.1E+00
Iron	1	1	.	.	8.9E+03	.	.	8.9E+03
Kjeldahl Nitrogen	1	1	.	.	5.7E+03	.	.	5.7E+03
Lead	1	1	.	.	5.8E+00	.	.	5.8E+00
Magnesium	1	1	.	.	8.5E+02	.	.	8.5E+02
Manganese	1	1	.	.	2.0E+02	.	.	2.0E+02
Nickel	1	1	.	.	8.4E+00	.	.	8.4E+00
Potassium	1	1	.	.	4.8E+02	.	.	4.8E+02
Silver	1	1	.	.	3.8E-02	.	.	3.8E-02
Uranium	1	1	.	.	1.1E-01	.	.	1.1E-01
Vanadium	1	1	.	.	6.0E+00	.	.	6.0E+00
Zinc	1	1	.	.	3.0E+01	.	.	3.0E+01
Subreach 2.02								
Arsenic	1	1	.	.	6.1E+00	.	.	6.1E+00
Beryllium	1	1	.	.	6.5E-01	.	.	6.5E-01
Cadmium	1	1	.	.	3.6E-01	.	.	3.6E-01
Chromium	1	1	.	.	1.3E+01	.	.	1.3E+01
Copper	1	1	.	.	1.5E+01	.	.	1.5E+01
Lead	1	1	.	.	2.8E+01	.	.	2.8E+01
Mercury	1	1	.	.	9.6E-02	.	.	9.6E-02
Nickel	1	1	.	.	1.3E+01	.	.	1.3E+01
Selenium	1	1	.	.	3.2E-01	.	.	3.2E-01
Silver	1	1	.	.	3.3E-01	.	.	3.3E-01
Zinc	1	1	.	.	7.6E+01	.	.	7.6E+01
Subreach 2.03								
Aluminum	1	1	.	.	8.6E+03	.	.	8.6E+03
Arsenic	1	1	.	.	2.0E+00	.	.	2.0E+00
Barium	1	1	.	.	9.4E+01	.	.	9.4E+01
Beryllium	1	1	.	.	7.5E-01	.	.	7.5E-01
Cadmium	1	1	.	.	2.2E-01	.	.	2.2E-01

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Calcium	1	1	.	.	2.0E+03	.	.	2.0E+03
Chromium	1	1	.	.	1.3E+01	.	.	1.3E+01
Cobalt	1	1	.	.	9.0E+00	.	.	9.0E+00
Copper	1	1	.	.	7.8E+00	.	.	7.8E+00
Iron	1	1	.	.	1.6E+04	.	.	1.6E+04
Kjeldahl Nitrogen	1	1	.	.	6.5E+03	.	.	6.5E+03
Lead	1	1	.	.	9.8E+00	.	.	9.8E+00
Magnesium	1	1	.	.	1.8E+03	.	.	1.8E+03
Manganese	1	1	.	.	5.8E+02	.	.	5.8E+02
Nickel	1	1	.	.	1.8E+01	.	.	1.8E+01
Potassium	1	1	.	.	8.2E+02	.	.	8.2E+02
Silver	1	1	.	.	4.1E-02	.	.	4.1E-02
Uranium	1	1	.	.	2.4E-01	.	.	2.4E-01
Vanadium	1	1	.	.	1.2E+01	.	.	1.2E+01
Zinc	1	1	.	.	5.5E+01	.	.	5.5E+01
Subreach 2.04								
Aluminum	6	6	7.6E+03	1.8E+04	1.1E+04	1459.03	1.4E+04	1.0E+04
Antimony	5	1	7.0E-01	7.0E-01	7.0E-01	.	.	7.0E-01
Arsenic	7	7	3.6E+00	1.0E+01	5.7E+00	0.88	7.4E+00	4.4E+00
Barium	6	6	6.5E+01	1.9E+02	1.2E+02	18.61	1.5E+02	1.2E+02
Beryllium	7	7	4.4E-01	1.3E+00	7.6E-01	0.1	9.6E-01	7.8E-01
Boron	6	6	2.9E+00	4.9E+00	3.7E+00	0.3	4.3E+00	3.6E+00
Cadmium	7	7	1.9E-01	4.8E-01	3.3E-01	0.05	4.2E-01	3.4E-01
Calcium	6	6	2.2E+03	9.1E+03	4.6E+03	1082.15	6.8E+03	4.0E+03
Chromium	7	7	1.1E+01	2.1E+01	1.5E+01	1.13	1.7E+01	1.5E+01
Cobalt	6	6	8.8E+00	2.1E+01	1.4E+01	1.85	1.8E+01	1.4E+01
Copper	7	7	5.9E+00	1.2E+01	9.9E+00	0.86	1.2E+01	1.0E+01
Iron	6	6	1.2E+04	2.6E+04	1.8E+04	2016.73	2.2E+04	1.8E+04
Kjeldahl Nitrogen	6	6	2.2E+02	1.3E+03	7.1E+02	167.3	1.0E+03	6.9E+02
Lead	7	7	1.7E+01	6.5E+01	3.2E+01	5.93	4.3E+01	2.8E+01
Magnesium	6	6	1.7E+03	4.1E+03	2.5E+03	366.02	3.2E+03	2.3E+03
Manganese	6	6	8.0E+02	4.5E+03	2.0E+03	578.86	3.2E+03	1.6E+03
Mercury	7	7	4.5E-02	2.5E-01	1.2E-01	0.03	1.8E-01	7.6E-02
Nickel	7	7	1.1E+01	2.5E+01	1.6E+01	1.7	1.9E+01	1.5E+01
Potassium	6	6	9.5E+02	2.0E+03	1.1E+03	166	1.5E+03	9.7E+02
Selenium	5	1	3.3E-01	2.4E+00	3.3E-01	.	.	3.3E+00
Silver	7	6	1.9E-02	5.5E-01	1.6E-01	0.07	2.9E-01	8.3E-02
Sodium	6	6	2.6E+01	4.4E+01	3.3E+01	2.59	3.9E+01	3.4E+01
Uranium	6	6	3.5E-01	1.0E+00	6.5E-01	0.11749	8.9E-01	6.0E-01
Vanadium	6	6	1.2E+01	2.1E+01	1.6E+01	1.35705	1.9E+01	1.6E+01

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Zinc	7	7	4.7E+01	8.2E+01	6.1E+01	4.45556	7.0E+01	5.8E+01
Subreach 3.01								
Aluminum	2	2	7.0E+03	1.9E+04	1.3E+04	6113.12	5.2E+04	1.3E+04
Arsenic	2	2	1.3E+00	4.8E+00	3.1E+00	1.77	1.4E+01	3.1E+00
Barium	2	2	6.0E+01	1.3E+02	9.5E+01	35.3	3.2E+02	9.5E+01
Beryllium	2	2	5.3E-01	1.0E+00	7.6E-01	0.24	2.3E+00	7.6E-01
Boron	2	1	1.1E+00	6.0E+00	6.0E+00	.	.	6.0E+00
Cadmium	2	2	9.2E-02	3.0E+00	1.5E+00	1.45	1.1E+01	1.5E+00
Calcium	2	2	5.0E+02	2.7E+03	1.6E+03	1095.9	8.5E+03	1.6E+03
Chromium	2	2	1.0E+01	3.3E+01	2.2E+01	11.45	9.4E+01	2.2E+01
Cobalt	2	2	9.7E+00	2.1E+01	1.5E+01	5.73	5.2E+01	1.5E+01
Copper	2	2	5.4E+00	5.5E+01	3.0E+01	24.75	1.9E+02	3.0E+01
Iron	2	2	1.1E+04	2.2E+04	1.7E+04	5790.01	5.3E+04	1.7E+04
Kjeldahl Nitrogen	2	2	7.7E+01	2.1E+03	1.1E+03	1020.64	7.5E+03	1.1E+03
Lead	2	2	8.5E+00	2.2E+01	1.5E+01	6.86	5.9E+01	1.5E+01
Magnesium	2	2	9.5E+02	2.3E+03	1.6E+03	655.06	5.7E+03	1.6E+03
Manganese	2	2	3.2E+02	5.8E+02	4.5E+02	130.86	1.3E+03	4.5E+02
Mercury	2	2	3.9E-02	1.5E+00	7.7E-01	0.73	5.4E+00	7.7E-01
Nickel	2	2	1.0E+01	3.5E+01	2.3E+01	12.19	9.9E+01	2.3E+01
Potassium	2	2	6.1E+02	2.2E+03	1.4E+03	812.2	6.5E+03	1.4E+03
Silver	2	2	3.2E-02	9.5E-01	4.9E-01	0.46	3.4E+00	4.9E-01
Sodium	2	2	2.3E+01	6.4E+01	4.3E+01	20.56	1.7E+02	4.3E+01
Uranium	2	2	6.1E-01	4.3E+00	2.5E+00	1.86	1.4E+01	2.5E+00
Vanadium	2	2	1.1E+01	2.6E+01	1.8E+01	7.49	6.5E+01	1.8E+01
Zinc	2	2	2.8E+01	1.2E+02	7.4E+01	46.09	3.7E+02	7.4E+01
Subreach 3.02								
Aluminum	8	8	7.9E+03	1.8E+04	1.2E+04	1346.57	1.5E+04	1.0E+04
Antimony	8	1	3.0E-01	5.9E-01	3.0E-01	.	.	3.0E-01
Arsenic	10	10	1.4E+00	2.5E+01	5.4E+00	2.18	9.4E+00	3.2E+00
Barium	8	8	5.9E+01	1.4E+02	1.0E+02	9.73	1.2E+02	1.1E+02
Beryllium	10	10	3.0E-01	1.1E+00	6.4E-01	0.08	7.8E-01	6.5E-01
Boron	8	6	9.5E-01	9.4E+00	4.7E+00	0.9	6.4E+00	4.2E+00
Cadmium	10	10	2.3E-01	3.1E+00	1.1E+00	0.34	1.7E+00	5.5E-01
Calcium	8	8	9.3E+02	1.4E+04	4.0E+03	1550.96	6.9E+03	2.7E+03
Chromium	10	10	9.3E+00	8.4E+01	3.2E+01	8.12	4.7E+01	1.8E+01
Cobalt	8	8	1.1E+01	2.5E+01	1.7E+01	1.79	2.0E+01	1.8E+01
Copper	10	10	9.3E+00	1.7E+02	3.6E+01	15.86	6.5E+01	1.7E+01
Iron	8	8	1.5E+04	3.2E+04	1.9E+04	1967.02	2.3E+04	1.8E+04
Kjeldahl Nitrogen	8	8	1.3E+02	1.3E+03	5.7E+02	150.95	8.6E+02	4.9E+02

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Lead	10	10	7.4E+00	5.8E+01	2.2E+01	4.88	3.1E+01	1.6E+01
Magnesium	8	8	9.5E+02	2.7E+03	1.7E+03	200.41	2.1E+03	1.8E+03
Manganese	8	8	2.7E+02	1.1E+03	5.8E+02	99.4	7.7E+02	5.1E+02
Mercury	10	10	2.5E-02	2.0E+01	5.5E+00	1.94	9.1E+00	4.2E+00
Nickel	10	10	7.8E+00	3.3E+02	6.7E+01	30.26	1.2E+02	2.9E+01
Potassium	8	8	7.0E+02	2.2E+03	1.2E+03	177.34	1.6E+03	1.1E+03
Selenium	9	2	2.5E-01	1.4E+00	2.8E-01	0.02	3.2E-01	2.8E-01
Silver	10	10	2.2E-02	2.0E+00	5.8E-01	0.21	9.6E-01	2.1E-01
Sodium	8	8	2.9E+01	6.5E+01	4.8E+01	3.66	5.5E+01	5.0E+01
Uranium	8	8	1.2E+00	1.1E+02	1.9E+01	13.08	4.4E+01	5.5E+00
Vanadium	8	8	1.3E+01	2.7E+01	1.8E+01	1.58	2.1E+01	1.8E+01
Zinc	10	10	4.8E+01	2.1E+02	8.8E+01	17.07	1.2E+02	6.5E+01
Subreach 3.03								
Aluminum	9	9	7.8E+03	1.5E+04	1.3E+04	837.67	1.4E+04	1.3E+04
Arsenic	9	9	4.1E+00	7.3E+00	5.6E+00	0.4	6.3E+00	5.3E+00
Barium	9	9	6.6E+01	1.7E+02	1.0E+02	10.36	1.2E+02	1.0E+02
Beryllium	9	9	5.4E-01	9.5E-01	7.7E-01	0.05	8.6E-01	7.5E-01
Boron	9	5	9.0E-01	1.2E+01	4.2E+00	1.05	6.2E+00	2.9E+00
Cadmium	9	9	4.7E-01	5.3E+00	2.3E+00	0.54	3.3E+00	2.4E+00
Calcium	9	9	1.1E+03	4.2E+03	2.3E+03	325.12	2.9E+03	1.8E+03
Chromium	9	9	1.3E+01	1.1E+02	5.4E+01	10.52	7.4E+01	4.4E+01
Cobalt	9	9	1.0E+01	2.4E+01	1.7E+01	1.41	1.9E+01	1.6E+01
Copper	9	9	7.5E+00	8.2E+01	3.9E+01	7.51	5.3E+01	3.6E+01
Iron	9	9	1.5E+04	2.5E+04	2.1E+04	1378.17	2.4E+04	2.1E+04
Kjeldahl Nitrogen	9	9	9.1E+01	1.3E+03	7.9E+02	109.56	9.9E+02	8.3E+02
Lead	9	9	1.5E+01	3.8E+01	2.5E+01	2.22	3.0E+01	2.6E+01
Magnesium	9	9	1.0E+03	2.2E+03	1.7E+03	137.57	1.9E+03	1.7E+03
Manganese	9	9	4.2E+02	8.5E+02	6.4E+02	57.43	7.4E+02	6.9E+02
Mercury	9	9	1.5E-01	1.1E+02	2.5E+01	12.31	4.8E+01	6.7E+00
Nickel	9	9	1.3E+01	1.8E+02	6.3E+01	16.25	9.3E+01	5.9E+01
Potassium	9	9	7.7E+02	1.7E+03	1.3E+03	98.64	1.5E+03	1.3E+03
Silver	9	9	7.0E-02	3.8E+00	1.5E+00	0.44	2.3E+00	1.5E+00
Sodium	9	9	2.5E+01	7.4E+01	4.6E+01	5.3	5.6E+01	4.3E+01
Uranium	9	9	7.8E-01	3.6E+01	1.4E+01	3.61	2.1E+01	1.1E+01
Vanadium	9	9	1.3E+01	2.7E+01	1.9E+01	1.61	2.2E+01	1.8E+01
Zinc	9	9	4.2E+01	1.9E+02	1.2E+02	15.38	1.4E+02	1.2E+02
Subreach 3.04								
Aluminum	6	6	6.5E+03	2.0E+04	1.4E+04	2024.74	1.8E+04	1.4E+04
Antimony	7	1	2.8E-01	5.2E-01	3.1E-01	.	.	3.1E-01

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Arsenic	7	7	3.2E+00	1.4E+02	4.5E+01	19.48	8.3E+01	2.4E+01
Barium	6	6	7.2E+01	2.9E+02	1.6E+02	32.05	2.3E+02	1.5E+02
Beryllium	7	7	6.4E-01	1.7E+00	1.1E+00	0.15	1.4E+00	1.1E+00
Boron	6	6	7.9E+00	4.4E+01	1.8E+01	5.38	2.9E+01	1.4E+01
Cadmium	7	7	1.3E-01	5.6E+00	1.8E+00	0.68	3.1E+00	1.4E+00
Calcium	6	6	1.2E+03	6.4E+03	3.2E+03	770.16	4.7E+03	2.8E+03
Chromium	7	7	1.3E+01	4.7E+01	3.2E+01	4.19	4.0E+01	3.2E+01
Cobalt	6	6	9.5E+00	1.8E+01	1.4E+01	1.26	1.7E+01	1.4E+01
Copper	7	7	5.7E+00	6.8E+01	4.0E+01	8.29	5.6E+01	3.9E+01
Iron	6	6	1.5E+04	3.6E+04	2.4E+04	3010.32	3.0E+04	2.4E+04
Kjeldahl Nitrogen	6	6	1.8E+02	5.7E+02	3.9E+02	62.73	5.1E+02	4.1E+02
Lead	7	7	1.2E+01	2.7E+01	2.2E+01	1.92	2.5E+01	2.1E+01
Magnesium	6	6	9.9E+02	2.1E+03	1.6E+03	170.31	2.0E+03	1.7E+03
Manganese	6	6	5.9E+02	8.0E+02	6.8E+02	31.69	7.4E+02	6.6E+02
Mercury	7	7	2.7E-01	4.0E+01	1.3E+01	5.6	2.4E+01	7.1E+00
Nickel	7	7	1.0E+01	5.3E+01	3.5E+01	6.12	4.7E+01	3.4E+01
Potassium	6	6	6.6E+02	2.4E+03	1.5E+03	253.52	2.0E+03	1.5E+03
Selenium	7	6	1.7E-01	3.3E+00	1.1E+00	0.4	1.9E+00	7.9E-01
Silver	7	7	3.8E-02	1.4E+00	8.5E-01	0.17	1.2E+00	8.9E-01
Sodium	6	6	3.9E+01	3.0E+02	1.4E+02	40.51	2.2E+02	1.2E+02
Thallium	7	5	1.8E-01	1.6E+00	5.4E-01	0.2	9.2E-01	3.1E-01
Uranium	6	6	4.6E-01	1.6E+01	6.9E+00	2.27	1.2E+01	5.5E+00
Vanadium	6	6	1.3E+01	5.9E+01	3.1E+01	6.85	4.5E+01	2.9E+01
Zinc	7	7	3.8E+01	1.2E+02	8.4E+01	10.36	1.0E+02	9.3E+01
Subreach 4.01								
Aluminum	9	9	6.9E+03	1.2E+04	9.7E+03	654.383	1.1E+04	9.4E+03
Arsenic	10	10	2.2E+00	1.0E+01	5.1E+00	0.863	6.6E+00	4.0E+00
Barium	9	9	6.2E+01	1.2E+02	8.3E+01	5.798	9.4E+01	7.8E+01
Beryllium	10	10	4.4E-01	1.0E+00	6.8E-01	0.052	7.8E-01	6.5E-01
Boron	9	9	2.7E+00	7.5E+00	4.8E+00	0.455	5.6E+00	4.8E+00
Cadmium	10	10	1.7E-01	1.2E+00	3.7E-01	0.1	5.6E-01	2.4E-01
Calcium	9	9	1.1E+03	3.2E+03	2.2E+03	219.364	2.6E+03	2.3E+03
Chromium	10	10	1.2E+01	2.0E+01	1.7E+01	0.872	1.8E+01	1.7E+01
Cobalt	9	9	7.0E+00	1.2E+01	9.4E+00	0.516	1.0E+01	9.6E+00
Copper	10	10	6.2E+00	2.2E+01	1.1E+01	1.812	1.4E+01	8.9E+00
Iron	9	9	1.2E+04	2.0E+04	1.5E+04	881.67	1.7E+04	1.4E+04
Kjeldahl Nitrogen	9	7	9.9E+00	6.3E+02	2.3E+02	65.79	3.5E+02	2.1E+02
Lead	10	10	1.2E+01	3.2E+01	1.8E+01	1.828	2.2E+01	1.7E+01
Magnesium	9	9	1.1E+03	2.1E+03	1.7E+03	112.775	1.9E+03	1.8E+03
Manganese	9	9	2.9E+02	1.4E+03	8.3E+02	120.835	1.1E+03	8.4E+02

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Mercury	10	10	8.5E-02	1.2E+01	3.1E+00	1.269	5.5E+00	1.0E+00
Nickel	10	10	1.2E+01	2.2E+01	1.7E+01	1.284	1.9E+01	1.8E+01
Potassium	9	9	8.1E+02	1.6E+03	1.1E+03	76.362	1.3E+03	1.1E+03
Selenium	10	4	1.6E-01	1.2E+00	3.1E-01	0.109	5.1E-01	2.0E-01
Silver	10	10	5.0E-02	1.8E+00	2.9E-01	0.16938	6.0E-01	9.3E-02
Sodium	9	9	3.1E+01	4.7E+01	3.8E+01	1.86938	4.1E+01	3.8E+01
Uranium	9	9	3.9E-01	2.2E+00	8.4E-01	0.20304	1.2E+00	6.9E-01
Vanadium	9	9	1.2E+01	2.0E+01	1.5E+01	0.85068	1.7E+01	1.5E+01
Zinc	10	10	4.2E+01	6.8E+01	5.8E+01	2.81486	6.3E+01	5.9E+01
Subreach 4.02								
Aluminum	6	6	4.7E+03	1.1E+04	7.7E+03	997.87	9.7E+03	7.7E+03
Arsenic	6	6	2.6E+00	1.1E+01	5.1E+00	1.32	7.8E+00	4.2E+00
Barium	6	6	4.5E+01	1.1E+02	7.4E+01	9.17	9.3E+01	7.5E+01
Beryllium	6	6	3.4E-01	8.0E-01	5.7E-01	0.07	7.2E-01	5.9E-01
Boron	6	6	1.4E+00	4.8E+00	2.4E+00	0.58	3.5E+00	1.6E+00
Cadmium	6	6	1.4E-01	5.2E-01	2.3E-01	0.06	3.5E-01	1.8E-01
Calcium	6	6	9.6E+02	4.1E+03	2.0E+03	487.08	3.0E+03	1.6E+03
Chromium	6	6	1.1E+01	2.3E+01	1.6E+01	1.67	1.9E+01	1.5E+01
Cobalt	6	6	7.8E+00	1.4E+01	9.7E+00	.0.88	1.2E+01	9.4E+00
Copper	6	6	4.4E+00	1.9E+01	9.0E+00	2.08	1.3E+01	7.3E+00
Iron	6	6	9.6E+03	1.8E+04	1.4E+04	1300.85	1.6E+04	1.3E+04
Kjeldahl Nitrogen	6	6	3.5E+02	1.3E+03	6.2E+02	151.25	9.2E+02	4.4E+02
Lead	6	6	9.7E+00	3.0E+01	2.1E+01	3.06	2.7E+01	2.1E+01
Magnesium	6	6	8.9E+02	2.5E+03	1.4E+03	242.6	1.9E+03	1.2E+03
Manganese	6	6	2.7E+02	1.2E+03	5.5E+02	140.43	8.3E+02	4.0E+02
Mercury	6	6	1.6E-01	3.6E+00	1.0E+00	0.54	2.1E+00	4.2E-01
Nickel	6	6	9.6E+00	2.7E+01	1.5E+01	2.58	2.0E+01	1.3E+01
Potassium	6	6	5.7E+02	1.1E+03	7.6E+02	81.38	9.3E+02	7.4E+02
Silver	6	6	3.0E-02	2.7E-01	9.1E-02	0.04	1.7E-01	4.6E-02
Sodium	6	6	1.9E+01	3.6E+01	2.5E+01	2.5	3.0E+01	2.3E+01
Uranium	6	6	3.1E-01	1.6E+00	7.0E-01	0.2	1.1E+00	5.2E-01
Vanadium	6	6	8.2E+00	1.8E+01	1.4E+01	1.6	1.8E+01	1.4E+01
Zinc	6	6	3.5E+01	7.8E+01	5.3E+01	6.9	6.7E+01	4.6E+01
Subreach 4.03								
Aluminum	7	7	6.5E+03	1.5E+04	1.0E+04	1099.49	1.3E+04	1.1E+04
Antimony	7	1	3.2E-01	4.4E-01	4.4E-01	.	.	4.4E-01
Arsenic	7	7	4.5E+00	8.7E+00	6.8E+00	0.65	8.0E+00	7.8E+00
Barium	7	7	5.0E+01	1.3E+02	8.4E+01	11.09	1.1E+02	7.3E+01
Beryllium	7	7	5.2E-01	1.1E+00	7.3E-01	0.07	8.6E-01	7.1E-01

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Boron	7	7	2.3E+00	4.2E+00	3.2E+00	0.28	3.7E+00	2.9E+00
Cadmium	7	7	1.8E-01	6.0E-01	4.0E-01	0.06	5.1E-01	3.8E-01
Calcium	7	7	7.1E+02	4.4E+03	2.5E+03	528.84	3.5E+03	1.9E+03
Chromium	7	7	1.9E+01	3.7E+01	2.8E+01	2.36	3.3E+01	2.8E+01
Cobalt	7	7	8.7E+00	2.5E+01	1.5E+01	2.05	1.9E+01	1.4E+01
Copper	7	7	9.5E+00	3.6E+01	2.1E+01	3.25	2.8E+01	2.0E+01
Iron	7	7	1.4E+04	2.6E+04	1.9E+04	1354.67	2.2E+04	1.9E+04
Kjeldahl Nitrogen	7	7	3.4E+02	1.5E+03	7.4E+02	161.68	1.1E+03	5.1E+02
Lead	7	7	1.8E+01	5.0E+01	3.1E+01	4.01	3.8E+01	2.7E+01
Magnesium	7	7	5.6E+02	2.7E+03	1.7E+03	296.89	2.3E+03	1.4E+03
Manganese	7	7	5.4E+02	2.0E+03	1.1E+03	214.8	1.5E+03	8.3E+02
Mercury	7	7	5.9E-01	4.1E+00	2.4E+00	0.46	3.3E+00	2.0E+00
Nickel	7	7	1.2E+01	4.0E+01	2.5E+01	3.46	3.2E+01	2.6E+01
Potassium	7	7	4.5E+02	1.4E+03	9.6E+02	121.42	1.2E+03	1.1E+03
Selenium	7	1	3.4E-01	1.4E+00	3.5E-01	.	.	3.5E-01
Silver	7	7	4.4E-02	4.1E-01	2.3E-01	0.05	3.3E-01	1.7E-01
Sodium	7	7	2.0E+01	4.7E+01	3.6E+01	3.73	4.3E+01	3.6E+01
Uranium	7	7	7.7E-01	2.2E+00	1.5E+00	0.16	1.9E+00	1.5E+00
Vanadium	7	7	1.4E+01	2.7E+01	2.1E+01	1.73	2.4E+01	1.9E+01
Zinc	7	7	3.9E+01	1.1E+02	7.4E+01	9.22	9.2E+01	7.4E+01
Subreach 4.04								
Aluminum	11	11	7.4E+03	2.0E+04	1.5E+04	1228.59	1.7E+04	1.5E+04
Antimony	12	1	2.7E-01	7.8E-01	4.1E-01	.	.	4.1E-01
Arsenic	12	12	6.0E+00	1.2E+01	9.4E+00	0.54	1.0E+01	9.7E+00
Barium	11	11	7.6E+01	1.5E+02	1.2E+02	8.22	1.4E+02	1.3E+02
Beryllium	12	12	8.2E-01	1.4E+00	1.1E+00	0.05	1.2E+00	1.2E+00
Boron	11	11	3.7E+00	7.3E+00	5.5E+00	0.35	6.1E+00	5.5E+00
Cadmium	12	12	4.5E-01	1.4E+00	5.8E-01	0.08	7.3E-01	4.9E-01
Calcium	11	11	1.8E+03	3.3E+03	2.8E+03	120.63	3.0E+03	2.8E+03
Chromium	12	12	1.1E+01	3.3E+01	2.2E+01	2.06	2.6E+01	2.2E+01
Cobalt	11	11	1.2E+01	2.6E+01	1.9E+01	1.54	2.2E+01	1.8E+01
Copper	12	12	1.9E+01	5.3E+01	3.7E+01	3.17	4.3E+01	3.9E+01
Iron	11	11	1.3E+04	3.1E+04	2.4E+04	1855.06	2.7E+04	2.6E+04
Kjeldahl Nitrogen	11	11	7.8E+02	2.1E+03	1.7E+03	130.56	1.9E+03	1.8E+03
Lead	12	12	1.5E+01	4.6E+01	3.0E+01	2.32	3.4E+01	3.0E+01
Magnesium	11	11	1.3E+03	2.7E+03	2.0E+03	134.63	2.3E+03	2.0E+03
Manganese	11	11	6.2E+02	2.0E+03	1.4E+03	141.42	1.7E+03	1.3E+03
Mercury	12	12	1.0E+00	5.6E+00	2.5E+00	0.33	3.1E+00	2.2E+00
Nickel	12	12	2.1E+01	4.0E+01	3.2E+01	1.95	3.6E+01	3.3E+01
Potassium	11	11	4.8E+02	1.7E+03	1.2E+03	118.79	1.4E+03	1.2E+03

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Selenium	12	8	1.8E-01	1.2E+00	6.3E-01	0.12	8.4E-01	4.5E-01
Silver	11	11	2.0E-01	1.0E+00	3.9E-01	0.07	5.1E-01	3.5E-01
Sodium	11	11	4.0E+01	7.6E+01	6.2E+01	3.58	6.8E+01	6.0E+01
Thallium	12	7	1.1E-01	4.1E-01	1.3E-01	0.01	1.4E-01	1.2E-01
Uranium	11	11	9.5E-01	2.2E+00	1.5E+00	0.12	1.7E+00	1.3E+00
Vanadium	11	11	1.6E+01	3.3E+01	2.6E+01	1.71	2.9E+01	2.6E+01
Zinc	12	12	9.2E+01	1.6E+02	1.3E+02	6.85	1.4E+02	1.4E+02
Subreach 5								
Antimony	3	1	4.0E-01	4.8E-01	4.6E-01	.	.	4.6E-01
Arsenic	4	4	7.5E+00	9.2E+00	8.6E+00	0.38009	9.4E+00	8.8E+00
Beryllium	4	4	1.0E+00	1.5E+00	1.2E+00	0.09752	1.5E+00	1.2E+00
Cadmium	4	4	1.1E+00	5.2E+00	2.3E+00	0.98322	4.6E+00	1.4E+00
Chromium	4	4	2.8E+01	3.5E+01	3.2E+01	1.79194	3.6E+01	3.3E+01
Copper	4	4	2.9E+01	3.9E+01	3.5E+01	2.195	4.0E+01	3.6E+01
Lead	4	4	3.9E+01	4.6E+01	4.4E+01	1.65588	4.7E+01	4.5E+01
Mercury	4	4	9.9E-01	3.1E+00	1.9E+00	0.46841	3.0E+00	1.7E+00
Nickel	4	4	1.9E+01	3.0E+01	2.3E+01	2.25762	2.9E+01	2.2E+01
Silver	4	4	1.6E-01	7.4E-01	3.6E-01	0.13372	6.7E-01	2.6E-01
Zinc	4	4	2.3E+02	2.7E+02	2.5E+02	8.03156	2.7E+02	2.5E+02
Subreach 7.01								
Aluminum	1	1	.	.	1.5E+04	.	.	1.5E+04
Arsenic	1	1	.	.	6.4E+01	.	.	6.4E+01
Barium	1	1	.	.	1.3E+02	.	.	1.3E+02
Beryllium	1	1	.	.	1.0E+00	.	.	1.0E+00
Boron	1	1	.	.	4.8E+00	.	.	4.8E+00
Cadmium	1	1	.	.	3.1E-01	.	.	3.1E-01
Calcium	1	1	.	.	6.5E+03	.	.	6.5E+03
Chromium	1	1	.	.	1.9E+01	.	.	1.9E+01
Cobalt	1	1	.	.	1.3E+01	.	.	1.3E+01
Copper	1	1	.	.	1.7E+01	.	.	1.7E+01
Iron	1	1	.	.	2.4E+04	.	.	2.4E+04
Kjeldahl Nitrogen	1	1	.	.	1.4E+03	.	.	1.4E+03
Lead	1	1	.	.	2.1E+01	.	.	2.1E+01
Magnesium	1	1	.	.	2.3E+03	.	.	2.3E+03
Manganese	1	1	.	.	1.0E+03	.	.	1.0E+03
Mercury	1	1	.	.	1.7E-01	.	.	1.7E-01
Nickel	1	1	.	.	2.1E+01	.	.	2.1E+01
Potassium	1	1	.	.	1.4E+03	.	.	1.4E+03
Selenium	1	1	.	.	9.5E+00	.	.	9.5E+00

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Silver	1	1	.	.	4.6E-02	.	.	4.6E-02
Sodium	1	1	.	.	4.7E+01	.	.	4.7E+01
Uranium	1	1	.	.	7.8E-01	.	.	7.8E-01
Vanadium	1	1	.	.	4.3E+01	.	.	4.3E+01
Zinc	1	1	.	.	7.4E+01	.	.	7.4E+01
Subreach 7.02								
Aluminum	1	1	.	.	1.6E+04	.	.	.
Antimony	9	4	2.0E-01	6.5E-01	2.7E-01	0.03812	3.4E-01	2.0E-01
Arsenic	9	9	4.3E+00	1.8E+01	1.1E+01	1.3298	1.4E+01	1.2E+01
Barium	1	1	.	.	1.6E+02	.	.	1.6E+02
Beryllium	9	9	7.5E-01	1.5E+00	1.1E+00	0.06768	1.2E+00	1.1E+00
Boron	1	1	.	.	5.8E+00	.	.	5.8E+00
Cadmium	9	4	2.6E-01	8.2E-01	4.0E-01	0.08163	5.6E-01	2.6E-01
Calcium	1	1	.	.	4.6E+03	.	.	4.6E+03
Chromium	9	9	2.0E+01	5.9E+01	3.1E+01	4.19867	3.9E+01	2.5E+01
Cobalt	1	1	.	.	1.3E+01	.	.	1.3E+01
Copper	9	9	1.5E+01	3.7E+01	2.4E+01	2.55048	2.9E+01	2.3E+01
Iron	1	1	.	.	2.9E+04	.	.	2.9E+04
Kjeldahl Nitrogen	1	1	.	.	1.0E+03	.	.	1.0E+03
Lead	9	9	1.4E+01	3.0E+01	2.1E+01	2.08572	2.5E+01	1.9E+01
Magnesium	1	1	.	.	2.7E+03	.	.	2.7E+03
Manganese	1	1	.	.	1.6E+03	.	.	1.6E+03
Mercury	9	1	5.0E-02	2.3E-01	1.2E-01	.	.	1.2E-01
Nickel	9	9	1.8E+01	4.1E+01	2.7E+01	2.09712	3.1E+01	2.6E+01
Potassium	1	1	.	.	2.0E+03	.	.	2.0E+03
Selenium	9	7	2.7E-01	3.5E+00	1.2E+00	0.34776	1.9E+00	8.2E-01
Silver	9	6	2.5E-02	2.6E-01	1.0E-01	0.02646	1.5E-01	6.0E-02
Sodium	1	1	.	.	5.4E+01	.	.	5.4E+01
Thallium	9	1	2.5E-01	5.7E-01	5.7E-01	.	.	5.7E-01
Uranium	1	1	.	.	7.3E-01	.	.	7.3E-01
Vanadium	1	1	.	.	3.1E+01	.	.	3.1E+01
Zinc	9	9	4.6E+01	1.0E+02	7.7E+01	6.94781	9.0E+01	8.1E+01
Subreach 8								
Aluminum	1	1	.	.	1.6E+04	.	.	1.6E+04
Arsenic	1	1	.	.	5.5E+00	.	.	5.5E+00
Barium	1	1	.	.	1.2E+02	.	.	1.2E+02
Beryllium	1	1	.	.	1.1E+00	.	.	1.1E+00
Boron	1	1	.	.	4.4E+00	.	.	4.4E+00
Cadmium	1	1	.	.	2.5E-01	.	.	2.5E-01

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Calcium	1	1	.	.	4.1E+03	.	.	4.1E+03
Chromium	1	1	.	.	2.0E+01	.	.	2.0E+01
Cobalt	1	1	.	.	3.0E+01	.	.	3.0E+01
Copper	1	1	.	.	1.8E+01	.	.	1.8E+01
Iron	1	1	.	.	2.7E+04	.	.	2.7E+04
Kjeldahl Nitrogen	1	1	.	.	1.5E+03	.	.	1.5E+03
Lead	1	1	.	.	5.2E+01	.	.	5.2E+01
Magnesium	1	1	.	.	2.4E+03	.	.	2.4E+03
Manganese	1	1	.	.	1.2E+03	.	.	1.2E+03
Mercury	1	1	.	.	3.4E-01	.	.	3.4E-01
Nickel	1	1	.	.	2.2E+01	.	.	2.2E+01
Potassium	1	1	.	.	1.6E+03	.	.	1.6E+03
Silver	1	1	.	.	7.3E-02	.	.	7.3E-02
Sodium	1	1	.	.	4.6E+01	.	.	4.6E+01
Uranium	1	1	.	.	7.0E-01	.	.	7.0E-01
Vanadium	1	1	.	.	2.8E+01	.	.	2.8E+01
Zinc	1	1	.	.	8.2E+01	.	.	8.2E+01
Subreach 10								
Antimony	1	1	.	.	4.1E-01	.	.	4.1E-01
Arsenic	1	1	.	.	5.2E+00	.	.	5.2E+00
Beryllium	1	1	.	.	1.3E+00	.	.	1.3E+00
Cadmium	1	1	.	.	6.4E-01	.	.	6.4E-01
Chromium	1	1	.	.	2.2E+01	.	.	2.2E+01
Copper	1	1	.	.	1.9E+01	.	.	1.9E+01
Lead	1	1	.	.	3.3E+01	.	.	3.3E+01
Mercury	1	1	.	.	8.2E-02	.	.	8.2E-02
Nickel	1	1	.	.	2.1E+01	.	.	2.1E+01
Zinc	1	1	.	.	8.7E+01	.	.	8.7E+01
Subreach 13								
Aluminum	5	5	9.6E+03	1.3E+04	1.1E+04	674.973	1.3E+04	1.0E+04
Arsenic	5	5	2.6E+00	4.0E+00	3.2E+00	0.261	3.8E+00	3.2E+00
Barium	5	5	8.3E+01	1.2E+02	9.8E+01	6.67	1.1E+02	9.6E+01
Beryllium	5	5	6.0E-01	8.3E-01	7.0E-01	0.04	7.8E-01	6.9E-01
Boron	5	5	2.1E+00	9.1E+00	7.1E+00	1.29	9.9E+00	8.1E+00
Cadmium	5	5	8.0E-02	3.8E-01	2.0E-01	0.055	3.2E-01	1.6E-01
Calcium	5	5	1.0E+03	1.2E+03	1.1E+03	47.455	1.2E+03	1.2E+03
Chromium	5	5	1.4E+01	1.8E+01	1.6E+01	0.664	1.7E+01	1.7E+01
Cobalt	5	5	1.1E+01	1.8E+01	1.5E+01	1.208	1.7E+01	1.5E+01
Copper	5	5	8.9E+00	1.4E+01	1.1E+01	0.923	1.3E+01	1.1E+01

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Iron	5	5	1.5E+04	1.9E+04	1.7E+04	814.655	1.9E+04	1.6E+04
Kjeldahl Nitrogen	5	5	3.8E+02	1.1E+03	6.2E+02	113.868	8.7E+02	5.5E+02
Lead	5	5	1.4E+01	1.6E+01	1.5E+01	0.445	1.6E+01	1.6E+01
Magnesium	5	5	1.4E+03	1.7E+03	1.6E+03	56.404	1.7E+03	1.5E+03
Manganese	5	5	2.4E+02	9.1E+02	5.8E+02	122.288	8.5E+02	5.5E+02
Mercury	5	5	3.7E-02	4.4E+00	9.4E-01	0.856	2.8E+00	8.7E-02
Nickel	5	5	1.8E+01	4.0E+01	2.4E+01	4.241	3.3E+01	1.9E+01
Potassium	5	5	1.1E+03	1.4E+03	1.3E+03	53.924	1.4E+03	1.3E+03
Selenium	5	1	2.0E-01	2.4E+00	3.2E-01	.	.	3.2E-01
Silver	5	5	3.7E-02	9.4E-02	5.8E-02	0.011	8.2E-02	4.8E-02
Sodium	5	5	2.9E+01	5.5E+01	4.7E+01	4.7	5.7E+01	4.8E+01
Uranium	5	5	7.1E-01	2.7E+00	1.2E+00	0.38671	2.0E+00	7.7E-01
Vanadium	5	5	1.6E+01	2.0E+01	1.8E+01	0.75416	1.9E+01	1.7E+01
Zinc	5	5	4.5E+01	8.5E+01	6.2E+01	7.48114	7.8E+01	5.8E+01
Subreach 18								
Aluminum	3	3	8.8E+03	1.4E+04	1.2E+04	1694.82	1.7E+04	1.3E+04
Arsenic	3	3	4.9E+00	5.3E+00	5.1E+00	0.11	5.4E+00	5.0E+00
Barium	3	3	8.4E+01	1.2E+02	1.1E+02	12.33	1.4E+02	1.2E+02
Beryllium	3	3	5.6E-01	7.8E-01	7.0E-01	0.07	9.0E-01	7.5E-01
Boron	3	3	3.5E+00	5.1E+00	4.3E+00	0.46	5.7E+00	4.5E+00
Cadmium	3	3	4.6E-01	5.0E-01	4.8E-01	0.01	5.2E-01	4.9E-01
Calcium	3	3	2.0E+03	2.3E+03	2.1E+03	83.73	2.4E+03	2.0E+03
Chromium	3	3	1.4E+01	1.9E+01	1.7E+01	1.56	2.1E+01	1.8E+01
Cobalt	3	3	9.1E+00	1.2E+01	1.1E+01	0.78	1.3E+01	1.1E+01
Copper	3	3	1.4E+01	2.0E+01	1.7E+01	1.77	2.2E+01	1.8E+01
Iron	3	3	1.5E+04	2.1E+04	1.8E+04	1863.98	2.4E+04	2.0E+04
Kjeldahl Nitrogen	3	3	6.4E+02	1.2E+03	9.6E+02	162.29	1.4E+03	1.0E+03
Lead	3	3	2.0E+01	2.7E+01	2.4E+01	1.76	2.9E+01	2.4E+01
Magnesium	3	3	2.1E+03	2.6E+03	2.3E+03	146.14	2.8E+03	2.3E+03
Manganese	3	3	1.2E+03	2.1E+03	1.7E+03	280.09	2.5E+03	1.9E+03
Mercury	3	3	1.2E-01	1.3E-01	1.2E-01	0	1.3E-01	1.2E-01
Molybdenum	3	3	7.4E-01	9.0E-01	8.3E-01	0.05	9.7E-01	8.6E-01
Nickel	3	3	8.9E+00	1.4E+01	1.2E+01	1.55	1.6E+01	1.3E+01
Potassium	3	3	1.2E+03	1.4E+03	1.3E+03	76.61	1.6E+03	1.4E+03
Silver	3	3	9.6E-02	2.1E-01	1.5E-01	0.03	2.5E-01	1.5E-01
Sodium	3	3	4.6E+01	5.3E+01	4.9E+01	2.03	5.5E+01	4.8E+01
Uranium	3	3	9.4E-01	1.0E+00	9.8E-01	0.02	1.0E+00	9.8E-01
Vanadium	3	3	1.7E+01	2.4E+01	2.1E+01	2.31	2.8E+01	2.3E+01
Zinc	3	3	1.3E+02	1.4E+02	1.4E+02	3.73	1.5E+02	1.3E+02

Table B8. (Continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Subreach 22								
Antimony	1	1	.	.	9.6E+00	.	.	9.6E+00
Arsenic	1	1	.	.	4.4E+00	.	.	4.4E+00
Beryllium	1	1	.	.	1.5E+00	.	.	1.5E+00
Cadmium	1	1	.	.	2.4E+00	.	.	2.4E+00
Chromium	1	1	.	.	5.3E+01	.	.	5.3E+01
Copper	1	1	.	.	2.4E+01	.	.	2.4E+01
Lead	1	1	.	.	6.1E+01	.	.	6.1E+01
Mercury	1	1	.	.	7.4E+01	.	.	7.4E+01
Nickel	1	1	.	.	2.3E+01	.	.	2.3E+01
Silver	1	1	.	.	7.6E+00	.	.	7.6E+00
Thallium	1	1	.	.	6.6E-01	.	.	6.6E-01
Zinc	1	1	.	.	7.7E+01	.	.	7.7E+01

Table B9 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error.	95% UCB	Median
Boron	33	31	1.80e-02	6.30e-02	3.40e-02	1.90e-03	3.70e-02	3.30e-02
Cadmium	33	1	0.00e+00	0.00e+00	1.00e-03	.	.	0.00e+00
Calcium	33	33	1.80e+01	7.80e+01	3.60e+01	2.10e+00	4.00e+01	3.50e+01
Calculated Hardness	33	33	6.60e+01	3.10e+02	1.40e+02	8.00e+00	1.50e+02	1.30e+02
Chromium	33	25	1.00e-03	3.10e-03	1.50e-03	9.40e-05	1.60e-03	1.20e-03
Cobalt	33	21	1.00e-03	1.20e-02	2.00e-03	4.20e-04	2.70e-03	1.20e-03
Copper	33	33	1.40e-03	8.50e-03	3.30e-03	3.00e-04	3.80e-03	2.70e-03
Iron	33	33	2.80e-02	6.00e+00	4.90e-01	2.20e-01	8.70e-01	1.80e-01
Kjeldahl Nitrogen	31	28	1.00e-01	7.20e+00	1.60e+00	2.80e-01	2.10e+00	1.20e+00
Lead	33	3	1.00e-03	2.80e-03	1.30e-03	5.90e-05	1.40e-03	1.20e-03
Magnesium	33	33	5.30e+00	1.90e+01	1.00e+01	5.20e-01	1.10e+01	9.90e+00
Manganese	33	30	1.00e-03	2.00e+01	2.80e+00	6.50e-01	3.80e+00	1.80e+00
Mercury	33	1	0.00e+00	0.00e+00	8.10e-04	.	.	0.00e+00
Mercury (BR)	9	2	3.30e-06	9.10e-06	5.90e-06	5.30e-07	6.90e-06	5.50e-06
Molybdenum	33	15	1.00e-03	4.70e-03	1.40e-03	1.30e-04	1.60e-03	1.10e-03
Nickel	33	33	2.10e-03	2.90e-02	7.40e-03	1.00e-03	9.10e-03	4.90e-03
Potassium	33	33	7.40e-01	3.70e+00	1.90e+00	1.00e-01	2.00e+00	1.80e+00
Sodium	33	33	2.40e+00	8.20e+00	4.80e+00	2.70e-01	5.20e+00	5.20e+00
Uranium	33	6	1.00e-03	2.10e-03	1.20e-03	4.20e-05	1.20e-03	1.10e-03
Vanadium	33	3	1.00e-03	1.30e-03	1.20e-03	3.70e-06	1.20e-03	1.20e-03
Zinc	33	33	2.40e-03	7.40e-02	1.30e-02	2.30e-03	1.70e-02	8.40e-03
Reach 7								
Aluminum	2	2	3.10e-02	2.70e-01	1.50e-01	1.20e-01	9.10e-01	1.50e-01
Ammonium Nitrogen	2	2	1.20e+00	2.00e+00	1.60e+00	4.00e-01	4.10e+00	1.60e+00
Antimony	2	2	5.30e-03	5.70e-03	5.50e-03	2.00e-04	6.80e-03	5.50e-03
Arsenic	2	2	1.50e-02	1.30e-01	7.00e-02	5.60e-02	4.20e-01	7.00e-02
Barium	2	2	6.00e-02	6.20e-02	6.10e-02	9.50e-04	6.70e-02	6.10e-02
Boron	2	2	3.50e-02	4.40e-02	3.90e-02	4.50e-03	6.70e-02	3.90e-02
Calcium	2	2	3.70e+01	4.90e+01	4.30e+01	5.90e+00	8.00e+01	4.30e+01
Calculated Hardness	2	2	1.40e+02	1.70e+02	1.60e+02	1.60e+01	2.60e+02	1.60e+02
Chromium	2	1	0.00e+00	0.00e+00	1.10e-03	.	.	0.00e+00
Copper	2	2	2.30e-03	4.20e-03	3.30e-03	9.50e-04	9.20e-03	3.30e-03
Iron	2	2	2.20e-02	3.30e-02	2.80e-02	5.60e-03	6.30e-02	2.80e-02
Kjeldahl Nitrogen	2	2	1.00e+00	1.90e+00	1.50e+00	4.50e-01	4.30e+00	1.50e+00
Magnesium	2	2	9.50e+00	1.00e+01	9.90e+00	3.40e-01	1.20e+01	9.90e+00
Manganese	2	2	4.20e+00	5.20e+00	4.70e+00	5.30e-01	8.00e+00	4.70e+00
Molybdenum	2	2	2.30e-03	2.80e-03	2.60e-03	2.50e-04	4.10e-03	2.60e-03
Nickel	2	2	1.10e-02	1.20e-02	1.10e-02	5.50e-04	1.50e-02	1.10e-02
Potassium	2	2	1.80e+00	2.30e+00	2.00e+00	2.60e-01	3.70e+00	2.00e+00

Table B9 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error.	95% UCB	Median
Sodium	2	2	3.10e+00	3.70e+00	3.40e+00	3.00e-01	5.20e+00	3.40e+00
Vanadium	2	2	1.00e-03	1.50e-03	1.30e-03	2.50e-04	2.80e-03	1.30e-03
Zinc	2	2	4.50e-03	6.60e-03	5.60e-03	1.10e-03	1.20e-02	5.60e-03
Reach 8								
Aluminum	1	1	0.00e+00	0.00e+00	2.70e-02	.	.	0.00e+00
Ammonium Nitrogen	1	1	0.00e+00	0.00e+00	1.50e+00	.	.	0.00e+00
Antimony	1	1	0.00e+00	0.00e+00	5.00e-03	.	.	0.00e+00
Barium	1	1	0.00e+00	0.00e+00	5.40e-02	.	.	0.00e+00
Calcium	1	1	0.00e+00	0.00e+00	4.20e+01	.	.	0.00e+00
Calculated Hardness	1	1	0.00e+00	0.00e+00	1.50e+02	.	.	0.00e+00
Chromium	1	1	0.00e+00	0.00e+00	1.10e-03	.	.	0.00e+00
Copper	1	1	0.00e+00	0.00e+00	2.60e-03	.	.	0.00e+00
Iron	1	1	0.00e+00	0.00e+00	2.90e-02	.	.	0.00e+00
Kjeldahl Nitrogen	1	1	0.00e+00	0.00e+00	1.30e+00	.	.	0.00e+00
Magnesium	1	1	0.00e+00	0.00e+00	1.00e+01	.	.	0.00e+00
Manganese	1	1	0.00e+00	0.00e+00	3.40e+00	.	.	0.00e+00
Nickel	1	1	0.00e+00	0.00e+00	1.20e-02	.	.	0.00e+00
Potassium	1	1	0.00e+00	0.00e+00	1.80e+00	.	.	0.00e+00
Sodium	1	1	0.00e+00	0.00e+00	3.60e+00	.	.	0.00e+00
Zinc	1	1	0.00e+00	0.00e+00	4.80e-03	.	.	0.00e+00
Reach 13								
Ammonium Nitrogen	5	5	3.20e-01	2.50e+00	1.40e+00	3.70e-01	2.20e+00	1.20e+00
Antimony	5	4	1.00e-03	4.50e-03	1.80e-03	6.90e-04	3.30e-03	1.10e-03
Barium	5	5	4.10e-02	1.20e-01	7.50e-02	1.40e-02	1.10e-01	7.00e-02
Boron	5	2	1.10e-02	4.80e-02	3.10e-02	6.60e-03	4.50e-02	2.60e-02
Calcium	5	5	1.90e+01	5.30e+01	3.60e+01	5.50e+00	4.80e+01	3.60e+01
Calculated Hardness	5	5	7.80e+01	2.10e+02	1.50e+02	2.20e+01	1.90e+02	1.60e+02
Chromium	5	1	0.00e+00	0.00e+00	1.50e-03	.	.	0.00e+00
Cobalt	5	4	1.00e-03	8.70e-03	3.00e-03	1.50e-03	6.10e-03	1.50e-03
Copper	5	4	1.20e-03	3.50e-03	1.80e-03	4.50e-04	2.80e-03	1.30e-03
Iron	5	1	0.00e+00	0.00e+00	4.40e-02	.	.	0.00e+00
Kjeldahl Nitrogen	5	5	5.80e-01	1.60e+00	9.50e-01	2.10e-01	1.40e+00	6.60e-01
Magnesium	5	5	6.70e+00	1.60e+01	1.10e+01	1.50e+00	1.50e+01	1.20e+01
Manganese	5	5	1.40e+00	9.10e+00	5.10e+00	1.40e+00	8.00e+00	5.30e+00
Mercury (BR)	5	3	3.70e-06	1.30e-05	6.60e-06	1.80e-06	1.00e-05	4.90e-06
Nickel	5	3	1.00e-03	1.20e-02	6.50e-03	1.50e-03	9.80e-03	4.40e-03
Potassium	5	5	1.40e+00	2.60e+00	1.90e+00	2.00e-01	2.30e+00	2.00e+00
Sodium	5	5	2.70e+00	5.10e+00	3.90e+00	3.80e-01	4.70e+00	3.90e+00

Table B9 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error.	95% UCB	Median
Uranium	5	2	1.00e-03	1.50e-03	1.10e-03	1.30e-04	1.40e-03	1.00e-03
Zinc	5	4	2.70e-03	1.30e-02	4.40e-03	6.00e-04	5.70e-03	4.70e-03
Reach 18								
Aluminum	3	3	3.90e-02	3.10e-01	1.30e-01	9.10e-02	4.00e-01	4.20e-02
Ammonium Nitrogen	3	3	4.60e-01	5.40e+00	2.20e+00	1.60e+00	6.90e+00	7.10e-01
Antimony	3	3	4.50e-03	5.80e-03	5.10e-03	3.80e-04	6.20e-03	4.90e-03
Arsenic	3	2	1.00e-03	1.30e-03	1.20e-03	3.80e-05	1.30e-03	1.20e-03
Barium	3	3	4.30e-02	6.50e-02	5.50e-02	6.40e-03	7.40e-02	5.70e-02
Boron	3	3	2.40e-02	3.90e-02	3.20e-02	4.40e-03	4.50e-02	3.40e-02
Calcium	3	3	2.20e+01	2.50e+01	2.30e+01	1.00e+00	2.60e+01	2.30e+01
Calculated Hardness	3	3	7.70e+01	9.00e+01	8.20e+01	3.80e+00	9.30e+01	8.00e+01
Chromium	3	3	1.00e-03	1.20e-03	1.10e-03	5.80e-05	1.30e-03	1.10e-03
Cobalt	3	2	1.00e-03	1.40e-03	1.20e-03	1.20e-04	1.50e-03	1.10e-03
Copper	3	3	4.70e-03	5.40e-03	5.00e-03	2.10e-04	5.60e-03	4.90e-03
Iron	3	3	1.10e-01	1.90e-01	1.40e-01	2.30e-02	2.10e-01	1.30e-01
Kjeldahl Nitrogen	3	3	1.70e+00	2.00e+00	1.80e+00	8.80e-02	2.10e+00	1.80e+00
Magnesium	3	3	5.50e+00	6.00e+00	5.70e+00	1.80e-01	6.20e+00	5.50e+00
Molybdenum	3	3	2.20e-03	2.70e-03	2.50e-03	1.50e-04	2.90e-03	2.50e-03
Nickel	3	3	2.40e-03	4.30e-03	3.10e-03	6.20e-04	4.90e-03	2.50e-03
Potassium	3	3	1.60e+00	1.90e+00	1.80e+00	8.70e-02	2.10e+00	1.90e+00
Sodium	3	3	8.70e+00	1.00e+01	9.40e+00	3.60e-01	1.00e+01	9.60e+00
Vanadium	3	1	0.00e+00	0.00e+00	1.10e-03	.	.	0.00e+00
Zinc	3	3	8.20e-03	1.30e-02	1.00e-02	1.30e-03	1.40e-02	1.00e-02

Table B10. Summary statistics for porewater inorganic concentrations (mg/l) by subreach. Mercury data includes Brooks Rand results.

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Subreach 0								
Aluminum	5	5	1.60e-02	4.4E-01	1.3E-01	7.9E-02	5.0E-02	3.0E-01
Ammonium Nitrogen	5	5	1.00e+00	3.4E+00	2.0E+00	4.0E-01	2.0E+00	2.9E+00
Antimony	5	5	2.60e-03	3.7E-03	3.1E-03	2.4E-04	2.9E-03	3.6E-03
Barium	5	5	3.00e-02	1.0E-01	7.7E-02	1.4E-02	9.6E-02	1.1E-01
Boron	5	4	1.80e-02	1.7E-01	6.2E-02	2.9E-02	4.0E-02	1.3E-01
Calcium	5	5	2.60e+01	4.4E+01	3.3E+01	3.4E+00	3.0E+01	4.0E+01
Calculated Hardness	5	5	8.80e+01	1.9E+02	1.3E+02	1.7E+01	1.3E+02	1.7E+02
Chromium	5	4	1.00e-03	1.9E-03	1.5E-03	1.7E-04	1.6E-03	1.8E-03
Cobalt	5	3	1.00e-03	3.3E-03	1.6E-03	4.6E-04	1.2E-03	2.6E-03
Copper	5	5	1.80e-03	2.2E-03	2.0E-03	6.7E-05	2.0E-03	2.1E-03
Iron	5	5	2.90e-02	2.2E-01	6.9E-02	3.7E-02	3.3E-02	1.5E-01
Kjeldahl Nitrogen	5	5	1.40e+00	4.1E+00	2.5E+00	4.7E-01	2.5E+00	3.5E+00
Magnesium	5	5	5.40e+00	1.3E+01	9.6E+00	1.3E+00	9.2E+00	1.2E+01
Manganese	5	4	1.00e-03	1.1E+01	6.5E+00	1.4E+00	5.1E+00	9.5E+00
Molybdenum	5	4	1.00e-03	1.9E-03	1.5E-03	1.6E-04	1.2E-03	1.8E-03
Nickel	5	4	1.00e-03	2.3E-02	1.7E-02	2.4E-03	1.5E-02	2.2E-02
Potassium	5	5	8.90e-01	2.1E+00	1.8E+00	2.2E-01	2.0E+00	2.2E+00
Selenium	5	1	.	.	3.6E-03	.	.	.
Sodium	5	5	3.4E+00	4.0E+00	3.7E+00	1.1E-01	3.8E+00	4.0E+00
Zinc	5	5	5.9E-03	8.5E-03	7.60e-03	5.0E-04	7.9E-03	8.6E-03
Subreach 2.01								
Aluminum	1	1	.	.	1.8E-02	.	.	.
Ammonium Nitrogen	1	1	.	.	6.4E-02	.	.	.
Antimony	1	1	.	.	5.2E-03	.	.	.
Barium	1	1	.	.	9.7E-02	.	.	.
Calcium	1	1	.	.	4.3E+01	.	.	.
Calculated Hardness	1	1	.	.	1.7E+02	.	.	.
Cobalt	1	1	.	.	1.9E-03	.	.	.
Copper	1	1	.	.	3.7E-03	.	.	.
Iron	1	1	.	.	3.4E-01	.	.	.
Kjeldahl Nitrogen	1	1	.	.	1.7E-01	.	.	.
Magnesium	1	1	.	.	1.3E+01	.	.	.
Manganese	1	1	.	.	6.5E+00	.	.	.
Molybdenum	1	1	.	.	3.9E-03	.	.	.

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Nickel	1	1	.	.	2.6E-03	.	.	.
Potassium	1	1	.	.	2.3E+00	.	.	.
Sodium	1	1	.	.	6.0E+00	.	.	.
Vanadium	1	1	.	.	1.0E-03	.	.	.
Zinc	1	1	.	.	3.1E-03	.	.	.
Subreach 2.03								
Aluminum	1	1	.	.	1.7E-02	.	.	.
Antimony	1	1	.	.	3.2E-03	.	.	.
Barium	1	1	.	.	2.8E-02	.	.	.
Calcium	1	1	.	.	3.0E+01	.	.	.
Calculated Hardness	1	1	.	.	1.1E+02	.	.	.
Copper	1	1	.	.	1.1E-03	.	.	.
Iron	1	1	.	.	2.4E-01	.	.	.
Kjeldahl Nitrogen	1	1	.	.	3.2E-01	.	.	.
Magnesium	1	1	.	.	7.8E+00	.	.	.
Manganese	1	1	.	.	3.0E-03	.	.	.
Potassium	1	1	.	.	1.2E+00	.	.	.
Sodium	1	1	.	.	4.8E+00	.	.	.
Zinc	1	1	.	.	1.1E-02	.	.	.
Subreach 2.04								
Aluminum	6	6	1.2E-02	4.3E-02	2.4E-02	4.6E-03	2.1E-02	3.3E-02
Ammonium Nitrogen	6	5	5.0E-02	2.9E+00	9.3E-01	4.5E-01	6.8E-01	1.8E+00
Antimony	6	6	1.7E-03	1.0E-02	4.5E-03	1.2E-03	3.9E-03	7.0E-03
Arsenic	6	2	1.0E-03	3.3E-03	2.3E-03	2.6E-04	2.1E-03	2.8E-03
Barium	6	6	1.6E-02	8.7E-02	4.7E-02	1.1E-02	4.3E-02	7.0E-02
Boron	6	4	1.8E-02	6.7E-02	4.3E-02	6.6E-03	3.5E-02	5.6E-02
Calcium	6	6	2.3E+01	4.0E+01	2.9E+01	2.5E+00	2.9E+01	3.4E+01
Calculated Hardness	6	6	9.6E+01	1.4E+02	1.1E+02	7.4E+00	1.0E+02	1.2E+02
Chromium	6	4	1.0E-03	2.3E-03	1.3E-03	2.2E-04	1.1E-03	1.7E-03
Cobalt	6	1	.	.	1.5E-03	.	.	.
Copper	6	6	1.2E-03	2.9E-03	2.1E-03	2.8E-04	2.0E-03	2.6E-03
Iron	6	6	3.6E-02	1.7E-01	7.8E-02	2.2E-02	5.4E-02	1.2E-01
Kjeldahl Nitrogen	6	6	2.8E-01	2.8E+00	1.1E+00	3.8E-01	9.2E-01	1.9E+00
Magnesium	6	6	5.9E+00	9.4E+00	7.9E+00	5.0E-01	7.7E+00	8.9E+00

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Manganese	6	6	1.3E-03	3.2E+00	1.3E+00	5.1E-01	1.2E+00	2.3E+00
Molybdenum	6	3	1.0E-03	1.7E-03	1.5E-03	5.5E-05	1.4E-03	1.6E-03
Nickel	6	6	3.6E-03	1.7E-02	7.6E-03	2.1E-03	5.6E-03	1.2E-02
Potassium	6	6	8.3E-01	2.3E+00	1.6E+00	2.1E-01	1.8E+00	2.1E+00
Sodium	6	6	2.6E+00	3.7E+00	3.2E+00	1.6E-01	3.3E+00	3.5E+00
Zinc	6	6	3.3E-03	1.7E-02	7.6E-03	2.0E-03	6.2E-03	1.2E-02
Subreach 3.01								
Aluminum	2	1	.	.	4.3E-02	.	.	.
Ammonium Nitrogen	2	2	8.2E-01	9.5E-01	8.9E-01	6.5E-02	8.9E-01	1.3E+00
Antimony	2	2	3.3E-03	4.6E-03	4.0E-03	6.5E-04	4.0E-03	8.1E-03
Barium	2	2	2.7E-02	4.7E-02	3.7E-02	1.0E-02	3.7E-02	1.0E-01
Boron	2	1	.	.	5.5E-02	.	.	.
Calcium	2	1	.	.	2.0E+01	.	.	.
Calculated Hardness	2	1	.	.	7.6E+01	.	.	.
Chromium	2	2	1.3E-03	2.8E-03	2.1E-03	7.5E-04	2.1E-03	6.8E-03
Cobalt	2	2	6.6E-03	1.4E-02	1.0E-02	3.7E-03	1.0E-02	3.3E-02
Copper	2	1	.	.	1.2E-02	.	.	.
Iron	2	1	.	.	3.1E-02	.	.	.
Kjeldahl Nitrogen	2	2	8.6E-01	1.4E+00	1.1E+00	2.7E-01	1.1E+00	2.8E+00
Magnesium	2	1	.	.	5.2E+00	.	.	.
Manganese	2	2	2.2E+00	2.6E+00	2.4E+00	2.1E-01	2.4E+00	3.7E+00
Mercury	2	1	.	.	5.6E-04	.	.	.
Mercury (BR)	2	1	5.8E-06	6.0E-04	6.0E-04	.	6.0E-04	.
Methyl Mercury (BR)	2	1	2.3E-07	1.8E-06	1.8E-06	.	1.8E-06	.
Nickel	2	2	7.1E-03	1.0E-01	5.4E-02	4.7E-02	5.4E-02	3.5E-01
Potassium	2	1	.	.	1.0E+00	.	.	.
Selenium	2	1	.	.	1.5E-03	.	.	.
Sodium	2	1	.	.	4.5E+00	.	.	.
Zinc	2	1	.	.	2.3E-02	.	.	.
Subreach 3.02								
Aluminum	8	6	6.2E-03	7.5E-02	2.5E-02	8.7E-03	1.9E-02	4.1E-02
Ammonium Nitrogen	8	8	2.4E-01	9.0E+00	2.6E+00	9.9E-01	1.9E+00	4.5E+00
Antimony	8	8	1.5E-03	5.9E-03	2.6E-03	5.0E-04	2.2E-03	3.6E-03
Arsenic	8	5	1.0E-03	6.4E-03	2.1E-03	6.6E-04	1.4E-03	3.3E-03
Barium	8	8	2.8E-02	1.2E-01	6.3E-02	9.3E-03	6.3E-02	8.0E-02

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Boron	8	6	1.8E-02	9.7E-02	5.9E-02	9.3E-03	6.8E-02	7.7E-02
Calcium	8	6	2.7E-02	4.3E+01	3.5E+01	3.0E+00	3.9E+01	4.0E+01
Calculated Hardness	8	6	7.3E+00	1.6E+02	1.3E+02	1.1E+01	1.4E+02	1.5E+02
Chromium	8	7	1.3E-03	2.7E-03	1.9E-03	1.8E-04	2.0E-03	2.3E-03
Cobalt	8	7	1.0E-03	4.0E-03	2.4E-03	2.9E-04	2.2E-03	3.0E-03
Copper	8	8	1.4E-03	8.6E-03	3.9E-03	7.7E-04	3.5E-03	5.3E-03
Iron	8	8	1.4E-02	2.1E+00	3.6E-01	2.5E-01	8.6E-02	8.4E-01
Kjeldahl Nitrogen	8	8	5.7E-01	6.8E+00	2.3E+00	7.2E-01	1.6E+00	3.6E+00
Magnesium	8	6	9.0E-03	1.0E+01	8.4E+00	6.9E-01	8.4E+00	9.7E+00
Manganese	8	8	3.4E-01	9.7E+00	4.0E+00	1.0E+00	4.1E+00	5.9E+00
Mercury	7	1	.	.	2.3E-04	.	.	.
Mercury (BR)	5	4	4.6E-06	1.6E-04	3.8E-05	3.1E-05	9.6E-06	1.0E-04
Methyl Mercury (BR)	5	1	1.3E-07	7.8E-07	3.4E-07	.	3.4E-07	.
Molybdenum	8	3	1.3E-03	5.0E-03	2.3E-03	5.8E-04	2.2E-03	3.4E-03
Nickel	8	7	4.6E-03	4.2E-02	1.5E-02	4.1E-03	9.9E-03	2.3E-02
Potassium	8	6	1.3E-02	2.6E+00	2.1E+00	1.5E-01	2.1E+00	2.4E+00
Selenium	8	1	.	.	2.0E-03	.	.	.
Sodium	8	6	2.0E-02	8.1E+00	5.3E+00	8.3E-01	4.7E+00	6.8E+00
Uranium	8	8	1.4E-03	9.9E-02	2.2E-02	1.1E-02	9.1E-03	4.4E-02
Zinc	8	7	5.5E-03	1.2E-02	8.0E-03	8.7E-04	7.4E-03	9.7E-03
Subreach 3.03								
Aluminum	9	7	7.0E-03	3.5E-02	1.4E-02	2.9E-03	1.1E-02	1.9E-02
Ammonium Nitrogen	9	9	1.3E-01	2.4E+00	1.4E+00	2.6E-01	1.4E+00	1.8E+00
Antimony	9	9	1.7E-03	5.8E-03	2.8E-03	4.1E-04	2.4E-03	3.6E-03
Arsenic	9	3	2.1E-03	1.0E-02	3.3E-03	1.0E-03	2.1E-03	5.2E-03
Barium	9	9	2.7E-02	8.7E-02	5.2E-02	6.6E-03	4.6E-02	6.5E-02
Boron	9	8	2.9E-02	8.9E-02	5.4E-02	7.9E-03	4.5E-02	6.9E-02
Calcium	9	9	2.8E+01	5.3E+01	4.0E+01	3.1E+00	4.3E+01	4.6E+01
Calculated Hardness	9	9	9.8E+01	2.0E+02	1.5E+02	1.2E+01	1.6E+02	1.7E+02
Chromium	9	7	1.0E-03	3.7E-03	2.2E-03	3.4E-04	2.1E-03	2.8E-03
Cobalt	9	8	1.0E-03	6.5E-03	2.8E-03	5.6E-04	2.4E-03	3.9E-03
Copper	9	9	1.7E-03	8.3E-03	3.4E-03	8.1E-04	2.4E-03	4.9E-03
Iron	9	8	1.3E-02	2.4E-01	7.7E-02	2.5E-02	4.2E-02	1.2E-01
Kjeldahl Nitrogen	9	9	3.7E-01	2.7E+00	1.6E+00	2.9E-01	2.0E+00	2.1E+00
Magnesium	9	9	6.8E+00	1.4E+01	1.0E+01	7.7E-01	1.1E+01	1.2E+01

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Manganese	9	9	3.5E-02	5.8E+00	3.5E+00	6.1E-01	3.3E+00	4.6E+00
Mercury	9	1	.	.	2.0E-04	.	.	.
Mercury (BR)	8	8	5.6E-06	1.8E-05	1.2E-05	1.5E-06	1.4E-05	1.5E-05
Methyl Mercury (BR)	8	4	1.3E-07	7.6E-07	3.1E-07	7.4E-08	2.0E-07	4.5E-07
Molybdenum	9	8	1.5E-03	5.0E-03	2.4E-03	3.7E-04	2.2E-03	3.1E-03
Nickel	9	9	7.9E-03	2.5E-02	1.3E-02	1.8E-03	1.1E-02	1.6E-02
Potassium	9	9	1.4E+00	2.8E+00	2.2E+00	1.7E-01	2.2E+00	2.5E+00
Selenium	9	1	.	.	3.0E-03	.	.	.
Sodium	9	9	4.8E+00	6.2E+00	5.8E+00	1.9E-01	6.1E+00	6.1E+00
Uranium	9	9	1.3E-03	2.1E-02	6.9E-03	2.0E-03	6.9E-03	1.1E-02
Zinc	9	8	5.4E-03	3.2E-02	1.2E-02	2.7E-03	1.0E-02	1.7E-02
Subreach 3.04								
Aluminum	6	4	6.0E-03	9.0E-02	3.3E-02	1.2E-02	2.1E-02	5.7E-02
Ammonium Nitrogen	6	6	8.7E-01	3.6E+00	2.2E+00	4.4E-01	2.1E+00	3.0E+00
Antimony	6	6	2.0E-03	1.3E-02	4.6E-03	1.7E-03	3.1E-03	8.1E-03
Arsenic	6	6	2.2E-03	1.2E-01	2.5E-02	2.0E-02	5.9E-03	6.5E-02
Barium	6	6	4.9E-02	1.1E-01	7.0E-02	8.7E-03	6.5E-02	8.7E-02
Boron	6	5	7.0E-03	1.2E+00	2.7E-01	1.8E-01	1.0E-01	6.4E-01
Calcium	6	6	3.0E+01	6.1E+01	4.3E+01	4.3E+00	4.2E+01	5.2E+01
Calculated Hardness	6	6	1.1E+02	2.3E+02	1.6E+02	1.6E+01	1.6E+02	2.0E+02
Chromium	6	4	1.0E-03	2.9E-03	1.4E-03	3.1E-04	1.1E-03	2.0E-03
Cobalt	6	5	1.0E-03	2.0E-03	1.5E-03	1.8E-04	1.4E-03	1.8E-03
Copper	6	6	1.3E-03	1.4E-02	4.5E-03	1.9E-03	3.0E-03	8.2E-03
Iron	6	6	2.1E-02	3.7E-01	1.3E-01	5.1E-02	9.7E-02	2.3E-01
Kjeldahl Nitrogen	6	6	9.7E-01	3.4E+00	2.0E+00	3.7E-01	2.0E+00	2.7E+00
Magnesium	6	6	8.5E+00	1.6E+01	1.2E+01	1.0E+00	1.2E+01	1.4E+01
Manganese	6	6	1.0E+00	6.3E+00	3.5E+00	9.0E-01	3.0E+00	5.3E+00
Mercury (BR)	6	4	2.0E-06	3.6E-05	1.7E-05	5.0E-06	9.5E-06	2.7E-05
Methyl Mercury (BR)	6	3	1.1E-07	1.2E-06	6.1E-07	1.3E-07	4.6E-07	8.6E-07
Molybdenum	6	2	2.4E-03	1.0E-01	1.9E-02	2.1E-02	2.4E-03	6.2E-02
Nickel	6	6	2.4E-03	7.0E-03	5.0E-03	8.2E-04	5.9E-03	6.6E-03
Potassium	6	6	2.0E+00	3.1E+00	2.5E+00	2.2E-01	2.4E+00	2.9E+00
Selenium	6	1	.	.	1.6E-03	.	.	.
Sodium	6	6	3.8E+00	4.7E+00	4.3E+00	1.2E-01	4.2E+00	4.5E+00
Uranium	6	6	1.2E-03	1.0E-02	5.5E-03	1.5E-03	5.0E-03	8.6E-03
Vanadium	6	3	1.0E-03	1.0E-02	2.5E-03	1.7E-03	1.0E-03	6.0E-03

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Zinc	6	6	2.7E-03	1.2E-02	5.7E-03	1.4E-03	4.9E-03	8.5E-03
Subreach 4.01								
Aluminum	9	9	1.1E-02	6.2E-01	1.2E-01	7.1E-02	2.0E-02	2.5E-01
Ammonium Nitrogen	7	7	7.1E-02	1.2E+00	5.6E-01	1.5E-01	5.7E-01	8.6E-01
Antimony	9	9	1.6E-03	1.4E-02	3.8E-03	1.3E-03	2.8E-03	6.2E-03
Barium	9	9	2.6E-02	5.6E-02	4.1E-02	2.9E-03	4.1E-02	4.7E-02
Boron	9	9	1.9E-02	6.3E-02	3.4E-02	5.0E-03	2.8E-02	4.4E-02
Calcium	9	9	1.8E+01	4.6E+01	3.8E+01	2.9E+00	4.0E+01	4.3E+01
Calculated Hardness	9	9	6.6E+01	1.7E+02	1.4E+02	1.0E+01	1.5E+02	1.6E+02
Chromium	9	8	1.0E-03	2.7E-03	1.9E-03	1.1E-04	1.8E-03	2.1E-03
Cobalt	9	1	.	.	1.3E-03	.	.	.
Copper	9	9	1.7E-03	4.0E-03	2.7E-03	2.2E-04	2.7E-03	3.1E-03
Iron	9	9	1.3E-01	3.6E-01	2.9E-01	2.8E-02	3.2E-01	3.4E-01
Kjeldahl Nitrogen	7	5	2.0E-01	1.4E+00	6.6E-01	1.7E-01	6.0E-01	1.0E+00
Magnesium	9	9	5.3E+00	1.3E+01	1.1E+01	7.9E-01	1.1E+01	1.2E+01
Manganese	9	9	3.6E-02	2.4E+00	5.7E-01	2.5E-01	1.8E-01	1.0E+00
Mercury (BR)	5	1	3.3E-06	5.5E06	5.5E-06	.	5.5E-06	.
Molybdenum	9	2	1.0E-03	1.2E-03	1.2E-03	0.0E+00	1.2E-03	1.2E-03
Nickel	9	9	2.1E-03	5.2E-03	3.7E-03	3.0E-04	3.5E-03	4.2E-03
Potassium	9	9	7.4E-01	2.0E+00	1.6E+00	1.6E-01	1.8E+00	1.9E+00
Sodium	9	9	2.4E+00	5.4E+00	4.5E+00	4.0E-01	5.2E+00	5.3E+00
Uranium	9	3	1.0E-03	1.6E-03	1.3E-03	5.4E-05	1.2E-03	1.4E-03
Zinc	9	9	4.7E-03	1.8E-02	7.6E-03	1.4E-03	6.4E-03	1.0E-02
Subreach 4.02								
Aluminum	6	6	1.2E-02	9.0E-02	3.3E-02	1.2E-02	2.0E-02	5.8E-02
Ammonium Nitrogen	6	6	6.5E-01	2.8E+00	1.5E+00	3.2E-01	1.3E+00	2.1E+00
Antimony	6	6	2.7E-03	8.0E-03	5.4E-03	7.8E-04	5.2E-03	7.0E-03
Arsenic	6	2	1.0E-03	3.0E-03	1.7E-03	6.5E-04	1.1E-03	3.0E-03
Barium	6	6	3.5E-02	8.8E-02	5.9E-02	8.2E-03	6.1E-02	7.6E-02
Boron	6	5	1.8E-02	4.8E-02	3.8E-02	4.6E-03	4.3E-02	4.7E-02
Calcium	6	6	2.8E+01	4.7E+01	3.8E+01	2.9E+00	3.8E+01	4.4E+01
Calculated Hardness	6	6	1.2E+02	1.8E+02	1.5E+02	1.1E+01	1.5E+02	1.7E+02
Chromium	6	3	1.0E-03	2.2E-03	1.2E-03	2.2E-04	1.0E-03	1.7E-03
Cobalt	6	5	1.0E-03	3.0E-03	1.6E-03	3.1E-04	1.3E-03	2.2E-03
Copper	6	6	1.4E-03	3.6E-03	2.4E-03	3.7E-04	2.3E-03	3.2E-03

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Iron	6	6	2.8E-02	8.6E-02	5.0E-02	9.1E-03	4.1E-02	6.9E-02
Kjeldahl Nitrogen	6	5	1.0E-01	2.6E+00	1.3E+00	2.9E-01	1.1E+00	1.9E+00
Magnesium	6	6	9.1E+00	1.5E+01	1.1E+01	8.2E-01	1.1E+01	1.3E+01
Manganese	6	6	1.3E+00	7.9E+00	4.0E+00	9.7E-01	3.9E+00	5.9E+00
Molybdenum	6	2	1.0E-03	1.4E-03	1.3E-03	2.2E-05	1.3E-03	1.4E-03
Nickel	6	6	4.7E-03	2.9E-02	1.3E-02	3.8E-03	9.2E-03	2.1E-02
Potassium	6	6	1.5E+00	2.4E+00	1.9E+00	1.3E-01	1.9E+00	2.2E+00
Sodium	6	6	2.8E+00	3.9E+00	3.4E+00	1.6E-01	3.5E+00	3.7E+00
Uranium	6	2	1.0E-03	1.8E-03	1.2E-03	1.5E-04	1.1E-03	1.5E-03
Zinc	6	6	1.0E-02	2.8E-02	1.6E-02	3.1E-03	1.2E-02	2.2E-02
Subreach 4.03								
Aluminum	7	6	1.0E-02	3.4E-02	2.0E-02	3.0E-03	1.6E-02	2.6E-02
Ammonium Nitrogen	7	7	3.4E-01	4.9E+00	1.5E+00	6.2E-01	6.2E-01	2.7E+00
Antimony	7	7	1.5E-03	5.8E-03	3.5E-03	5.2E-04	3.7E-03	4.5E-03
Arsenic	7	2	1.5E-03	3.0E-03	1.6E-03	8.5E-05	1.6E-03	1.8E-03
Barium	7	7	2.5E-02	2.2E-01	7.4E-02	2.5E-02	5.0E-02	1.2E-01
Boron	7	6	1.8E-02	5.0E-02	3.9E-02	2.9E-03	3.6E-02	4.5E-02
Calcium	7	7	2.3E+01	7.8E+01	3.5E+01	7.4E+00	2.7E+01	4.9E+01
Calculated Hardness	7	7	8.4E+01	3.1E+02	1.4E+02	3.0E+01	1.1E+02	2.0E+02
Chromium	7	5	1.0E-03	2.0E-03	1.3E-03	1.8E-04	1.1E-03	1.7E-03
Cobalt	7	5	1.0E-03	1.2E-02	3.1E-03	1.6E-03	1.7E-03	6.2E-03
Copper	7	7	1.9E-03	8.5E-03	3.2E-03	9.0E-04	2.3E-03	4.9E-03
Iron	7	7	2.9E-02	1.0E-01	4.9E-02	1.0E-02	3.1E-02	6.9E-02
Kjeldahl Nitrogen	7	7	5.9E-01	4.8E+00	1.7E+00	5.3E-01	1.3E+00	2.8E+00
Lead	7	3	1.0E-03	2.8E-03	1.4E-03	2.6E-04	1.2E-03	1.9E-03
Magnesium	7	7	6.6E+00	1.9E+01	9.8E+00	1.6E+00	8.3E+00	1.3E+01
Manganese	7	7	2.1E-03	2.0E+01	5.4E+00	2.6E+00	2.8E+00	1.0E+01
Mercury (BR)	1	1	9.1E-06	9.1E-06	9.1E-06	.	9.1E-06	.
Molybdenum	7	6	1.0E-03	4.7E-03	2.1E-03	4.9E-04	1.5E-03	3.1E-03
Nickel	7	7	4.8E-03	1.8E-02	1.1E-02	1.6E-03	1.1E-02	1.4E-02
Potassium	7	7	1.4E+00	3.7E+00	1.9E+00	3.0E-01	1.6E+00	2.5E+00
Sodium	7	7	2.9E+00	5.2E+00	3.6E+00	2.8E-01	3.5E+00	4.1E+00
Uranium	7	1	.	.	2.1E-03	.	.	.
Vanadium	7	1	.	.	1.2E-03	.	.	.
Zinc	7	7	8.4E-03	7.4E-02	2.6E-02	8.3E-03	2.2E-02	4.3E-02

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Subreach 4.04								
Aluminum	11	11	1.4E-02	1.2E-01	4.9E-02	1.2E-02	2.8E-02	7.1E-02
Ammonium Nitrogen	11	11	5.6E-01	4.4E+00	1.6E+00	4.3E-01	7.4E-01	2.3E+00
Antimony	11	11	1.2E-03	1.3E-02	5.9E-03	1.1E-03	7.0E-03	7.8E-03
Arsenic	11	5	1.0E-03	3.9E-03	1.9E-03	2.2E-04	1.6E-03	2.3E-03
Barium	11	11	3.5E-02	2.0E-01	6.5E-02	1.6E-02	4.1E-02	9.3E-02
Boron	11	11	2.2E-02	4.0E-02	3.0E-02	1.6E-03	3.0E-02	3.3E-02
Cadmium	11	1	.	.	1.0E-03	.	.	.
Calcium	11	11	2.4E+01	5.9E+01	3.5E+01	3.5E+00	3.3E+01	4.1E+01
Calculated Hardness	11	11	9.6E+01	2.3E+02	1.3E+02	1.3E+01	1.2E+02	1.6E+02
Chromium	11	9	1.0E-03	3.1E-03	1.4E-03	1.9E-04	1.2E-03	1.7E-03
Cobalt	11	10	1.0E-03	9.2E-03	2.4E-03	7.4E-04	1.5E-03	3.8E-03
Copper	11	11	2.2E-03	8.3E-03	4.3E-03	5.5E-04	4.3E-03	5.3E-03
Iron	11	11	1.7E-01	6.0E+00	1.2E+00	6.4E-01	2.4E-01	2.3E+00
Kjeldahl Nitrogen	11	11	9.9E-01	7.2E+00	2.4E+00	6.2E-01	1.4E+00	3.5E+00
Magnesium	11	11	7.0E+00	1.6E+01	9.6E+00	8.9E-01	8.9E+00	1.1E+01
Manganese	11	8	1.0E-03	4.3E+00	2.8E+00	2.9E-01	2.9E+00	3.3E+00
Mercury	11	1	.	.	8.1E-04	.	.	.
Molybdenum	11	5	1.0E-03	2.2E-03	1.4E-03	1.3E-04	1.1E-03	1.6E-03
Nickel	11	11	3.2E-03	6.7E-03	4.8E-03	3.3E-04	4.6E-03	5.4E-03
Potassium	11	11	1.6E+00	3.6E+00	2.0E+00	1.8E-01	1.8E+00	2.4E+00
Sodium	11	11	5.3E+00	8.2E+00	6.5E+00	2.7E-01	6.6E+00	7.0E+00
Vanadium	11	2	1.0E-03	1.3E-03	1.2E-03	1.2E-05	1.2E-03	1.2E-03
Zinc	11	11	2.4E-03	2.6E-02	7.2E-03	2.1E-03	4.8E-03	1.1E-02
Subreach 7.01								
Aluminum	1	1	.	.	3.1E-02	.	.	.
Ammonium Nitrogen	1	1	.	.	2.0E+00	.	.	.
Antimony	1	1	.	.	5.7E-03	.	.	.
Arsenic	1	1	.	.	1.3E-01	.	.	.
Barium	1	1	.	.	6.0E-02	.	.	.
Boron	1	1	.	.	4.4E-02	.	.	.
Calcium	1	1	.	.	4.9E+01	.	.	.
Calculated Hardness	1	1	.	.	1.7E+02	.	.	.
Chromium	1	1	.	.	1.1E-03	.	.	.
Copper	1	1	.	.	4.2E-03	.	.	.
Iron	1	1	.	.	3.3E-02	.	.	.

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Kjeldahl Nitrogen	1	1	.	.	1.9E+00	.	.	.
Magnesium	1	1	.	.	1.0E+01	.	.	.
Manganese	1	1	.	.	5.2E+00	.	.	.
Molybdenum	1	1	.	.	2.8E-03	.	.	.
Nickel	1	1	.	.	1.2E-02	.	.	.
Potassium	1	1	.	.	2.3E+00	.	.	.
Sodium	1	1	.	.	3.1E+00	.	.	.
Vanadium	1	1	.	.	1.5E-03	.	.	.
Zinc	1	1	.	.	4.5E-03	.	.	.
Subreach 7.02								
Aluminum	1	1	.	.	2.7E-01	.	.	.
Ammonium Nitrogen	1	1	.	.	1.2E+00	.	.	.
Antimony	1	1	.	.	5.3E-03	.	.	.
Arsenic	1	1	.	.	1.5E-02	.	.	.
Barium	1	1	.	.	6.2E-02	.	.	.
Boron	1	1	.	.	3.5E-02	.	.	.
Calcium	1	1	.	.	3.7E+01	.	.	.
Calculated Hardness	1	1	.	.	1.4E+02	.	.	.
Copper	1	1	.	.	2.3E-03	.	.	.
Iron	1	1	.	.	2.2E-02	.	.	.
Kjeldahl Nitrogen	1	1	.	.	1.0E+00	.	.	.
Magnesium	1	1	.	.	9.5E+00	.	.	.
Manganese	1	1	.	.	4.2E+00	.	.	.
Molybdenum	1	1	.	.	2.3E-03	.	.	.
Nickel	1	1	.	.	1.1E-02	.	.	.
Potassium	1	1	.	.	1.8E+00	.	.	.
Sodium	1	1	.	.	3.7E+00	.	.	.
Vanadium	1	1	.	.	1.0E-03	.	.	.
Zinc	1	1	.	.	6.6E-03	.	.	.
Subreach 8								
Aluminum	1	1	.	.	2.7E-02	.	.	.
Ammonium Nitrogen	1	1	.	.	1.5E+00	.	.	.
Antimony	1	1	.	.	5.0E-03	.	.	.
Barium	1	1	.	.	5.4E-02	.	.	.
Calcium	1	1	.	.	4.2E+01	.	.	.

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Calculated Hardness	1	1	.	.	1.5E+02	.	.	.
Chromium	1	1	.	.	1.1E-03	.	.	.
Copper	1	1	.	.	2.6E-03	.	.	.
Iron	1	1	.	.	2.9E-02	.	.	.
Kjeldahl Nitrogen	1	1	.	.	1.3E+00	.	.	.
Magnesium	1	1	.	.	1.0E+01	.	.	.
Manganese	1	1	.	.	3.4E+00	.	.	.
Nickel	1	1	.	.	1.2E-02	.	.	.
Potassium	1	1	.	.	1.8E+00	.	.	.
Sodium	1	1	.	.	3.6E+00	.	.	.
Zinc	1	1	.	.	4.8E-03	.	.	.
Subreach 13								
Ammonium Nitrogen	5	5	3.2E-01	2.5E+00	1.4E+00	3.7E-01	1.2E+00	2.2E+00
Antimony	5	4	1.0E-03	4.5E-03	1.8E-03	6.9E-04	1.1E-03	3.3E-03
Barium	5	5	4.1E-02	1.2E-01	7.5E-02	1.4E-02	7.0E-02	1.1E-01
Boron	5	2	1.1E-02	4.8E-02	3.1E-02	6.6E-03	2.6E-02	4.5E-02
Calcium	5	5	1.9E+01	5.3E+01	3.6E+01	5.5E+00	3.6E+01	4.8E+01
Calculated Hardness	5	5	7.8E+01	2.1E+02	1.5E+02	2.2E+01	1.6E+02	1.9E+02
Chromium	5	1	.	.	1.5E-03	.	.	.
Cobalt	5	4	1.0E-03	8.7E-03	3.0E-03	1.5E-03	1.5E-03	6.1E-03
Copper	5	4	1.2E-03	3.5E-03	1.8E-03	4.5E-04	1.3E-03	2.8E-03
Iron	5	1	.	.	4.4E-02	.	.	.
Kjeldahl Nitrogen	5	5	5.8E-01	1.6E+00	9.5E-01	2.1E-01	6.6E-01	1.4E+00
Magnesium	5	5	6.7E+00	1.6E+01	1.1E+01	1.5E+00	1.2E+01	1.5E+01
Manganese	5	5	1.4E+00	9.1E+00	5.1E+00	1.4E+00	5.3E+00	8.0E+00
Mercury (BR)	5	3	3.7E-06	1.3E-05	6.6E-06	1.8E-06	4.9E-06	1.0E-05
Nickel	5	3	1.0E-03	1.2E-02	6.5E-03	1.5E-03	4.4E-03	9.8E-03
Potassium	5	5	1.4E+00	2.6E+00	1.9E+00	2.0E-01	2.0E+00	2.3E+00
Sodium	5	5	2.7E+00	5.1E+00	3.9E+00	3.8E-01	3.9E+00	4.7E+00
Uranium	5	2	1.0E-03	1.5E-03	1.1E-03	1.3E-04	1.0E-03	1.4E-03
Zinc	5	4	2.7E-03	1.3E-02	4.4E-03	6.0E-04	4.7E-03	5.7E-03
Subreach 18								
Aluminum	3	3	3.9E-02	3.1E-01	1.3E-01	9.1E-02	4.2E-02	4.0E-01
Ammonium Nitrogen	3	3	4.6E-01	5.4E+00	2.2E+00	1.6E+00	7.1E-01	6.9E+00

Table B10 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	Median	95% UCB
Antimony	3	3	4.5E-03	5.8E-03	5.1E-03	3.8E-04	4.9E-03	6.2E-03
Arsenic	3	2	1.0E-03	1.3E-03	1.2E-03	3.8E-05	1.2E-03	1.3E-03
Barium	3	3	4.3E-02	6.5E-02	5.5E-02	6.4E-03	5.7E-02	7.4E-02
Boron	3	3	2.4E-02	3.9E-02	3.2E-02	4.4E-03	3.4E-02	4.5E-02
Calcium	3	3	2.2E+01	2.5E+01	2.3E+01	1.0E+00	2.3E+01	2.6E+01
Calculated Hardness	3	3	7.7E+01	9.0E+01	8.2E+01	3.8E+00	8.0E+01	9.3E+01
Chromium	3	3	1.0E-03	1.2E-03	1.1E-03	5.8E-05	1.1E-03	1.3E-03
Cobalt	3	2	1.0E-03	1.4E-03	1.2E-03	1.2E-04	1.1E-03	1.5E-03
Copper	3	3	4.7E-03	5.4E-03	5.0E-03	2.1E-04	4.9E-03	5.6E-03
Iron	3	3	1.1E-01	1.9E-01	1.4E-01	2.3E-02	1.3E-01	2.1E-01
Kjeldahl Nitrogen	3	3	1.7E+00	2.0E+00	1.8E+00	8.8E-02	1.8E+00	2.1E+00
Magnesium	3	3	5.5E+00	6.0E+00	5.7E+00	1.8E-01	5.5E+00	6.2E+00
Molybdenum	3	3	2.2E-03	2.7E-03	2.5E-03	1.5E-04	2.5E-03	2.9E-03
Nickel	3	3	2.4E-03	4.3E-03	3.1E-03	6.2E-04	2.5E-03	4.9E-03
Potassium	3	3	1.6E+00	1.9E+00	1.8E+00	8.7E-02	1.9E+00	2.1E+00
Sodium	3	3	8.7E+00	1.0E+01	9.4E+00	3.6E-01	9.6E+00	1.0E+01
Vanadium	3	1	.	.	1.1E-03	.	.	.
Zinc	3	3	8.2E-03	1.3E-02	1.0E-02	1.3E-03	1.0E-02	1.4E-02

Table B11. Organic contaminants that were 100% Non-Detects in surface sediment, whole core sediment and pore-water

ANALYTE	PORE WATER	SURFACE SEDIMENT	MASS WEIGHTED SEDIMENT
1,2,4-Trichlorobenzene	X	X	X
1,2-Dichlorobenzene		X	X
1,3-Dichlorobenzene		X	X
2,2'-oxybis(1-Chloropropa	X	X	X
2,4,5-Trichlorophenol	X	X	X
2,4,6-Trichlorophenol	X	X	X
2,4-Dichlorophenol	X	X	X
2,4-Dimethylphenol	X		
2,4-Dinitrophenol	X	X	X
2,4-Dinitrotoluene	X	X	X
2,6-Dinitrotoluene	X	X	X
2-Chloronaphthalene	X	X	X
2-Chlorophenol	X	X	X
2-Methyl-4,6-dinitrophenol	X	X	X
2-Methylnaphthalene	X		
2-Methylphenol	X	X	X
2-Nitroaniline	X	X	X
2-Nitrophenol	X	X	X
3,3'-Dichlorobenzidine	X	X	X
3-Nitroaniline	X	X	X
4,4'-DDD	X		
4,4'-DDE	X	X	X
4,4'-DDT	X		
4-Bromophenyl phenyl ether	X	X	X
4-Chloro-3-methylphenol	X		
4-Chlorobenzenamine	X	X	X
4-Chlorophenylphenyl ether	X	X	X
4-Methylphenol	X		
4-Nitroaniline	X	X	X
4-Nitrophenol	X		
Acenaphthene	X		
Acenaphthylene	X		
Anthracene	X		
Aldrin		X	X
Benzo(a)anthracene	X		
Benzo(a)pyrene	X		
Benzo(b)fluoranthene	X		
Benzo(ghi)perylene	X		
Benzo(k)fluoranthene	X		
Benzyl alcohol	X	X	X
Bis(2-chloroethoxy)methan	X	X	X
Bis(2-chloroethyl) ether	X	X	X
Butylbenzylphthalate	X		
Carbazole	X		
Chlordane, total	X	X	X
Chrysene	X		
Dibenz(a,h)anthracene	X		

Table B11. (Continued)

ANALYTE	PORE WATER	SURFACE SEDIMENT	MASS WEIGHTED SEDIMENT
Dibenzofuran	X		
Dieldrin	X	X	X
Diethylphthalate	X		
Dimethylphthalate	X	X	
Endosulfan	X	X	X
Endosulfan I	X	X	X
Endosulfan II	X	X	X
Endosulfan sulfate	X	X	X
Endrin	X	X	X
Endrin aldehyde	X	X	X
Endrin ketone	X	X	X
Fluoranthene	X		
Fluorene	X		
Heptachlor	X		
Heptachlor epoxide	X	X	X
Hexachlorobenzene	X	X	X
Hexachlorobutadiene	X	X	X
Hexachlorocyclopentadiene	X	X	X
Hexachloroethane	X	X	X
Indeno(1,2,3-cd)pyrene	X		
Isophorone	X	X	X
Lindane	X	X	X
Methoxychlor	X		
N-Nitroso-di-n-propylamin	X	X	
N-Nitrosodiphenylamine	X	X	X
Naphthalene	X		
Nitrobenzene	X	X	X
PCB-1016	X	X	X
PCB-1221	X	X	X
PCB-1232	X	X	X
PCB-1242	X	X	X
PCB-1248	X		
PCB-1260	X		
Pentachlorophenol	X		
Phenanthrene	X		
Phenol	X		
Pyrene	X		
Toxaphene	X		
alpha-BHC	X	X	X
alpha-Chlordane	X	X	X
beta-BHC	X	X	X
delta-BHC	X	X	X
gamma-Chlordane	X	X	X

Table B12. Summary statistics for surface sediment (0-15 cm) organic concentrations (mg/kg) by subreach

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Subreach 0							
2-Methylnaphthalene	5	5	4.00e-02	6.70e-01	2.70e-01	1.40e-01	5.80e-01
Acenaphthene	5	1	2.00e-02	2.70e-01	2.00e-02	.	.
Benzo(a)anthracene	5	2	7.00e-02	2.30e-01	9.00e-02	2.00e-02	1.30e-01
Benzo(a)pyrene	5	2	7.00e-02	2.30e-01	8.00e-02	1.00e-02	1.00e-01
Benzo(b)fluoranthene	5	4	2.00e-02	2.00e-01	7.00e-02	2.00e-02	1.20e-01
Benzo(ghi)perylene	5	1	5.00e-02	2.70e-01	5.00e-02	.	.
Benzo(k)fluoranthene	5	2	2.00e-02	2.30e-01	2.00e-02	1.00e-02	4.00e-02
Butylbenzylphthalate	5	1	3.00e-02	2.80e-01	3.00e-02	.	.
Carbazole	5	2	2.00e-02	2.30e-01	2.00e-02	0.00e+00	2.00e-02
Chrysene	5	4	2.00e-02	2.00e-01	7.00e-02	3.00e-02	1.30e-01
Dibenzofuran	5	2	1.30e-01	2.30e-01	1.40e-01	1.00e-02	1.60e-01
Diethylphthalate	5	1	1.00e-01	2.80e-01	1.00e-01	.	.
Fluoranthene	5	3	2.00e-02	2.00e-01	7.00e-02	3.00e-02	1.30e-01
Fluorene	5	2	4.00e-02	2.30e-01	4.00e-02	0.00e+00	4.00e-02
Indeno(1,2,3-cd)pyre	5	1	3.00e-02	2.70e-01	3.00e-02	.	.
Naphthalene	5	5	2.00e-02	3.80e-01	1.60e-01	8.00e-02	3.40e-01
Phenanthrene	5	5	3.00e-02	3.70e-01	1.60e-01	8.00e-02	3.20e-01
Pyrene	5	5	2.00e-02	1.50e-01	7.00e-02	3.00e-02	1.30e-01
Total combustible or	5	5	4.30e+04	4.29e+05	2.85e+05	6.57e+04	4.25e+05
Total organic carbon	5	5	9.89e+03	2.00e+04	1.43e+04	2.27e+03	1.91e+04
Subreach 1							
4,4'-DDD	2	1	2.80e-01	5.90e-01	2.80e-01	.	.
4,4'-DDT	2	1	2.80e-01	5.90e-01	2.80e-01	.	.
Subreach 2.01							
Bis(2-ethylhexyl)pht	1	1	2.00e-02	2.00e-02	2.00e-02	.	.
Total combustible or	1	1	1.70e+04	1.70e+04	1.70e+04	.	.

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Total organic carbon	1	1	3.95e+03	3.95e+03	3.95e+03	.	.
Subreach 2.02							
Bis(2-ethylhexyl)pht	1	1	3.00e-01	3.00e-01	3.00e-01	.	.
PCB-1254	1	1	1.17e+00	1.17e+00	1.17e+00	.	.
PCB-1260	1	1	1.17e+00	1.17e+00	1.17e+00	.	.
Toxaphene	1	1	1.17e+00	1.17e+00	1.17e+00	.	.
Subreach 2.03							
Bis(2-ethylhexyl)pht	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Diethylphthalate	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Heptachlor	1	1	0.00e+00	0.00e+00	0.00e+00	.	.
Total combustible or	1	1	2.40e+04	2.40e+04	2.40e+04	.	.
Total organic carbon	1	1	3.78e+03	3.78e+03	3.78e+03	.	.
Subreach 2.04							
2-Methylnaphthalene	8	5	4.00e-02	6.50e-01	1.20e-01	8.00e-02	2.70e-01
4-Methylphenol	8	1	4.00e-02	5.00e-01	4.00e-02	.	.
4-Nitrophenol	8	1	2.70e-01	2.38e+00	2.70e-01	.	.
Benzo(a)anthracene	8	2	7.00e-02	5.00e-01	9.00e-02	2.00e-02	1.20e-01
Benzo(a)pyrene	8	4	2.00e-02	5.00e-01	1.20e-01	7.00e-02	2.40e-01
Benzo(b)fluoranthene	8	6	3.00e-02	5.00e-01	7.00e-02	2.00e-02	1.00e-01
Benzo(ghi)perylene	8	3	2.00e-02	5.00e-01	4.00e-02	1.00e-02	7.00e-02
Benzo(k)fluoranthene	8	1	2.00e-02	5.00e-01	2.00e-02	.	.
Bis(2-ethylhexyl)pht	8	4	4.00e-02	5.10e-01	1.10e-01	6.00e-02	2.30e-01
Carbazole	7	1	2.00e-02	2.90e-01	2.00e-02	.	.
Chrysene	8	6	2.00e-02	5.00e-01	5.00e-02	1.00e-02	8.00e-02
Di-n-butylphthalate	8	2	2.00e-01	5.00e-01	3.40e-01	2.00e-02	3.80e-01
Dibenzofuran	8	2	2.00e-02	5.00e-01	6.00e-02	4.00e-02	1.40e-01
Diethylphthalate	8	1	3.00e-02	5.00e-01	3.00e-02	.	.

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Fluoranthene	8	7	2.00e-02	5.00e-01	1.20e-01	6.00e-02	2.30e-01
Indeno(1,2,3-cd)pyre	8	3	2.00e-02	5.00e-01	4.00e-02	2.00e-02	7.00e-02
Naphthalene	8	5	2.00e-02	5.00e-01	7.00e-02	5.00e-02	1.70e-01
Pentachlorophenol	7	1	2.60e-01	2.38e+00	2.60e-01	.	.
Phenanthrene	8	6	3.00e-02	5.00e-01	1.30e-01	6.00e-02	2.40e-01
Pyrene	8	4	3.00e-02	5.00e-01	1.10e-01	6.00e-02	2.30e-01
Total combustible or	7	7	2.93e+05	4.07e+05	3.42e+05	1.40e+04	3.69e+05
Total organic carbon	7	7	4.05e+03	4.14e+04	1.52e+04	4.71e+03	2.43e+04
Subreach 3.01							
2-Methylnaphthalene	2	1	2.00e-02	2.00e-01	2.00e-02	.	.
Benzo(a)anthracene	2	1	1.00e-01	2.00e-01	1.00e-01	.	.
Benzo(a)pyrene	2	1	7.00e-02	2.00e-01	7.00e-02	.	.
Benzo(b)fluoranthene	2	2	3.00e-02	1.70e-01	1.00e-01	7.00e-02	5.50e-01
Benzo(ghi)perylene	2	1	9.00e-02	2.00e-01	9.00e-02	.	.
Bis(2-ethylhexyl)pht	2	2	2.00e-02	3.00e-02	3.00e-02	0.00e+00	5.00e-02
Chrysene	2	2	1.00e-02	9.00e-02	5.00e-02	4.00e-02	2.90e-01
Di-n-butylphthalate	2	1	4.00e-02	3.90e-01	4.00e-02	.	.
Fluoranthene	2	2	3.00e-02	1.40e-01	8.00e-02	6.00e-02	4.50e-01
Heptachlor	2	1	0.00e+00	0.00e+00	0.00e+00	.	.
Indeno(1,2,3-cd)pyre	2	1	9.00e-02	2.00e-01	9.00e-02	.	.
PCB-1260	2	1	1.00e-02	2.00e-02	2.00e-02	.	.
Phenanthrene	2	2	2.00e-02	7.00e-02	5.00e-02	3.00e-02	2.10e-01
Pyrene	2	2	2.00e-02	1.30e-01	7.00e-02	6.00e-02	4.30e-01
Total combustible or	2	2	3.52e+04	5.03e+05	2.69e+05	2.34e+05	1.75e+06
Total organic carbon	2	2	5.73e+03	1.21e+04	8.93e+03	3.20e+03	2.91e+04
Subreach 3.02							
2-Methylnaphthalene	9	8	1.00e-02	4.90e-01	1.60e-01	4.00e-02	2.40e-01
4-Chloro-3-methylphe	9	1	6.00e-02	4.90e-01	6.00e-02	.	.

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Acenaphthene	9	5	2.00e-02	4.90e-01	4.00e-02	1.00e-02	6.00e-02
Acenaphthylene	9	1	3.00e-02	4.90e-01	3.00e-02	.	.
Anthracene	9	5	5.00e-02	4.90e-01	6.00e-02	1.00e-02	8.00e-02
Benzo(a)anthracene	9	7	8.00e-02	5.00e-01	2.40e-01	6.00e-02	3.50e-01
Benzo(a)pyrene	9	8	4.00e-02	4.90e-01	1.70e-01	4.00e-02	2.50e-01
Benzo(b)fluoranthene	9	8	2.00e-02	6.10e-01	2.60e-01	7.00e-02	3.80e-01
Benzo(ghi)perylene	9	6	5.00e-02	4.90e-01	1.20e-01	2.00e-02	1.70e-01
Benzo(k)fluoranthene	9	7	2.00e-02	4.90e-01	8.00e-02	3.00e-02	1.40e-01
Bis(2-ethylhexyl)pht	9	4	2.00e-02	1.60e+00	1.90e-01	8.00e-02	3.40e-01
Butylbenzylphthalate	9	4	2.00e-02	4.90e-01	3.00e-02	1.00e-02	5.00e-02
Carbazole	8	5	2.00e-02	2.50e-01	5.00e-02	1.00e-02	8.00e-02
Chrysene	9	7	8.00e-02	4.90e-01	2.00e-01	4.00e-02	2.80e-01
Dibenz(a,h)anthracen	9	3	3.00e-02	4.90e-01	4.00e-02	1.00e-02	5.00e-02
Dibenzofuran	9	7	2.00e-02	4.90e-01	6.00e-02	2.00e-02	9.00e-02
Fluoranthene	9	8	8.00e-02	7.10e-01	3.90e-01	8.00e-02	5.40e-01
Fluorene	9	4	3.00e-02	4.90e-01	6.00e-02	1.00e-02	9.00e-02
Indeno(1,2,3-cd)pyre	9	5	1.00e-01	4.90e-01	1.50e-01	2.00e-02	1.90e-01
Naphthalene	9	7	5.00e-02	4.90e-01	1.20e-01	3.00e-02	1.70e-01
PCB-1248	9	2	1.00e-02	1.17e+00	8.00e-02	4.00e-02	1.50e-01
PCB-1254	9	7	1.00e-02	1.50e+00	3.30e-01	1.50e-01	6.20e-01
PCB-1260	9	6	1.00e-02	2.39e+00	1.30e-01	6.00e-02	2.50e-01
Phenanthrene	9	8	1.10e-01	7.80e-01	3.10e-01	8.00e-02	4.50e-01
Phenol	9	2	7.00e-02	4.90e-01	1.00e-01	4.00e-02	1.70e-01
Pyrene	9	8	1.30e-01	6.60e-01	3.50e-01	6.00e-02	4.70e-01
Total combustible or	7	7	3.20e+03	3.99e+05	1.42e+05	6.72e+04	2.72e+05
Total organic carbon	4	4	1.48e+04	1.95e+05	6.27e+04	4.40e+04	1.66e+05
Subreach 3.03							
2-Methylnaphthalene	9	9	5.00e-02	5.10e-01	1.90e-01	5.00e-02	2.90e-01
4-Methylphenol	9	1	6.00e-02	3.10e-01	6.00e-02	.	.

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Acenaphthene	9	7	2.00e-02	2.40e-01	6.00e-02	2.00e-02	1.00e-01
Acenaphthylene	9	2	2.00e-02	3.10e-01	2.00e-02	0.00e+00	2.00e-02
Anthracene	9	7	2.00e-02	2.40e-01	8.00e-02	3.00e-02	1.30e-01
Benzo(a)anthracene	9	9	8.00e-02	8.70e-01	2.50e-01	8.00e-02	4.00e-01
Benzo(a)pyrene	9	9	5.00e-02	6.70e-01	1.80e-01	6.00e-02	2.90e-01
Benzo(b)fluoranthene	9	9	8.00e-02	1.00e+00	3.10e-01	9.00e-02	4.80e-01
Benzo(ghi)perylene	9	9	4.00e-02	4.80e-01	1.10e-01	5.00e-02	2.00e-01
Benzo(k)fluoranthene	9	9	3.00e-02	4.20e-01	9.00e-02	4.00e-02	1.70e-01
Benzoic acid	9	1	4.80e-01	7.40e-01	4.80e-01	.	.
Bis(2-ethylhexyl)pht	9	4	1.50e-01	3.10e-01	1.80e-01	2.00e-02	2.10e-01
Butylbenzylphthalate	9	1	2.00e-02	3.10e-01	2.00e-02	.	.
Carbazole	9	8	2.00e-02	2.30e-01	7.00e-02	2.00e-02	1.10e-01
Chrysene	9	9	8.00e-02	7.30e-01	2.20e-01	7.00e-02	3.50e-01
Di-n-octylphthlate	9	1	6.00e-02	3.10e-01	6.00e-02	.	.
Dibenz(a,h)anthracen	9	7	2.00e-02	2.40e-01	4.00e-02	1.00e-02	6.00e-02
Dibenzofuran	9	8	2.00e-02	2.30e-01	6.00e-02	2.00e-02	1.00e-01
Diethylphthalate	9	1	1.40e-01	3.10e-01	1.40e-01	.	.
Fluoranthene	9	9	1.10e-01	1.40e+00	4.00e-01	1.30e-01	6.50e-01
Fluorene	9	6	4.00e-02	2.40e-01	7.00e-02	2.00e-02	1.10e-01
Indeno(1,2,3-cd)pyre	9	9	4.00e-02	5.60e-01	1.30e-01	5.00e-02	2.30e-01
Methoxychlor	9	1	1.00e-02	1.50e-01	1.50e-01	.	.
Naphthalene	9	9	4.00e-02	3.90e-01	1.30e-01	4.00e-02	2.00e-01
PCB-1254	9	9	0.00e+00	5.30e-01	1.30e-01	5.00e-02	2.30e-01
PCB-1260	9	8	1.00e-02	2.80e-01	8.00e-02	3.00e-02	1.30e-01
Phenanthrene	9	9	1.00e-01	1.20e+00	3.30e-01	1.10e-01	5.40e-01
Phenol	9	1	8.00e-02	2.70e-01	8.00e-02	.	.
Pyrene	9	9	1.40e-01	1.25e+00	3.90e-01	1.10e-01	6.00e-01
Total combustible or	9	9	3.27e+03	4.27e+05	2.65e+05	5.50e+04	3.67e+05
Total organic carbon	1	1	1.84e+04	1.84e+04	1.84e+04	.	.

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Subreach 3.04							
1,4-Dichlorobenzene	7	1	1.30e-01	5.30e-01	1.30e-01	.	.
2-Methylnaphthalene	7	7	3.00e-02	2.80e-01	1.30e-01	3.00e-02	1.90e-01
4-Chloro-3-methylphe	7	1	4.00e-02	5.30e-01	4.00e-02	.	.
4-Methylphenol	7	1	2.10e-01	5.30e-01	3.00e-01	.	.
Acenaphthene	7	2	2.00e-02	5.30e-01	8.00e-02	7.00e-02	2.10e-01
Acenaphthylene	7	1	2.00e-02	5.30e-01	2.00e-02	.	.
Anthracene	7	3	5.00e-02	5.30e-01	1.10e-01	3.00e-02	1.70e-01
Benzo(a)anthracene	7	5	2.00e-02	5.30e-01	1.20e-01	3.00e-02	1.70e-01
Benzo(a)pyrene	7	6	2.00e-02	5.30e-01	1.00e-01	2.00e-02	1.50e-01
Benzo(b)fluoranthene	7	6	3.00e-02	4.70e-01	1.90e-01	5.00e-02	2.90e-01
Benzo(ghi)perylene	7	4	7.00e-02	5.30e-01	1.00e-01	1.00e-02	1.20e-01
Benzo(k)fluoranthene	7	3	2.00e-02	5.30e-01	3.00e-02	0.00e+00	4.00e-02
Bis(2-ethylhexyl)pht	7	4	4.00e-02	3.28e+00	5.20e-01	4.90e-01	1.47e+00
Butylbenzylphthalate	7	2	1.60e-01	5.30e-01	1.60e-01	0.00e+00	1.70e-01
Carbazole	6	3	3.00e-02	2.70e-01	6.00e-02	3.00e-02	1.20e-01
Chrysene	7	5	2.00e-02	5.30e-01	1.20e-01	3.00e-02	1.80e-01
Dibenz(a,h)anthracen	7	3	2.00e-02	5.30e-01	6.00e-02	3.00e-02	1.30e-01
Dibenzofuran	7	4	3.00e-02	5.30e-01	7.00e-02	3.00e-02	1.20e-01
Diethylphthalate	7	2	1.40e-01	5.30e-01	1.60e-01	2.00e-02	2.10e-01
Fluoranthene	7	7	3.00e-02	2.70e-01	1.70e-01	3.00e-02	2.30e-01
Fluorene	7	4	2.00e-02	5.30e-01	8.00e-02	3.00e-02	1.40e-01
Indeno(1,2,3-cd)pyre	7	4	7.00e-02	5.30e-01	9.00e-02	1.00e-02	1.00e-01
Naphthalene	7	7	2.00e-02	3.30e-01	1.20e-01	4.00e-02	1.90e-01
PCB-1248	7	2	1.00e-02	2.88e+00	6.00e-02	2.00e-02	1.10e-01
PCB-1254	7	6	0.00e+00	5.72e+00	9.00e-02	3.00e-02	1.50e-01
PCB-1260	7	5	1.00e-02	5.72e+00	8.00e-02	2.00e-02	1.20e-01
Phenanthrene	7	7	3.00e-02	3.10e-01	1.60e-01	4.00e-02	2.30e-01
Phenol	7	1	7.00e-02	5.30e-01	7.00e-02	.	.
Pyrene	7	7	3.00e-02	2.70e-01	1.80e-01	3.00e-02	2.40e-01

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Total combustible or	6	6	3.30e+04	3.43e+05	1.75e+05	5.77e+04	2.91e+05
Total organic carbon	4	4	5.95e+03	1.28e+04	9.10e+03	1.60e+03	1.29e+04
Subreach 4.01							
2-Methylnaphthalene	10	7	3.00e-02	4.90e-01	5.00e-02	1.00e-02	6.00e-02
Acenaphthene	10	1	1.10e-01	4.90e-01	1.10e-01	.	.
Anthracene	10	1	1.10e-01	4.90e-01	1.10e-01	.	.
Benzo(a)anthracene	10	5	4.00e-02	4.90e-01	6.00e-02	1.00e-02	8.00e-02
Benzo(a)pyrene	10	6	1.00e-02	4.90e-01	4.00e-02	1.00e-02	6.00e-02
Benzo(b)fluoranthene	10	6	2.00e-02	4.90e-01	7.00e-02	2.00e-02	1.00e-01
Benzo(ghi)perylene	10	3	3.00e-02	4.90e-01	5.00e-02	1.00e-02	7.00e-02
Benzo(k)fluoranthene	10	1	2.00e-02	4.90e-01	2.00e-02	.	.
Bis(2-ethylhexyl)pht	10	9	2.00e-02	4.90e-01	6.00e-02	1.00e-02	8.00e-02
Butylbenzylphthalate	10	2	2.00e-02	4.90e-01	2.00e-02	0.00e+00	2.00e-02
Carbazole	9	1	1.20e-01	4.50e-01	1.20e-01	.	.
Chrysene	10	6	2.00e-02	4.90e-01	5.00e-02	1.00e-02	7.00e-02
Dibenz(a,h)anthracen	10	1	1.10e-01	4.90e-01	1.10e-01	.	.
Dibenzofuran	10	3	1.00e-02	4.90e-01	5.00e-02	3.00e-02	1.10e-01
Diethylphthalate	10	1	4.00e-02	4.90e-01	4.00e-02	.	.
Fluoranthene	10	7	2.00e-02	4.90e-01	9.00e-02	2.00e-02	1.30e-01
Heptachlor	10	5	0.00e+00	1.20e-01	0.00e+00	0.00e+00	0.00e+00
Indeno(1,2,3-cd)pyre	10	3	4.00e-02	4.90e-01	6.00e-02	1.00e-02	9.00e-02
Naphthalene	10	7	2.00e-02	4.90e-01	3.00e-02	0.00e+00	4.00e-02
PCB-1254	10	8	0.00e+00	8.60e-01	1.10e-01	8.00e-02	2.60e-01
PCB-1260	10	5	1.00e-02	2.38e+00	2.00e-02	0.00e+00	2.00e-02
Pentachlorophenol	10	1	2.70e-01	2.38e+00	2.70e-01	.	.
Phenanthrene	10	7	2.00e-02	4.90e-01	6.00e-02	1.00e-02	8.00e-02
Phenol	10	1	1.20e-01	4.90e-01	1.20e-01	.	.
Pyrene	10	7	2.00e-02	4.90e-01	7.00e-02	2.00e-02	1.00e-01
Total combustible or	9	9	1.20e+04	5.50e+04	3.32e+04	4.53e+03	4.16e+04

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Total organic carbon	8	8	2.77e+03	1.34e+04	8.36e+03	1.38e+03	1.10e+04
Subreach 4.02							
2-Methylnaphthalene	5	4	3.00e-02	2.80e-01	1.00e-01	5.00e-02	2.10e-01
Anthracene	5	1	2.00e-02	2.80e-01	2.00e-02	.	.
Benzo(a)anthracene	5	4	2.00e-02	2.00e-01	8.00e-02	3.00e-02	1.40e-01
Benzo(a)pyrene	5	4	2.00e-02	3.10e-01	1.00e-01	6.00e-02	2.20e-01
Benzo(b)fluoranthene	5	5	2.00e-02	2.00e-01	9.00e-02	4.00e-02	1.70e-01
Benzo(ghi)perylene	5	4	2.00e-02	2.00e-01	5.00e-02	1.00e-02	7.00e-02
Benzo(k)fluoranthene	5	2	5.00e-02	2.10e-01	5.00e-02	0.00e+00	5.00e-02
Bis(2-ethylhexyl)pht	5	3	6.00e-02	2.80e-01	7.00e-02	1.00e-02	1.00e-01
Butylbenzylphthalate	5	1	6.00e-02	2.80e-01	6.00e-02	.	.
Carbazole	5	1	2.00e-02	2.80e-01	2.00e-02	.	.
Chrysene	5	4	3.00e-02	2.00e-01	9.00e-02	3.00e-02	1.50e-01
Dibenz(a,h)anthracen	5	2	2.00e-02	2.10e-01	2.00e-02	0.00e+00	2.00e-02
Dibenzofuran	5	2	2.00e-02	2.80e-01	4.00e-02	2.00e-02	8.00e-02
Diethylphthalate	5	1	3.00e-02	2.80e-01	3.00e-02	.	.
Fluoranthene	5	4	4.00e-02	2.60e-01	1.30e-01	5.00e-02	2.30e-01
Fluorene	5	1	2.00e-02	2.80e-01	2.00e-02	.	.
Indeno(1,2,3-cd)pyre	5	4	2.00e-02	2.00e-01	5.00e-02	2.00e-02	9.00e-02
Naphthalene	5	4	2.00e-02	2.80e-01	6.00e-02	3.00e-02	1.20e-01
PCB-1254	5	2	1.00e-02	5.00e-02	2.00e-02	1.00e-02	4.00e-02
PCB-1260	5	1	1.00e-02	3.00e-02	3.00e-02	.	.
Phenanthrene	5	5	2.00e-02	2.20e-01	9.00e-02	4.00e-02	1.60e-01
Pyrene	5	5	2.00e-02	2.40e-01	1.10e-01	4.00e-02	2.00e-01
Total combustible or	6	6	2.23e+05	4.09e+05	2.99e+05	3.08e+04	3.61e+05
Total organic carbon	6	6	5.17e+03	2.15e+04	1.13e+04	2.45e+03	1.62e+04
Subreach 4.03							
2-Methylnaphthalene	7	7	4.00e-02	2.40e-01	1.10e-01	2.00e-02	1.60e-01

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Benzo(a)anthracene	7	7	5.00e-02	9.00e-02	6.00e-02	1.00e-02	7.00e-02
Benzo(a)pyrene	7	7	4.00e-02	1.10e+00	2.90e-01	1.40e-01	5.60e-01
Benzo(b)fluoranthene	7	7	7.00e-02	1.50e-01	9.00e-02	1.00e-02	1.10e-01
Benzo(ghi)perylene	7	7	3.00e-02	9.00e-02	5.00e-02	1.00e-02	6.00e-02
Benzo(k)fluoranthene	7	7	2.00e-02	4.00e-02	3.00e-02	0.00e+00	3.00e-02
Bis(2-ethylhexyl)pht	7	7	6.00e-02	1.90e-01	1.20e-01	2.00e-02	1.50e-01
Butylbenzylphthalate	7	3	3.00e-02	2.80e-01	3.00e-02	0.00e+00	4.00e-02
Chrysene	7	7	6.00e-02	1.20e-01	7.00e-02	1.00e-02	9.00e-02
Dibenz(a,h)anthracen	7	2	1.00e-02	2.80e-01	2.00e-02	1.00e-02	3.00e-02
Dibenzofuran	7	6	2.00e-02	2.20e-01	5.00e-02	2.00e-02	9.00e-02
Fluoranthene	7	7	7.00e-02	1.40e-01	1.00e-01	1.00e-02	1.10e-01
Fluorene	7	1	3.00e-02	2.80e-01	3.00e-02	.	.
Indeno(1,2,3-cd)pyre	7	7	3.00e-02	8.00e-02	5.00e-02	1.00e-02	6.00e-02
Naphthalene	7	7	2.00e-02	1.20e-01	6.00e-02	1.00e-02	8.00e-02
PCB-1254	7	2	1.00e-02	8.00e-02	6.00e-02	0.00e+00	7.00e-02
PCB-1260	7	2	1.00e-02	4.00e-02	3.00e-02	0.00e+00	4.00e-02
Pentachlorophenol	7	1	4.00e-02	7.40e-01	4.00e-02	.	.
Phenanthrene	7	7	6.00e-02	1.90e-01	1.00e-01	2.00e-02	1.30e-01
Pyrene	7	7	9.00e-02	1.50e-01	1.00e-01	1.00e-02	1.20e-01
Total combustible or	7	7	2.74e+05	4.92e+05	3.70e+05	3.13e+04	4.31e+05
Total organic carbon	7	7	9.93e+03	2.22e+04	1.59e+04	1.91e+03	1.97e+04
Subreach 4.04							
2-Methylnaphthalene	12	10	8.00e-02	5.33e+00	1.20e-01	1.00e-02	1.40e-01
4,4'-DDD	12	4.04	0.00e+00	9.90e-01	.	.	.
4,4'-DDT	12	4.04	0.00e+00	9.90e-01	.	.	.
4-Chloro-3-methylphe	12	4.04	1.00e+00	5.33e+00	.	.	.
4-Methylphenol	12	4.04	1.00e+00	5.33e+00	.	.	.
4-Nitrophenol	12	4.04	2.40e+00	2.60e+01	.	.	.
Acenaphthene	12	4.04	1.00e+00	5.33e+00	.	.	.

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Acenaphthylene	12	4.04	1.00e+00	5.33e+00	.	.	.
Anthracene	12	4.04	1.00e+00	5.33e+00	.	.	.
Benzo(a)anthracene	12	10	7.00e-02	5.33e+00	1.00e-01	1.00e-02	1.20e-01
Benzo(a)pyrene	12	8	7.00e-02	5.33e+00	5.50e-01	9.00e-02	7.00e-01
Benzo(b)fluoranthene	12	11	9.00e-02	5.33e+00	1.70e-01	2.00e-02	2.00e-01
Benzo(ghi)perylene	12	5	6.00e-02	5.33e+00	9.00e-02	1.00e-02	1.20e-01
Benzo(k)fluoranthene	12	4.04	1.00e+00	5.33e+00	.	.	.
Benzoic acid	12	4.04	2.40e+00	2.60e+01	.	.	.
Bis(2-ethylhexyl)pht	12	8	1.00e-01	3.34e+00	1.20e-01	1.00e-02	1.30e-01
Butylbenzylphthalate	12	4.04	1.00e+00	5.33e+00	.	.	.
Carbazole	11	4.04	1.00e+00	1.30e+00	.	.	.
Chrysene	12	8	8.00e-02	5.33e+00	1.20e-01	1.00e-02	1.50e-01
Fluoranthene	12	11	1.00e-01	5.33e+00	1.60e-01	1.00e-02	1.80e-01
Indeno(1,2,3-cd)pyre	12	1	9.00e-02	5.33e+00	9.00e-02	.	.
Naphthalene	12	7	6.00e-02	5.33e+00	1.00e-01	1.00e-02	1.10e-01
PCB-1254	12	1	1.00e-02	2.79e+00	2.79e+00	.	.
Phenanthrene	12	11	1.00e-01	5.33e+00	1.50e-01	1.00e-02	1.70e-01
Pyrene	12	11	1.10e-01	5.33e+00	1.80e-01	2.00e-02	2.20e-01
Total combustible or	11	11	1.26e+04	5.41e+05	1.18e+05	4.30e+04	1.96e+05
Total organic carbon	11	11	2.11e+04	3.45e+04	2.46e+04	1.15e+03	2.67e+04
Subreach 5							
Bis(2-ethylhexyl)pht	4	3	1.01e+00	4.52e+00	2.85e+00	6.30e-01	4.32e+00
Subreach 7.01							
4-Nitrophenol	1	1	1.40e-01	1.40e-01	1.40e-01	.	.
Benzo(a)anthracene	1	1	3.00e-02	3.00e-02	3.00e-02	.	.
Benzo(a)pyrene	1	1	3.90e-01	3.90e-01	3.90e-01	.	.
Benzo(b)fluoranthene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Benzo(ghi)perylene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Chrysene	1	1	3.00e-02	3.00e-02	3.00e-02	.	.
Indeno(1,2,3-cd)pyre	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Phenanthrene	1	1	3.00e-02	3.00e-02	3.00e-02	.	.
Pyrene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Total combustible or	1	1	7.08e+05	7.08e+05	7.08e+05	.	.
Subreach 7.02							
2-Methylnaphthalene	1	1	1.10e-01	1.10e-01	1.10e-01	.	.
Benzo(a)anthracene	1	1	3.00e-02	3.00e-02	3.00e-02	.	.
Benzo(a)pyrene	1	1	6.40e-01	6.40e-01	6.40e-01	.	.
Benzo(b)fluoranthene	1	1	6.00e-02	6.00e-02	6.00e-02	.	.
Benzo(ghi)perylene	1	1	6.00e-02	6.00e-02	6.00e-02	.	.
Chrysene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Indeno(1,2,3-cd)pyre	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Naphthalene	1	1	6.00e-02	6.00e-02	6.00e-02	.	.
Phenanthrene	1	1	8.00e-02	8.00e-02	8.00e-02	.	.
Pyrene	1	1	1.10e-01	1.10e-01	1.10e-01	.	.
Total combustible or	1	1	6.26e+05	6.26e+05	6.26e+05	.	.
Subreach 8							
2-Methylnaphthalene	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Benzo(a)pyrene	1	1	5.50e-01	5.50e-01	5.50e-01	.	.
Benzo(b)fluoranthene	1	1	7.00e-02	7.00e-02	7.00e-02	.	.
Benzo(ghi)perylene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Chrysene	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Fluoranthene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Indeno(1,2,3-cd)pyre	1	1	7.00e-02	7.00e-02	7.00e-02	.	.
Naphthalene	1	1	3.00e-02	3.00e-02	3.00e-02	.	.
Phenanthrene	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Pyrene	1	1	8.00e-02	8.00e-02	8.00e-02	.	.

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Total combustible or	1	1	5.49e+05	5.49e+05	5.49e+05	.	.
Subreach 13							
2,4-Dimethylphenol	5	1	2.20e-01	2.70e-01	2.70e-01	.	.
2-Methylnaphthalene	5	5	4.00e-02	1.10e+01	2.37e+00	2.16e+00	6.97e+00
Acenaphthene	5	1	1.90e-01	2.70e-01	1.90e-01	.	.
Acenaphthylene	5	1	2.00e-02	1.20e+00	2.00e-02	.	.
Anthracene	5	1	2.00e-02	1.20e+00	2.00e-02	.	.
Benzo(a)anthracene	5	3	6.00e-02	1.20e+00	1.10e-01	3.00e-02	1.80e-01
Benzo(a)pyrene	5	4	6.00e-02	1.20e+00	1.70e-01	7.00e-02	3.00e-01
Benzo(b)fluoranthene	5	4	2.00e-02	3.00e-01	1.50e-01	6.00e-02	2.70e-01
Benzo(ghi)perylene	5	4	7.00e-02	2.30e-01	1.10e-01	3.00e-02	1.70e-01
Benzo(k)fluoranthene	5	2	2.00e-02	1.20e+00	3.00e-02	1.00e-02	5.00e-02
Benzoic acid	5	2	7.00e-02	2.80e+00	9.00e-02	3.00e-02	1.50e-01
Bis(2-ethylhexyl)pht	5	5	3.00e-02	2.70e-01	1.00e-01	4.00e-02	1.90e-01
Carbazole	5	3	2.00e-02	2.70e-01	8.00e-02	6.00e-02	2.20e-01
Chrysene	5	4	7.00e-02	5.50e-01	2.00e-01	9.00e-02	4.00e-01
Dibenz(a,h)anthracen	5	1	2.00e-02	1.20e+00	2.00e-02	.	.
Dibenzofuran	5	4	5.00e-02	2.00e+00	4.50e-01	4.00e-01	1.30e+00
Fluoranthene	5	4	8.00e-02	2.70e-01	1.60e-01	4.00e-02	2.40e-01
Fluorene	5	2	2.00e-02	2.70e-01	8.00e-02	7.00e-02	2.40e-01
Indeno(1,2,3-cd)pyre	5	4	6.00e-02	2.30e-01	9.00e-02	2.00e-02	1.20e-01
Naphthalene	5	5	3.00e-02	8.30e+00	1.76e+00	1.63e+00	5.25e+00
PCB-1254	5	1	1.00e-02	2.00e-02	2.00e-02	.	.
Phenanthrene	5	5	2.00e-02	3.70e+00	8.70e-01	7.10e-01	2.38e+00
Phenol	5	1	5.00e-02	1.20e+00	5.00e-02	.	.
Pyrene	5	4	9.00e-02	6.10e-01	2.50e-01	1.00e-01	4.60e-01
Total combustible or	5	5	3.92e+04	3.96e+05	2.88e+05	6.35e+04	4.23e+05
Total organic carbon	5	5	8.32e+03	1.12e+05	3.18e+04	2.00e+04	7.43e+04

Table B12 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Subreach 18							
Benzo(a)anthracene	3	3	2.00e-01	6.80e-01	3.60e-01	1.60e-01	8.20e-01
Benzo(a)pyrene	3	3	1.30e-01	1.60e-01	1.50e-01	1.00e-02	1.80e-01
Benzo(b)fluoranthene	3	3	2.50e-01	3.10e-01	2.80e-01	2.00e-02	3.30e-01
Chrysene	3	3	1.80e-01	2.30e-01	2.00e-01	2.00e-02	2.50e-01
Fluoranthene	3	3	3.10e-01	4.10e-01	3.60e-01	3.00e-02	4.50e-01
Phenanthrene	3	3	1.10e-01	1.90e-01	1.50e-01	2.00e-02	2.10e-01
Pyrene	3	3	3.10e-01	3.70e-01	3.50e-01	2.00e-02	4.10e-01
Total combustible or	3	3	4.86e+04	8.73e+04	6.67e+04	1.12e+04	9.95e+04
Total organic carbon	3	3	6.16e+03	2.49e+04	1.65e+04	5.48e+03	3.24e+04
Subreach 22							
Bis(2-ethylhexyl)pht	1	1	1.47e+00	1.47e+00	1.47e+00	.	.
Diethylphthalate	1	1	2.99e+00	2.99e+00	2.99e+00	.	.
PCB-1254	1	1	1.59e+00	1.59e+00	1.59e+00	.	.

Table B13. Summary statistics for mass- weighted sediment organic (PCB/pesticide) concentrations (mg/kg) by subreach

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Subreach 0							
2-Methylnaphthalene	5	5	4.00e-02	7.20e-01	2.90e-01	1.50e-01	6.20e-01
Acenaphthene	5	2	2.00e-02	2.30e-01	6.00e-02	4.00e-02	1.60e-01
Anthracene	5	2	1.00e-01	2.30e-01	1.00e-01	0.00e+00	1.00e-01
Benzo(a)anthracene	5	2	9.00e-02	2.30e-01	1.00e-01	1.00e-02	1.20e-01
Benzo(a)pyrene	5	2	9.00e-02	2.30e-01	1.00e-01	1.00e-02	1.10e-01
Benzo(b)fluoranthene	5	4	2.00e-02	2.00e-01	7.00e-02	3.00e-02	1.30e-01
Benzo(ghi)perylene	5	2	5.00e-02	2.30e-01	1.00e-01	4.00e-02	1.90e-01
Benzo(k)fluoranthene	5	2	2.00e-02	2.30e-01	3.00e-02	0.00e+00	4.00e-02
Butylbenzylphthalate	5	1	3.00e-02	2.70e-01	3.00e-02	.	.
Carbazole	5	2	2.00e-02	2.30e-01	2.00e-02	0.00e+00	2.00e-02
Chrysene	5	4	2.00e-02	2.00e-01	7.00e-02	3.00e-02	1.40e-01
Dibenzofuran	5	2	1.40e-01	2.30e-01	1.60e-01	2.00e-02	1.90e-01
Diethylphthalate	5	2	1.20e-01	2.30e-01	1.40e-01	3.00e-02	2.00e-01
Fluoranthene	5	3	2.00e-02	2.00e-01	7.00e-02	3.00e-02	1.30e-01
Fluorene	5	2	5.00e-02	2.30e-01	5.00e-02	0.00e+00	5.00e-02
Indeno(1,2,3-cd)pyre	5	1	1.90e-01	2.70e-01	1.90e-01	.	.
Naphthalene	5	5	2.00e-02	4.10e-01	1.70e-01	9.00e-02	3.60e-01
Phenanthrene	5	5	3.00e-02	4.20e-01	1.70e-01	9.00e-02	3.60e-01
Pyrene	5	5	2.00e-02	1.40e-01	7.00e-02	3.00e-02	1.30e-01
Total combustible or	5	5	5.29e+04	4.29e+05	2.95e+05	6.59e+04	4.35e+05
Total organic carbon	5	5	9.83e+03	2.17e+04	1.54e+04	2.42e+03	2.06e+04
Subreach 1							
4,4'-DDD	2	1	1.30e-01	3.80e-01	1.30e-01	.	.
4,4'-DDT	2	1	1.30e-01	3.80e-01	1.30e-01	.	.
Benzo(a)anthracene	2	1	5.20e-01	7.90e-01	7.90e-01	.	.
Benzo(k)fluoranthene	2	1	5.20e-01	7.90e-01	7.90e-01	.	.
Chrysene	2	1	5.20e-01	7.90e-01	7.90e-01	.	.

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Fluoranthene	2	1	5.20e-01	8.20e-01	8.20e-01	.	.
Pyrene	2	1	5.20e-01	8.10e-01	8.10e-01	.	.
Subreach 2.01							
Bis(2-ethylhexyl)pht	1	1	2.00e-02	2.00e-02	2.00e-02	.	.
Total Combustible Or	1	1	1.81e+04	1.81e+04	1.81e+04	.	.
Total Organic Carbon	1	1	3.82e+03	3.82e+03	3.82e+03	.	.
Subreach 2.02							
Benzo(a)anthracene	1	1	4.90e-01	4.90e-01	4.90e-01	.	.
Benzo(a)pyrene	1	1	4.90e-01	4.90e-01	4.90e-01	.	.
Benzo(b)fluoranthene	1	1	4.80e-01	4.80e-01	4.80e-01	.	.
Benzo(k)fluoranthene	1	1	5.00e-01	5.00e-01	5.00e-01	.	.
Bis(2-ethylhexyl)pht	1	1	4.10e-01	4.10e-01	4.10e-01	.	.
Chrysene	1	1	4.90e-01	4.90e-01	4.90e-01	.	.
Di-n-butylphthalate	1	1	4.80e-01	4.80e-01	4.80e-01	.	.
Diethylphthalate	1	1	4.80e-01	4.80e-01	4.80e-01	.	.
Fluoranthene	1	1	4.20e-01	4.20e-01	4.20e-01	.	.
Indeno(1,2,3-cd)pyre	1	1	4.90e-01	4.90e-01	4.90e-01	.	.
PCB-1254	1	1	2.10e+00	2.10e+00	2.10e+00	.	.
PCB-1260	1	1	2.10e+00	2.10e+00	2.10e+00	.	.
Phenanthrene	1	1	4.80e-01	4.80e-01	4.80e-01	.	.
Pyrene	1	1	4.30e-01	4.30e-01	4.30e-01	.	.
Toxaphene	1	1	2.10e+00	2.10e+00	2.10e+00	.	.
Subreach 2.03							
4-Nitrophenol	1	1	2.60e-01	2.60e-01	2.60e-01	.	.
Bis(2-ethylhexyl)pht	1	1	3.00e-02	3.00e-02	3.00e-02	.	.
Diethylphthalate	1	1	1.40e-01	1.40e-01	1.40e-01	.	.
Heptachlor	1	1	0.00e+00	0.00e+00	0.00e+00	.	.

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Pentachlorophenol	1	1	2.40e-01	2.40e-01	2.40e-01	.	.
Pyrene	1	1	1.10e-01	1.10e-01	1.10e-01	.	.
Total combustible or	1	1	2.04e+04	2.04e+04	2.04e+04	.	.
Total organic carbon	1	1	3.99e+03	3.99e+03	3.99e+03	.	.
Subreach 2.04							
2-Methylnaphthalene	7	5	3.00e-02	4.40e-01	1.10e-01	6.00e-02	2.20e-01
4-Methylphenol	7	1	1.60e-01	5.00e-01	1.60e-01	.	.
4-Nitrophenol	7	2	1.90e-01	2.44e+00	2.30e-01	4.00e-02	3.00e-01
Benzo(a)anthracene	7	2	1.00e-01	5.00e-01	1.00e-01	1.00e-02	1.10e-01
Benzo(a)pyrene	7	4	3.00e-02	5.00e-01	1.90e-01	8.00e-02	3.40e-01
Benzo(b)fluoranthene	7	5	2.00e-02	5.00e-01	8.00e-02	2.00e-02	1.20e-01
Benzo(ghi)perylene	7	4	6.00e-02	5.00e-01	1.00e-01	2.00e-02	1.50e-01
Benzo(k)fluoranthene	7	1	3.00e-02	5.00e-01	3.00e-02	.	.
Bis(2-ethylhexyl)pht	7	4	5.00e-02	5.90e-01	1.40e-01	8.00e-02	3.00e-01
Chrysene	7	5	2.00e-02	5.00e-01	9.00e-02	2.00e-02	1.40e-01
Di-n-butylphthalate	7	2	2.00e-01	4.40e-01	3.90e-01	1.00e-02	4.10e-01
Dibenzofuran	7	1	3.00e-02	5.00e-01	3.00e-02	.	.
Diethylphthalate	7	1	3.00e-02	5.00e-01	3.00e-02	.	.
Fluoranthene	7	6	3.00e-02	3.30e-01	1.40e-01	4.00e-02	2.20e-01
Fluorene	7	1	1.10e-01	5.00e-01	1.10e-01	.	.
Indeno(1,2,3-cd)pyre	7	4	5.00e-02	5.00e-01	1.00e-01	2.00e-02	1.50e-01
Naphthalene	7	5	2.00e-02	4.70e-01	9.00e-02	7.00e-02	2.20e-01
Pentachlorophenol	6	2	1.70e-01	2.44e+00	2.20e-01	5.00e-02	3.10e-01
Phenanthrene	7	5	2.00e-02	3.30e-01	1.00e-01	4.00e-02	1.90e-01
Pyrene	7	4	3.00e-02	3.60e-01	1.00e-01	5.00e-02	2.00e-01
Total combustible or	6	6	2.93e+05	4.24e+05	3.42e+05	1.91e+04	3.80e+05
Total organic carbon	6	6	4.05e+03	1.39e+04	1.09e+04	1.56e+03	1.40e+04
Subreach 3.01							

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
2-Methylnaphthalene	2	1	2.00e-02	2.10e-01	2.00e-02	.	.
Acenaphthene	2	1	7.00e-02	2.10e-01	7.00e-02	.	.
Anthracene	2	1	7.00e-02	2.10e-01	7.00e-02	.	.
Benzo(a)anthracene	2	1	2.10e-01	2.20e-01	2.20e-01	.	.
Benzo(a)pyrene	2	1	1.10e-01	2.10e-01	1.10e-01	.	.
Benzo(b)fluoranthene	2	2	1.60e-01	3.20e-01	2.40e-01	8.00e-02	7.30e-01
Benzo(ghi)perylene	2	1	6.00e-02	2.10e-01	6.00e-02	.	.
Benzo(k)fluoranthene	2	1	9.00e-02	2.10e-01	9.00e-02	.	.
Bis(2-ethylhexyl)pht	2	2	3.00e-02	3.00e-02	3.00e-02	0.00e+00	6.00e-02
Carbazole	2	1	6.00e-02	2.10e-01	6.00e-02	.	.
Chrysene	2	2	1.60e-01	1.80e-01	1.70e-01	1.00e-02	2.40e-01
Di-n-butylphthalate	2	1	2.00e-02	4.60e-01	2.00e-02	.	.
Dibenzofuran	2	1	6.00e-02	2.10e-01	6.00e-02	.	.
Diethylphthalate	2	1	8.00e-02	2.60e-01	8.00e-02	.	.
Fluoranthene	2	2	1.60e-01	4.20e-01	2.90e-01	1.30e-01	1.10e+00
Fluorene	2	1	7.00e-02	2.10e-01	7.00e-02	.	.
Heptachlor	2	1	0.00e+00	0.00e+00	0.00e+00	.	.
Indeno(1,2,3-cd)pyre	2	1	6.00e-02	2.10e-01	6.00e-02	.	.
PCB-1254	2	1	1.00e-02	5.00e-02	5.00e-02	.	.
PCB-1260	2	1	1.00e-02	3.00e-02	3.00e-02	.	.
Pentachlorophenol	2	1	1.50e-01	6.20e-01	1.50e-01	.	.
Phenanthrene	2	2	1.60e-01	1.80e-01	1.70e-01	1.00e-02	2.20e-01
Pyrene	2	2	3.00e-02	4.20e-01	2.20e-01	2.00e-01	1.48e+00
Total combustible or	2	2	3.35e+04	4.70e+05	2.52e+05	2.18e+05	1.63e+06
Total organic carbon	2	2	6.29e+03	1.98e+04	1.30e+04	6.76e+03	5.57e+04
Subreach 3.02							
2-Methylnaphthalene	9	8	5.00e-02	4.10e-01	1.10e-01	2.00e-02	1.40e-01
4-Chloro-3-methylph e	9	1	2.10e-01	4.10e-01	2.10e-01	.	.

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Acenaphthene	9	5	4.00e-02	4.10e-01	1.30e-01	3.00e-02	1.90e-01
Acenaphthylene	9	3	2.00e-02	4.10e-01	8.00e-02	3.00e-02	1.30e-01
Anthracene	9	5	3.00e-02	4.10e-01	1.20e-01	4.00e-02	1.80e-01
Benzo(a)anthracene	9	7	5.00e-02	9.50e-01	2.40e-01	1.00e-01	4.30e-01
Benzo(a)pyrene	9	8	4.00e-02	5.70e-01	2.00e-01	6.00e-02	3.10e-01
Benzo(b)fluoranthene	9	8	6.00e-02	9.80e-01	2.80e-01	1.00e-01	4.70e-01
Benzo(ghi)perylene	9	6	4.00e-02	4.10e-01	1.30e-01	3.00e-02	1.80e-01
Benzo(k)fluoranthene	9	8	2.00e-02	4.10e-01	1.70e-01	5.00e-02	2.60e-01
Bis(2-ethylhexyl)pht	9	4	1.20e-01	4.70e-01	2.00e-01	5.00e-02	3.00e-01
Butylbenzylphthalate	9	5	2.00e-02	4.10e-01	8.00e-02	4.00e-02	1.40e-01
Carbazole	8	6	3.00e-02	2.30e-01	1.10e-01	3.00e-02	1.50e-01
Chrysene	9	7	5.00e-02	7.20e-01	2.00e-01	7.00e-02	3.40e-01
Dibenz(a,h)anthracen	9	4	3.00e-02	4.10e-01	7.00e-02	2.00e-02	1.00e-01
Dibenzofuran	9	7	4.00e-02	4.10e-01	1.30e-01	2.00e-02	1.70e-01
Fluoranthene	9	8	7.00e-02	1.38e+00	3.80e-01	1.40e-01	6.40e-01
Fluorene	9	4	4.00e-02	4.10e-01	1.40e-01	4.00e-02	2.10e-01
Indeno(1,2,3-cd)pyre	9	7	1.30e-01	4.10e-01	1.70e-01	2.00e-02	2.20e-01
Naphthalene	9	7	3.00e-02	4.10e-01	8.00e-02	2.00e-02	1.10e-01
PCB-1248	9	3	1.00e-02	3.90e-01	7.00e-02	3.00e-02	1.20e-01
PCB-1254	9	8	1.00e-02	1.03e+00	3.30e-01	1.20e-01	5.60e-01
PCB-1260	9	6	1.00e-02	7.90e-01	1.40e-01	4.00e-02	2.20e-01
Phenanthrene	9	8	4.00e-02	1.40e+00	3.30e-01	1.40e-01	5.90e-01
Phenol	9	2	1.70e-01	4.10e-01	2.00e-01	2.00e-02	2.40e-01
Pyrene	9	8	8.00e-02	1.29e+00	3.50e-01	1.30e-01	5.90e-01
Total combustible or	8	8	3.04e+03	3.99e+05	1.26e+05	5.84e+04	2.36e+05
Total organic carbon	5	5	9.68e+03	1.95e+05	5.11e+04	3.59e+04	1.28e+05
Subreach 3.03							
2-Methylnaphthalene	9	9	4.00e-02	3.50e-01	1.30e-01	3.00e-02	1.90e-01
4-Methylphenol	9	1	2.00e-01	2.90e-01	2.00e-01	.	.

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Acenaphthene	9	7	2.00e-02	2.50e-01	6.00e-02	3.00e-02	1.10e-01
Acenaphthylene	9	4	1.00e-01	2.60e-01	1.10e-01	1.00e-02	1.20e-01
Anthracene	9	7	3.00e-02	2.50e-01	7.00e-02	3.00e-02	1.20e-01
Benzo(a)anthracene	9	9	6.00e-02	2.60e-01	1.60e-01	2.00e-02	2.00e-01
Benzo(a)pyrene	9	9	4.00e-02	4.10e-01	1.50e-01	4.00e-02	2.40e-01
Benzo(b)fluoranthene	9	9	6.00e-02	4.30e-01	2.20e-01	4.00e-02	2.90e-01
Benzo(ghi)perylene	9	9	3.00e-02	3.00e-01	9.00e-02	3.00e-02	1.50e-01
Benzo(k)fluoranthene	9	9	2.00e-02	2.80e-01	7.00e-02	3.00e-02	1.20e-01
Benzoic acid	9	1	5.50e-01	7.10e-01	6.10e-01	.	.
Bis(2-ethylhexyl)pht	9	4	1.20e-01	3.60e-01	1.60e-01	2.00e-02	1.90e-01
Butylbenzylphthalate	9	1	2.00e-02	2.90e-01	2.00e-02	.	.
Carbazole	9	8	2.00e-02	2.50e-01	1.10e-01	3.00e-02	1.60e-01
Chrysene	9	9	6.00e-02	2.40e-01	1.50e-01	2.00e-02	1.90e-01
Di-n-octylphthlate	9	1	2.00e-01	2.90e-01	2.00e-01	.	.
Dibenz(a,h)anthracen	9	7	2.00e-02	2.50e-01	9.00e-02	3.00e-02	1.50e-01
Dibenzofuran	9	8	2.00e-02	2.50e-01	6.00e-02	1.00e-02	9.00e-02
Diethylphthalate	9	1	2.20e-01	2.90e-01	2.40e-01	.	.
Fluoranthene	9	9	8.00e-02	4.80e-01	2.80e-01	5.00e-02	3.70e-01
Fluorene	9	6	2.00e-02	2.50e-01	1.20e-01	3.00e-02	1.80e-01
Indeno(1,2,3-cd)pyre	9	9	3.00e-02	3.20e-01	1.00e-01	3.00e-02	1.60e-01
Methoxychlor	9	1	0.00e+00	4.00e-02	4.00e-02	.	.
Naphthalene	9	9	3.00e-02	2.10e-01	1.00e-01	2.00e-02	1.40e-01
PCB-1248	9	1	1.00e-02	1.70e-01	1.70e-01	.	.
PCB-1254	9	9	0.00e+00	6.20e-01	2.40e-01	6.00e-02	3.50e-01
PCB-1260	9	8	1.00e-02	2.10e-01	1.10e-01	2.00e-02	1.50e-01
Phenanthrene	9	9	7.00e-02	3.80e-01	2.10e-01	4.00e-02	2.80e-01
Phenol	9	1	2.10e-01	2.80e-01	2.10e-01	.	.
Pyrene	9	9	1.00e-01	3.90e-01	2.60e-01	3.00e-02	3.20e-01
Total combustible or	9	9	3.73e+03	4.42e+05	2.63e+05	5.60e+04	3.67e+05
Total organic carbon	1	1	1.70e+04	1.70e+04	1.70e+04	.	.

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Subreach 3.04							
1,4-Dichlorobenzene	7	1	2.10e-01	4.80e-01	2.30e-01	.	.
2-Methylnaphthalene	7	7	4.00e-02	4.40e-01	1.40e-01	6.00e-02	2.50e-01
4-Chloro-3-methylph	7	1	1.90e-01	4.80e-01	1.90e-01	.	.
4-Methylphenol	7	1	2.10e-01	4.80e-01	2.80e-01	.	.
Acenaphthene	7	3	1.50e-01	4.80e-01	1.70e-01	1.00e-02	1.90e-01
Acenaphthylene	7	2	1.70e-01	4.80e-01	1.80e-01	1.00e-02	2.00e-01
Anthracene	7	4	2.00e-02	4.70e-01	1.60e-01	7.00e-02	2.90e-01
Benzo(a)anthracene	7	7	6.00e-02	4.70e-01	1.60e-01	5.00e-02	2.60e-01
Benzo(a)pyrene	7	7	6.00e-02	4.70e-01	1.80e-01	6.00e-02	2.90e-01
Benzo(b)fluoranthene	7	7	7.00e-02	4.60e-01	2.00e-01	5.00e-02	2.90e-01
Benzo(ghi)perylene	7	4	1.00e-01	4.80e-01	1.40e-01	3.00e-02	1.90e-01
Benzo(k)fluoranthene	7	4	4.00e-02	4.70e-01	1.60e-01	7.00e-02	2.90e-01
Bis(2-ethylhexyl)phta	7	5	3.00e-02	9.70e-01	2.10e-01	1.50e-01	5.10e-01
Butylbenzylphthalate	7	2	1.70e-01	4.80e-01	1.80e-01	2.00e-02	2.10e-01
Carbazole	6	3	6.00e-02	2.50e-01	1.40e-01	4.00e-02	2.30e-01
Chrysene	7	7	7.00e-02	4.70e-01	1.50e-01	5.00e-02	2.60e-01
Di-n-butylphthalate	7	1	2.20e-01	6.00e-01	4.70e-01	.	.
Dibenz(a,h)anthracen	7	3	2.00e-02	4.80e-01	1.30e-01	6.00e-02	2.40e-01
Dibenzofuran	7	4	7.00e-02	4.80e-01	1.50e-01	4.00e-02	2.20e-01
Diethylphthalate	7	5	8.00e-02	4.70e-01	1.40e-01	3.00e-02	2.00e-01
Dimethylphthalate	7	1	2.10e-01	4.80e-01	4.80e-01	.	.
Fluoranthene	7	7	7.00e-02	3.60e-01	1.70e-01	4.00e-02	2.40e-01
Fluorene	7	4	3.00e-02	4.80e-01	1.50e-01	4.00e-02	2.40e-01
Indeno(1,2,3-cd)pyre	7	4	6.00e-02	4.80e-01	1.20e-01	3.00e-02	1.90e-01
Naphthalene	7	7	3.00e-02	4.60e-01	1.60e-01	5.00e-02	2.70e-01
PCB-1248	7	2	1.00e-02	1.12e+00	3.00e-02	1.00e-02	5.00e-02
PCB-1254	7	6	1.00e-02	2.27e+00	7.00e-02	3.00e-02	1.20e-01
PCB-1260	7	5	1.00e-02	2.27e+00	6.00e-02	1.00e-02	9.00e-02

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Phenanthrene	7	7	7.00e-02	3.80e-01	1.60e-01	4.00e-02	2.40e-01
Phenol	7	1	7.00e-02	4.80e-01	7.00e-02	.	.
Pyrene	7	7	7.00e-02	3.90e-01	1.90e-01	4.00e-02	2.70e-01
Total combustible or	6	6	4.10e+04	3.42e+05	1.77e+05	5.62e+04	2.90e+05
Total organic carbon	4	4	5.95e+03	1.35e+04	1.05e+04	1.68e+03	1.45e+04
Subreach 4.01							
2-Methylnaphthalene	10	7	4.00e-02	5.00e-01	8.00e-02	2.00e-02	1.10e-01
Acenaphthene	10	1	1.20e-01	5.00e-01	1.20e-01	.	.
Anthracene	10	1	1.20e-01	5.00e-01	1.20e-01	.	.
Benzo(a)anthracene	10	6	8.00e-02	5.00e-01	1.70e-01	3.00e-02	2.30e-01
Benzo(a)pyrene	10	6	1.00e-02	5.00e-01	3.00e-02	1.00e-02	5.00e-02
Benzo(b)fluoranthene	10	6	4.00e-02	5.00e-01	7.00e-02	1.00e-02	9.00e-02
Benzo(ghi)perylene	10	4	6.00e-02	5.00e-01	1.30e-01	4.00e-02	2.20e-01
Benzo(k)fluoranthene	10	1	1.70e-01	5.00e-01	1.70e-01	.	.
Bis(2-ethylhexyl)pht	10	10	2.00e-02	9.70e-01	1.90e-01	9.00e-02	3.50e-01
Butylbenzylphthalate	10	3	2.00e-02	5.00e-01	9.00e-02	4.00e-02	1.70e-01
Carbazole	9	1	1.20e-01	4.00e-01	1.20e-01	.	.
Chrysene	10	7	3.00e-02	5.00e-01	1.30e-01	4.00e-02	2.00e-01
Dibenz(a,h)anthracen	10	1	1.20e-01	5.00e-01	1.20e-01	.	.
Dibenzofuran	10	5	2.00e-02	5.00e-01	9.00e-02	4.00e-02	1.60e-01
Diethylphthalate	10	1	4.00e-02	5.00e-01	4.00e-02	.	.
Fluoranthene	10	8	5.00e-02	4.90e-01	1.40e-01	4.00e-02	2.20e-01
Fluorene	10	1	1.50e-01	5.00e-01	1.50e-01	.	.
Heptachlor	10	7	0.00e+00	1.00e-01	0.00e+00	0.00e+00	0.00e+00
Indeno(1,2,3-cd)pyre	10	3	7.00e-02	5.00e-01	1.50e-01	5.00e-02	2.50e-01
N-Nitroso-di-n-propy	10	1	2.00e-01	5.00e-01	5.00e-01	.	.
Naphthalene	10	7	2.00e-02	5.00e-01	4.00e-02	1.00e-02	5.00e-02
PCB-1254	10	8	0.00e+00	4.00e-01	6.00e-02	4.00e-02	1.30e-01
PCB-1260	10	5	1.00e-02	2.06e+00	2.00e-02	0.00e+00	2.00e-02

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Pentachlorophenol	10	1	4.40e-01	2.42e+00	4.40e-01	.	.
Phenanthrene	10	8	5.00e-02	5.00e-01	1.30e-01	4.00e-02	2.10e-01
Phenol	10	1	1.80e-01	5.00e-01	1.80e-01	.	.
Pyrene	10	8	4.00e-02	4.90e-01	1.40e-01	4.00e-02	2.20e-01
Total combustible or	9	9	2.28e+04	5.50e+04	4.05e+04	3.07e+03	4.62e+04
Total organic carbon	8	8	6.16e+03	1.22e+04	9.53e+03	7.93e+02	1.10e+04
Subreach 4.02							
2-Methylnaphthalene	6	5	2.00e-02	3.00e-01	1.00e-01	5.00e-02	1.90e-01
Acenaphthene	6	1	1.30e-01	2.50e-01	1.30e-01	.	.
Anthracene	6	1	3.00e-02	2.50e-01	3.00e-02	.	.
Benzo(a)anthracene	6	4	7.00e-02	2.10e-01	1.10e-01	3.00e-02	1.60e-01
Benzo(a)pyrene	6	4	3.00e-02	6.90e-01	1.60e-01	1.10e-01	3.90e-01
Benzo(b)fluoranthene	6	5	2.00e-02	2.40e-01	1.00e-01	3.00e-02	1.70e-01
Benzo(ghi)perylene	6	4	6.00e-02	2.10e-01	8.00e-02	1.00e-02	1.00e-01
Benzo(k)fluoranthene	6	2	3.00e-02	2.10e-01	4.00e-02	2.00e-02	8.00e-02
Bis(2-ethylhexyl)pht	6	3	4.00e-02	2.50e-01	7.00e-02	2.00e-02	1.20e-01
Butylbenzylphthalate	6	1	1.70e-01	2.50e-01	1.70e-01	.	.
Carbazole	6	1	2.00e-02	2.50e-01	2.00e-02	.	.
Chrysene	6	4	4.00e-02	2.10e-01	1.00e-01	3.00e-02	1.60e-01
Dibenz(a,h)anthracen	6	2	2.00e-02	2.10e-01	2.00e-02	0.00e+00	2.00e-02
Dibenzofuran	6	2	6.00e-02	2.50e-01	7.00e-02	0.00e+00	8.00e-02
Diethylphthalate	6	1	1.60e-01	2.50e-01	1.60e-01	.	.
Fluoranthene	6	4	6.00e-02	2.90e-01	1.30e-01	4.00e-02	2.00e-01
Fluorene	6	1	3.00e-02	2.50e-01	3.00e-02	.	.
Indeno(1,2,3-cd)pyre	6	4	6.00e-02	2.10e-01	8.00e-02	1.00e-02	1.10e-01
Naphthalene	6	4	2.00e-02	2.50e-01	1.00e-01	3.00e-02	1.60e-01
PCB-1254	6	5	1.00e-02	4.00e-02	2.00e-02	1.00e-02	3.00e-02
PCB-1260	6	3	1.00e-02	3.00e-02	1.00e-02	1.00e-02	2.00e-02
Pentachlorophenol	6	1	3.00e-01	6.20e-01	3.00e-01	.	.

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Phenanthrene	6	5	2.00e-02	2.80e-01	1.00e-01	4.00e-02	1.80e-01
Pyrene	6	5	2.00e-02	2.50e-01	9.00e-02	4.00e-02	1.60e-01
Total combustible or	6	6	2.20e+05	3.93e+05	2.97e+05	3.20e+04	3.62e+05
Total organic carbon	6	6	5.17e+03	2.20e+04	1.13e+04	2.44e+03	1.62e+04
Subreach 4.03							
2-Methylnaphthalene	7	7	6.00e-02	2.30e-01	1.20e-01	2.00e-02	1.70e-01
Acenaphthene	7	1	1.10e-01	2.70e-01	1.10e-01	.	.
Anthracene	7	1	1.10e-01	2.70e-01	1.10e-01	.	.
Benzo(a)anthracene	7	7	5.00e-02	1.80e-01	8.00e-02	2.00e-02	1.20e-01
Benzo(a)pyrene	7	7	4.00e-02	5.70e-01	3.40e-01	8.00e-02	4.90e-01
Benzo(b)fluoranthene	7	7	4.00e-02	1.80e-01	9.00e-02	2.00e-02	1.20e-01
Benzo(ghi)perylene	7	7	3.00e-02	9.00e-02	5.00e-02	1.00e-02	6.00e-02
Benzo(k)fluoranthene	7	7	2.00e-02	1.80e-01	6.00e-02	2.00e-02	1.00e-01
Bis(2-ethylhexyl)pht	7	7	5.00e-02	2.80e-01	1.30e-01	3.00e-02	1.80e-01
Butylbenzylphthalate	7	3	3.00e-02	2.70e-01	1.20e-01	5.00e-02	2.20e-01
Chrysene	7	7	3.00e-02	1.30e-01	7.00e-02	1.00e-02	9.00e-02
Dibenz(a,h)anthracen	7	3	2.00e-02	2.70e-01	1.00e-01	4.00e-02	1.80e-01
Dibenzofuran	7	6	2.00e-02	2.10e-01	8.00e-02	3.00e-02	1.40e-01
Diethylphthalate	7	1	1.00e-01	2.90e-01	1.00e-01	.	.
Fluoranthene	7	7	4.00e-02	1.60e-01	1.00e-01	1.00e-02	1.20e-01
Fluorene	7	1	3.00e-02	2.70e-01	3.00e-02	.	.
Indeno(1,2,3-cd)pyre	7	7	3.00e-02	9.00e-02	5.00e-02	1.00e-02	6.00e-02
Naphthalene	7	7	3.00e-02	1.70e-01	8.00e-02	2.00e-02	1.20e-01
PCB-1254	7	6	1.00e-02	8.00e-02	4.00e-02	1.00e-02	6.00e-02
PCB-1260	7	6	1.00e-02	4.00e-02	3.00e-02	0.00e+00	3.00e-02
Pentachlorophenol	7	1	3.50e-01	7.00e-01	3.50e-01	.	.
Phenanthrene	7	7	2.00e-02	2.00e-01	9.00e-02	2.00e-02	1.40e-01
Pyrene	7	7	4.00e-02	1.70e-01	1.00e-01	2.00e-02	1.30e-01
Total combustible or	7	7	2.83e+05	4.78e+05	3.73e+05	2.73e+04	4.26e+05

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Total organic carbon	7	7	9.03e+03	2.25e+04	1.64e+04	1.88e+03	2.00e+04
Subreach 4.04							
2-Methylnaphthalene	12	11	7.00e-02	3.54e+00	2.20e-01	7.00e-02	3.50e-01
Benzo(a)anthracene	12	10	7.00e-02	3.54e+00	1.70e-01	8.00e-02	3.00e-01
Benzo(a)pyrene	12	8	6.00e-02	3.54e+00	7.70e-01	1.40e-01	1.02e+00
Benzo(b)fluoranthene	12	11	9.00e-02	3.54e+00	1.40e-01	1.00e-02	1.60e-01
Benzo(ghi)perylene	12	6	7.00e-02	3.54e+00	3.50e-01	1.30e-01	5.90e-01
Bis(2-ethylhexyl)pht	12	8	7.00e-02	1.87e+00	1.00e-01	1.00e-02	1.20e-01
Chrysene	12	8	7.00e-02	3.54e+00	1.10e-01	1.00e-02	1.30e-01
Dibenz(a,h)anthracen	12	1	4.10e-01	3.54e+00	4.10e-01	.	.
Fluoranthene	12	11	9.00e-02	3.54e+00	1.40e-01	1.00e-02	1.60e-01
Indeno(1,2,3-cd)pyre	12	2	4.50e-01	3.54e+00	6.30e-01	1.80e-01	9.60e-01
Naphthalene	12	8	5.00e-02	3.54e+00	2.10e-01	9.00e-02	3.70e-01
PCB-1254	12	1	1.00e-02	9.80e-01	9.80e-01	.	.
Phenanthrene	12	11	1.00e-01	3.54e+00	1.50e-01	1.00e-02	1.80e-01
Pyrene	12	11	1.00e-01	3.54e+00	1.60e-01	1.00e-02	1.80e-01
Total combustible or	11	11	1.26e+04	5.41e+05	1.17e+05	4.29e+04	1.95e+05
Total organic carbon	11	11	2.13e+04	4.59e+04	2.64e+04	2.23e+03	3.05e+04
Subreach 5							
Bis(2-ethylhexyl)pht	4	3	8.40e-01	2.43e+00	1.95e+00	2.30e-01	2.49e+00
Subreach 7.01							
2-Methylnaphthalene	1	1	1.50e-01	1.50e-01	1.50e-01	.	.
4-Nitrophenol	1	1	5.70e-01	5.70e-01	5.70e-01	.	.
Benzo(a)anthracene	1	1	2.20e-01	2.20e-01	2.20e-01	.	.
Benzo(a)pyrene	1	1	4.60e-01	4.60e-01	4.60e-01	.	.
Benzo(b)fluoranthene	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Benzo(ghi)perylene	1	1	4.00e-02	4.00e-02	4.00e-02	.	.

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Chrysene	1	1	3.00e-02	3.00e-02	3.00e-02	.	.
Indeno(1,2,3-cd)pyre	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Phenanthrene	1	1	3.00e-02	3.00e-02	3.00e-02	.	.
Pyrene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Total combustible or	1	1	5.72e+05	5.72e+05	5.72e+05	.	.
Subreach 7.02							
2-Methylnaphthalene	1	1	7.00e-02	7.00e-02	7.00e-02	.	.
Benzo(a)anthracene	1	1	1.90e-01	1.90e-01	1.90e-01	.	.
Benzo(a)pyrene	1	1	6.30e-01	6.30e-01	6.30e-01	.	.
Benzo(b)fluoranthene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Benzo(ghi)perylene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Chrysene	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Fluoranthene	1	1	1.70e-01	1.70e-01	1.70e-01	.	.
Indeno(1,2,3-cd)pyre	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Naphthalene	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Phenanthrene	1	1	5.00e-02	5.00e-02	5.00e-02	.	.
Pyrene	1	1	7.00e-02	7.00e-02	7.00e-02	.	.
Total combustible or	1	1	5.69e+05	5.69e+05	5.69e+05	.	.
Subreach 8							
2-Methylnaphthalene	1	1	2.00e-02	2.00e-02	2.00e-02	.	.
Benzo(a)pyrene	1	1	4.60e-01	4.60e-01	4.60e-01	.	.
Benzo(b)fluoranthene	1	1	3.00e-02	3.00e-02	3.00e-02	.	.
Benzo(ghi)perylene	1	1	2.00e-01	2.00e-01	2.00e-01	.	.
Chrysene	1	1	1.90e-01	1.90e-01	1.90e-01	.	.
Fluoranthene	1	1	2.00e-01	2.00e-01	2.00e-01	.	.
Indeno(1,2,3-cd)pyre	1	1	2.00e-01	2.00e-01	2.00e-01	.	.
Naphthalene	1	1	1.90e-01	1.90e-01	1.90e-01	.	.
Phenanthrene	1	1	3.00e-02	3.00e-02	3.00e-02	.	.

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Pyrene	1	1	4.00e-02	4.00e-02	4.00e-02	.	.
Total combustible or	1	1	6.98e+05	6.98e+05	6.98e+05	.	.
Subreach 10							
Anthracene	1	1	4.18e+00	4.18e+00	4.18e+00	.	.
Bis(2-ethylhexyl)pht	1	1	3.29e+00	3.29e+00	3.29e+00	.	.
Chrysene	1	1	4.20e+00	4.20e+00	4.20e+00	.	.
Fluoranthene	1	1	4.19e+00	4.19e+00	4.19e+00	.	.
Phenanthrene	1	1	4.19e+00	4.19e+00	4.19e+00	.	.
Pyrene	1	1	4.19e+00	4.19e+00	4.19e+00	.	.
Subreach 13							
2,4-Dimethylphenol	5	1	2.20e-01	2.40e-01	2.40e-01	.	.
2-Methylnaphthalene	5	5	5.00e-02	1.66e+00	4.20e-01	3.10e-01	1.08e+00
Acenaphthene	5	1	2.20e-01	2.40e-01	2.20e-01	.	.
Acenaphthylene	5	1	1.50e-01	3.70e-01	1.50e-01	.	.
Anthracene	5	1	1.60e-01	3.70e-01	1.60e-01	.	.
Benzo(a)anthracene	5	3	1.10e-01	3.70e-01	1.60e-01	2.00e-02	2.00e-01
Benzo(a)pyrene	5	5	4.00e-02	4.40e-01	2.60e-01	9.00e-02	4.40e-01
Benzo(b)fluoranthene	5	4	4.00e-02	2.40e-01	8.00e-02	2.00e-02	1.30e-01
Benzo(ghi)perylene	5	4	4.00e-02	2.30e-01	1.50e-01	4.00e-02	2.40e-01
Benzo(k)fluoranthene	5	2	2.00e-02	3.70e-01	3.00e-02	1.00e-02	5.00e-02
Benzoic acid	5	2	1.30e-01	8.80e-01	2.50e-01	1.20e-01	5.10e-01
Bis(2-ethylhexyl)pht	5	5	5.00e-02	9.00e-02	7.00e-02	1.00e-02	9.00e-02
Butylbenzylphthalate	5	4	9.00e-02	2.40e-01	1.50e-01	3.00e-02	2.20e-01
Carbazole	5	3	1.50e-01	2.40e-01	1.80e-01	2.00e-02	2.30e-01
Chrysene	5	4	4.00e-02	2.30e-01	7.00e-02	2.00e-02	1.10e-01
Di-n-butylphthalate	5	1	1.10e-01	4.30e-01	1.10e-01	.	.
Dibenz(a,h)anthracen	5	1	1.50e-01	3.70e-01	1.50e-01	.	.
Dibenzofuran	5	4	1.60e-01	4.90e-01	2.30e-01	7.00e-02	3.70e-01

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Fluoranthene	5	4	4.00e-02	2.40e-01	1.10e-01	4.00e-02	2.00e-01
Fluorene	5	2	1.50e-01	2.40e-01	1.70e-01	3.00e-02	2.30e-01
Indeno(1,2,3-cd)pyre	5	4	4.00e-02	2.30e-01	1.50e-01	4.00e-02	2.30e-01
Naphthalene	5	5	4.00e-02	1.25e+00	3.10e-01	2.40e-01	8.10e-01
PCB-1254	5	1	1.00e-02	1.00e-02	1.00e-02	.	.
Phenanthrene	5	5	4.00e-02	5.70e-01	1.90e-01	1.00e-01	3.90e-01
Phenol	5	1	1.70e-01	3.70e-01	1.70e-01	.	.
Pyrene	5	4	5.00e-02	2.30e-01	1.10e-01	3.00e-02	1.80e-01
Total combustible or	5	5	3.78e+04	3.50e+05	2.66e+05	5.83e+04	3.91e+05
Total organic carbon	5	5	8.20e+03	8.92e+04	2.58e+04	1.59e+04	5.96e+04
Subreach 18							
4,4'-DDD	3	1	0.00e+00	0.00e+00	0.00e+00	.	.
Anthracene	3	1	5.90e-01	1.15e+00	5.90e-01	.	.
Benzo(a)anthracene	3	3	1.70e-01	6.70e-01	4.80e-01	1.60e-01	9.40e-01
Benzo(a)pyrene	3	3	1.20e-01	4.50e-01	3.40e-01	1.10e-01	6.60e-01
Benzo(b)fluoranthene	3	3	2.00e-01	6.60e-01	3.60e-01	1.50e-01	7.90e-01
Benzo(ghi)perylene	3	1	7.50e-01	1.23e+00	7.50e-01	.	.
Carbazole	3	1	5.00e-01	1.23e+00	5.00e-01	.	.
Chrysene	3	3	1.40e-01	5.10e-01	2.80e-01	1.20e-01	6.20e-01
Fluoranthene	3	3	2.70e-01	1.15e+00	5.70e-01	2.90e-01	1.42e+00
Indeno(1,2,3-cd)pyre	3	1	7.50e-01	1.23e+00	7.50e-01	.	.
Methoxychlor	3	1	1.00e-02	1.00e-02	1.00e-02	.	.
Phenanthrene	3	3	9.00e-02	6.20e-01	2.70e-01	1.70e-01	7.80e-01
Pyrene	3	3	2.80e-01	1.02e+00	5.40e-01	2.40e-01	1.25e+00
Total combustible or	3	3	5.12e+04	7.07e+04	6.28e+04	5.93e+03	8.01e+04
Total organic carbon	3	3	6.68e+03	2.07e+04	1.44e+04	4.11e+03	2.64e+04
Subreach 22							
Benzo(a)pyrene	1	1	2.26e+00	2.26e+00	2.26e+00	.	.

Table B13 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std Error	95% UCB
Benzo(k)fluoranthene	1	1	2.58e+00	2.58e+00	2.58e+00	.	.
Bis(2-ethylhexyl)pht	1	1	2.39e+00	2.39e+00	2.39e+00	.	.
Chrysene	1	1	2.45e+00	2.45e+00	2.45e+00	.	.
Diethylphthalate	1	1	2.62e+00	2.62e+00	2.62e+00	.	.
Fluoranthene	1	1	2.45e+00	2.45e+00	2.45e+00	.	.
PCB-1254	1	1	1.82e+00	1.82e+00	1.82e+00	.	.
Phenanthrene	1	1	2.45e+00	2.45e+00	2.45e+00	.	.
Pyrene	1	1	2.39e+00	2.39e+00	2.39e+00	.	.

Table B14. Summary statistics for porewater organic concentrations(mg/L)by subreach

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Subreach 0							
Di-n-octylphthlate	2	1	0.00e+00	1.00e-02	0.00e+00	.	.
Total organic carbon	5	5	4.80e+00	9.10e+00	6.50e+00	7.60e-01	8.12e+00
Subreach 2.01							
Total organic carbon	1	1	1.80e+00	1.80e+00	1.80e+00	.	.
Subreach 2.03							
Total organic carbon	1	1	2.00e+00	2.00e+00	2.00e+00	.	.
Subreach 2.04							
Bis(2-ethylhexyl)pht	3	1	0.00e+00	1.00e-02	0.00e+00	.	.
Di-n-butylphthalate	3	2	0.00e+00	1.00e-02	0.00e+00	0.00e+00	0.00e+00
Total organic carbon	6	6	2.60e+00	5.00e+00	4.10e+00	3.90e-01	4.89e+00
Subreach 3.01							
Aldrin	1	1	0.00e+00	0.00e+00	0.00e+00	.	.
Total organic carbon	2	2	2.60e+00	1.10e+01	6.80e+00	4.20e+00	3.33e+01
Subreach 3.02							
Bis(2-ethylhexyl)pht	5	1	0.00e+00	1.00e-02	0.00e+00	.	.
Di-n-butylphthalate	5	2	0.00e+00	1.00e-02	0.00e+00	0.00e+00	0.00e+00
Total organic carbon	7	7	4.30e+00	1.10e+01	6.81e+00	8.80e-01	8.52e+00
Subreach 3.03							
Bis(2-ethylhexyl)pht	5	1	0.00e+00	1.00e-02	0.00e+00	.	.
Total organic carbon	9	9	4.40e+00	1.20e+01	7.17e+00	9.50e-01	8.93e+00

Table B14 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Subreach 3.04							
Total organic carbon	6	6	3.90e+00	9.05e+00	6.23e+00	8.10e-01	7.86e+00
Subreach 4.01							
Benzoic acid	5	2	0.00e+00	4.00e-02	0.00e+00	0.00e+00	0.00e+00
Bis(2-ethylhexyl)pht	5	2	0.00e+00	1.00e-02	0.00e+00	0.00e+00	0.00e+00
Total organic carbon	7	7	3.50e+00	7.50e+00	5.06e+00	5.00e-01	6.03e+00
Subreach 4.02							
Total organic carbon	6	6	2.70e+00	5.30e+00	3.98e+00	3.90e-01	4.76e+00
Subreach 4.03							
Total organic carbon	7	7	3.00e+00	9.90e+00	4.76e+00	9.10e-01	6.53e+00
Subreach 4.04							
Total organic carbon	11	11	7.50e+00	3.80e+01	1.74e+01	3.70e+00	2.41e+01
Subreach 7.01							
Total organic carbon	1	1	7.20e+00	7.20e+00	7.20e+00	.	.
Subreach 7.02							
Total organic carbon	1	1	7.50e+00	7.50e+00	7.50e+00	.	.
Subreach 8							
Total organic carbon	1	1	4.10e+00	4.10e+00	4.10e+00	.	.
Subreach 13							
Total organic carbon	5	5	3.20e+00	7.60e+00	5.28e+00	7.00e-01	6.78e+00

Table B14 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB
Subreach 18							
Benzoic acid	4	1	1.00e-02	2.00e-02	1.00e-02	.	.
PCB-1254	4	1	0.00e+00	0.00e+00	0.00e+00	.	.
Total organic carbon	2	2	9.00e+00	1.10e+01	1.00e+01	1.00e+00	1.63e+01

Table B15. Summary statisitcs for radionuclide concentrations in surface sediment (pCi/g, ~0-15 cm) by reach.

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach ' '								
Beryllium-7	13	2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	16	16	5.30E-02	1.47E+01	1.09E+01	1.30E+01	1.31E+01	1.26E+00
Cobalt-60	16	15	6.17E-03	8.34E-01	4.02E-01	3.75E-01	5.15E-01	6.42E-02
Europium-152	13	0	4.20E-01	1.01E+00	.	.	.	.
Potassium-40	13	13	5.28E+00	1.77E+01	1.33E+01	1.43E+01	1.52E+01	1.06E+00
Reach 00								
Cesium-137	5	3	1.24E-01	2.50E-01	1.73E-01	1.24E-01	2.40E-01	3.16E-02
Cobalt-60	5	0	1.19E-01	1.73E-01	.	.	.	.
Strontium-90	5	0	1.08E+00	1.71E+00	.	.	.	.
Reach 1								
Cesium-137	27	27	4.45E-02	1.76E+00	4.57E-01	3.03E-01	6.06E-01	8.77E-02
Cobalt-60	27	25	1.27E-02	5.05E+00	1.27E+00	4.39E-01	1.83E+00	3.28E-01
Reach 2								
Americium-241	111	8	5.96E-02	2.01E-01	8.69E-02	7.78E-02	9.25E-02	3.39E-03
Beryllium-7	141	38	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	196	194	5.39E-02	5.20E+01	2.60E+00	1.26E+00	3.26E+00	4.00E-01
Cobalt-60	196	145	1.03E-02	3.76E-01	5.65E-02	4.46E-02	6.23E-02	3.49E-03
Curium-243/244	2	2	1.11E-02	1.46E-02	1.29E-02	1.29E-02	2.38E-02	1.73E-03
Curium-245/246	1	1	1.64E-02	1.64E-02	1.64E-02	1.64E-02	.	.
Curium-248	1	1	2.20E-02	2.20E-02	2.20E-02	2.20E-02	.	.
Europium-152	141	1	2.78E-02	2.01E-01	5.05E-02	5.05E-02	.	.
Europium-154	115	0	2.08E-02	9.75E-02	.	.	.	.
Plutonium-238	2	2	1.70E-02	6.12E-02	3.91E-02	3.91E-02	1.79E-01	2.21E-02
Plutonium-239/240	2	2	8.14E-02	4.35E-01	2.58E-01	2.58E-01	1.37E+00	1.77E-01
Potassium-40	141	141	2.64E+00	2.50E+01	1.01E+01	1.03E+01	1.07E+01	3.53E-01
Strontium-90	12	5	1.34E-02	4.33E+00	9.23E-01	4.18E-01	1.75E+00	4.62E-01
Technetium-99	2	0	1.47E+00	1.56E+00	.	.	.	.
Uranium-234	4	4	5.56E-01	1.39E+00	8.15E-01	6.59E-01	1.27E+00	1.93E-01
Uranium-235	4	2	2.04E-02	6.56E-02	3.17E-02	2.04E-02	6.43E-02	1.39E-02
Uranium-238	4	4	5.33E-01	1.32E+00	7.93E-01	6.58E-01	1.21E+00	1.79E-01
Reach 3								
Americium-241	1	1	7.63E-02	7.60E-02	7.63E-02	7.63E-02	.	.
Cesium-137	34	30	1.05E-01	1.90E+01	2.65E+00	5.79E-01	4.01E+00	8.00E-01
Cobalt-60	34	5	6.75E-03	2.00E-01	3.87E-02	4.07E-02	5.52E-02	9.72E-03
Curium-243/244	1	1	1.11E-02	1.10E-02	1.11E-02	1.11E-02	.	.
Curium-245/246	1	1	1.25E-02	1.20E-02	1.25E-02	1.25E-02	.	.
Curium-248	1	1	2.58E-02	2.60E-02	2.58E-02	2.58E-02	.	.
Plutonium-238	1	1	9.63E-03	1.00E-02	9.60E-03	9.63E-03	.	.

Table B15 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Plutonium-239/240	1	1	1.00E-02	1.00E-02	1.00E-02	1.00E-02	.	.
Strontium-90	30	4	6.36E-02	2.24E+00	2.62E-01	6.36E-02	4.66E-01	1.20E-01
Technetium-99	28	17	1.23E+00	1.79E+02	1.28E+01	4.04E+00	2.37E+01	6.38E+00
Uranium-234	28	28	4.62E-01	8.35E+01	8.21E+00	4.08E+00	1.34E+01	3.03E+00
Uranium-235	30	28	2.24E-02	4.46E+00	3.92E-01	1.64E-01	6.47E-01	1.50E-01
Uranium-238	29	29	2.37E-01	5.77E+01	5.83E+00	2.81E+00	9.29E+00	2.03E+00
Reach 4								
Americium-241	51	4	2.26E-02	2.89E-01	7.44E-02	5.93E-02	9.02E-02	9.46E-03
Beryllium-7	62	26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	192	192	1.62E-01	3.61E+01	3.51E+00	1.85E+00	4.05E+00	3.24E-01
Cobalt-60	194	164	1.32E-02	3.79E-01	8.87E-02	6.16E-02	9.73E-02	5.19E-03
Curium-243/244	1	1	3.42E-02	3.42E-02	3.42E-02	3.42E-02	.	.
Curium-245/246	1	1	1.95E-02	1.95E-02	1.95E-02	1.95E-02	.	.
Curium-248	1	1	1.80E-02	1.80E-02	1.80E-02	1.80E-02	.	.
Europium-152	62	0	1.59E-02	2.87E-01	.	.	.	.
Europium-154	53	0	7.68E-03	1.44E-01	.	.	.	.
Plutonium-238	1	1	1.28E-02	1.27E-02	1.28E-02	1.28E-02	.	.
Plutonium-239/240	1	1	1.33E-02	1.33E-02	1.33E-02	1.33E-02	.	.
Potassium-40	62	62	1.51E+00	2.20E+01	9.04E+00	8.28E+00	9.96E+00	5.56E-01
Strontium-90	36	2	1.75E-01	1.38E+01	2.49E-01	1.75E-01	4.21E-01	1.02E-01
Uranium-234	1	1	1.71E+00	1.71E+00	1.71E+00	1.71E+00	.	.
Uranium-235	1	1	1.24E-01	1.24E-01	1.24E-01	1.24E-01	.	.
Uranium-238	1	1	1.57E+00	1.57E+00	1.57E+00	1.57E+00	.	.
Reach 5								
Americium-241	50	2	5.03E-02	3.05E-01	6.36E-02	5.95E-02	7.19E-02	4.97E-03
Beryllium-7	283	104	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	526	519	1.31E-02	9.35E+00	5.05E-01	2.18E-01	5.62E-01	3.47E-02
Cobalt-60	526	179	1.53E-03	1.63E-01	1.54E-02	7.90E-03	1.71E-02	1.03E-03
Curium-243/244	2	2	2.00E-02	2.23E-02	2.11E-02	2.11E-02	2.84E-02	1.15E-03
Curium-245/246	2	2	2.00E-02	6.25E-02	4.12E-02	4.12E-02	1.75E-01	2.13E-02
Curium-248	2	2	1.25E-02	6.25E-02	3.75E-02	3.75E-02	1.95E-01	2.50E-02
Europium-152	283	0	2.50E-02	3.14E-01	.	.	.	.
Europium-154	53	0	1.52E-02	1.24E-01	.	.	.	.
Plutonium-238	2	2	9.62E-03	3.85E-02	2.41E-02	2.41E-02	1.15E-01	1.45E-02
Plutonium-239/240	2	2	1.00E-02	6.20E-02	3.60E-02	3.60E-02	2.00E-01	2.60E-02
Potassium-40	283	283	7.88E-01	4.02E+01	1.15E+01	1.10E+01	1.21E+01	3.97E-01
Radium-226	3	3	4.28E-01	7.44E-01	5.66E-01	5.27E-01	8.39E-01	9.33E-02
Strontium-90	2	2	1.01E-01	1.51E-01	1.26E-01	1.26E-01	2.85E-01	2.51E-02
Thorium-232	3	3	2.40E-01	8.61E-01	5.20E-01	4.59E-01	1.05E+00	1.82E-01
Uranium-234	2	2	1.65E+00	1.93E+00	1.79E+00	1.79E+00	2.68E+00	1.41E-01
Uranium-235	2	2	3.00E-02	9.30E-02	6.15E-02	6.15E-02	2.61E-01	3.15E-02

Table B15 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Uranium-238	2	2	1.43E+00	1.62E+00	1.53E+00	1.53E+00	2.13E+00	9.51E-02
Reach 6								
Cesium-137	31	31	4.85E-03	6.22E+00	9.26E-01	4.10E-01	1.36E+00	2.57E-01
Cobalt-60	30	15	7.89E-04	1.47E-01	2.46E-02	8.32E-03	3.70E-02	7.31E-03
Reach 7								
Cesium-137	11	10	2.66E-02	4.36E-01	2.97E-01	3.14E-01	3.48E-01	2.83E-02
Cobalt-60	11	7	1.66E-02	3.65E-01	3.51E-02	2.91E-02	4.65E-02	6.30E-03
Strontium-90	2	1	8.68E-01	5.17E+00	5.17E+00	5.17E+00	.	.
Reach 8								
Cesium-137	1	1	2.80E-01	2.80E-01	2.80E-01	2.80E-01	.	.
Cobalt-60	1	0	2.35E-01	2.35E-01	.	.	.	.
Strontium-90	1	0	1.39E+00	1.39E+00	.	.	.	.
Reach 10								
Americium-241	9	1	3.69E-02	1.55E-01	4.43E-02	4.43E-02	.	.
Beryllium-7	8	4	3.00E-06	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-06
Cesium-137	10	10	5.66E-02	4.12E-01	1.61E-01	1.39E-01	2.21E-01	3.28E-02
Cobalt-60	10	0	4.76E-03	9.97E-02	.	.	.	.
Curium-243/244	1	1	1.11E-02	1.11E-02	1.11E-02	1.11E-02	.	.
Curium-245/246	1	1	1.78E-02	1.78E-02	1.78E-02	1.78E-02	.	.
Curium-248	1	1	1.25E-02	1.25E-02	1.25E-02	1.25E-02	.	.
Europium-152	8	0	3.93E-02	1.54E-01	.	.	.	.
Europium-154	8	0	1.56E-02	8.72E-02	.	.	.	.
Plutonium-238	1	1	9.61E-03	9.61E-03	9.61E-03	9.61E-03	.	.
Plutonium-239/240	1	1	4.00E-02	4.00E-02	4.00E-02	4.00E-02	.	.
Potassium-40	8	8	2.25E+00	8.31E+00	4.71E+00	4.52E+00	5.91E+00	6.35E-01
Strontium-90	1	1	1.58E-01	1.58E-01	1.58E-01	1.58E-01	.	.
Uranium-234	1	1	1.22E+00	1.22E+00	1.22E+00	1.22E+00	.	.
Uranium-235	1	1	3.58E-02	3.58E-02	3.58E-02	3.58E-02	.	.
Uranium-238	1	1	1.27E+00	1.27E+00	1.27E+00	1.27E+00	.	.

Table B15 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach 13								
Cesium-137	5	1	1.22E-01	3.69E-01	3.69E-01	3.69E-01	.	.
Cobalt-60	5	0	1.18E-01	1.56E-01	.	.	.	.
Strontium-90	5	0	1.16E+00	2.18E+00	.	.	.	.
Technetium-99	5	0	1.33E+00	1.95E+00	.	.	.	.
Uranium-234	5	5	3.02E-01	1.73E+00	8.08E-01	6.33E-01	1.33E+00	2.44E-01
Uranium-235	5	2	3.06E-02	1.51E-01	5.30E-02	3.13E-02	1.10E-01	2.66E-02
Uranium-238	5	5	3.03E-01	1.47E+00	7.64E-01	6.64E-01	1.18E+00	1.93E-01
Reach 18								
Cesium-137	27	24	2.49E-02	4.64E-01	1.36E-01	7.31E-02	1.77E-01	2.37E-02
Cobalt-60	27	1	2.66E-03	1.72E-01	2.13E-02	2.13E-02	.	.
Strontium-90	4	1	1.21E+00	1.28E+00	1.28E+00	1.28E+00	.	.
Reach 22								
Americium-241	1	1	2.30E+01	2.30E+01	2.30E+01	2.30E+01	.	.
Cesium-137	7	7	6.30E-02	2.23E+04	3.18E+03	4.22E-01	9.37E+03	3.18E+03
Cobalt-60	7	7	1.00E-02	8.90E+01	1.27E+01	1.90E-02	3.75E+01	1.27E+01
Curium-243/244	1	1	1.00E-03	0.00E+00	0.00E+00	1.00E-03	.	.
Curium-248	1	1	1.80E-02	2.00E-02	2.00E-02	1.80E-02	.	.
Plutonium-238	1	1	6.56E+00	6.56E+00	6.56E+00	6.56E+00	.	.
Plutonium-239/240	1	1	2.18E+02	2.18E+02	2.18E+02	2.18E+02	.	.
Strontium-90	1	1	8.73E+02	8.73E+02	8.73E+02	8.73E+02	.	.
Uranium-234	1	1	1.01E+01	1.01E+01	1.01E+01	1.01E+01	.	.
Uranium-235	1	1	3.84E-01	3.80E-01	3.80E-01	3.84E-01	.	.
Uranium-238	1	1	6.24E+00	6.24E+00	6.24E+00	6.24E+00	.	.

Table B16. Summary statistics for radionuclide concentrations in surface sediment (pCi/g, ~0 - 15 cm) by subreach

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Subreach ''								
Beryllium-7	13	2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	16	16	5.30E-02	1.47E+01	1.09E+01	1.26E+00	1.31E+01	1.30E+01
Cobalt-60	16	15	6.17E-03	8.34E-01	4.02E-01	6.42E-02	5.15E-01	3.75E-01
Europium-152	13	0	4.20E-01	1.01E+00	.	.	.	.
Potassium-40	13	13	5.28E+00	1.77E+01	1.33E+01	1.06E+00	1.52E+01	1.43E+01
Subreach 0								
Cesium-137	5	3	1.24E-01	2.50E-01	1.73E-01	3.16E-02	2.40E-01	1.24E-01
Cobalt-60	5	0	1.19E-01	1.73E-01	.	.	.	.
Strontium-90	5	0	1.08E+00	1.71E+00	.	.	.	.
Subreach 1								
Cesium-137	27	27	4.45E-02	1.76E+00	4.57E-01	8.77E-02	6.06E-01	3.03E-01
Cobalt-60	27	25	1.27E-02	5.05E+00	1.27E+00	3.28E-01	1.83E+00	4.39E-01
Subreach 2.01								
Cesium-137	1	0	9.94E-02	9.94e-02	.	.	.	.
Cobalt-60	1	0	1.14E-01	1.14e-01	.	.	.	.
Strontium-90	1	0	1.09E+00	1.09e+00	.	.	.	.
Subreach 2.02								
Americium-241	52	2	8.45E-02	2.01E-01	9.68E-02	1.12E-03	9.86E-02	9.59E-02
Beryllium-7	55	12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	57	57	5.39E-02	2.95E+01	1.77E+00	5.39E-01	2.67E+00	5.21E-01
Cobalt-60	57	35	1.29E-02	3.76E-01	5.48E-02	8.40E-03	6.88E-02	2.68E-02
Curium-243/244	1	1	1.11E-02	1.11E-02	1.11E-02	.	.	1.11E-02
Europium-152	55	0	6.06E-02	1.79E-01	.	.	.	.
Europium-154	55	0	2.54E-02	9.12E-02	.	.	.	.
Plutonium-238	1	1	1.70E-02	1.70E-02	1.70E-02	.	.	1.70E-02
Plutonium-239/240	1	1	8.14E-02	8.14E-02	8.14E-02	.	.	8.14E-02
Potassium-40	55	55	2.87E+00	2.50E+01	1.07E+01	6.16E-01	1.17E+01	1.14E+01
Strontium-90	1	1	1.34E-02	1.34E-02	1.34E-02	.	.	1.34E-02
Uranium-234	1	1	5.56E-01	5.56E-01	5.56E-01	.	.	5.56E-01
Uranium-235	1	1	2.04E-02	2.04E-02	2.04E-02	.	.	2.04E-02
Uranium-238	1	1	5.33E-01	5.33E-01	5.33E-01	.	.	5.33E-01
Subreach 2.03								
Americium-241	54	5	5.96E-02	1.99E-01	8.79E-02	5.13E-03	9.65E-02	7.78E-02
Beryllium-7	55	20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table B16 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Cesium-137	84	83	1.11E-01	3.09E+01	2.23E+00	4.49E-01	2.98E+00	1.11E+00
Cobalt-60	84	65	1.03E-02	1.48E-01	4.92E-02	3.96E-03	5.58E-02	4.45E-02
Europium-152	55	1	4.19E-02	2.01E-01	5.05E-02	.	.	5.05E-02
Europium-154	55	0	2.08E-02	9.75E-02	.	.	.	.
Potassium-40	55	55	2.64E+00	1.84E+01	9.24E+00	5.86E-01	1.02E+01	8.95E+00
Strontium-90	1	0	1.24E+00	1.24E+00	.	.	.	.
Subreach 2.04								
Americium-241	5	1	1.70e-01	1.93e-01	1.79e-01		.	1.79E-01
Beryllium-7	31	6	0.00e+00	1.00e-05	0.00e+00	4.42E+04	1.22E-06	0.00E+00
Cesium-137	54	54	2.39E-01	5.20E+01	4.11E+00	1.12E+00	5.99E+00	1.71E+00
Cobalt-60	54	45	2.00E-02	2.24E-01	7.33E-02	5.94E-03	8.32E-02	5.83E-02
Curium-243/244	1	1	1.46E-02	1.46E-02	1.46E-02	.	.	1.46E-02
Curium-245/246	1	1	1.64E-02	1.64E-02	1.64E-02	.	.	1.64E-02
Curium-248	1	1	2.20E-02	2.20E-02	2.20E-02	.	.	2.20E-02
Europium-152	31	0	2.78E-02	1.81E-01	.	.	.	.
Europium-154	5	0	8.05E-02	8.91E-02	.	.	.	.
Plutonium-238	1	1	6.12E-02	6.12E-02	6.12E-02	.	.	6.12E-02
Plutonium-239/240	1	1	4.35E-01	4.35E-01	4.35E-01	.	.	4.35E-01
Potassium-40	31	31	5.62E+00	1.55E+01	1.07E+01	5.13E-01	1.15E+01	1.03E+01
Strontium-90	9	4	4.18E-01	4.33E+00	1.29E+00	5.56E-01	2.33E+00	4.18E-01
Technetium-99	2	0	1.47E+00	1.56E+00	.	.	.	.
Uranium-234	3	3	6.36E-01	1.39E+00	9.02E-01	2.43E-01	1.61E+00	6.81E-01
Uranium-235	3	1	2.13E-02	6.56E-02	6.56E-02	.	.	6.56E-02
Uranium-238	3	3	6.39E-01	1.32E+00	8.79E-01	2.22E-01	1.53E+00	6.76E-01
Subreach 3.01								
Cesium-137	2	0	1.24E-01	2.08E-01	.	.	.	.
Cobalt-60	2	0	1.33E-01	1.87E-01	.	.	.	.
Strontium-90	2	0	9.40E-01	1.38E+00	.	.	.	.
Technetium-99	2	0	1.53E+00	1.54E+00	.	.	.	.
Uranium-234	2	2	6.83E-01	1.88E+00	1.28E+00	5.99E-01	5.06E+00	1.28E+00
Uranium-235	2	1	2.24E-02	6.64E-02	6.64E-02	.	.	6.64E-02
Uranium-238	2	2	6.59E-01	1.20E+00	9.30E-01	2.71E-01	2.64E+00	9.30E-01
Subreach 3.02								
Cesium-137	10	9	1.29E-01	1.80E+00	5.78E-01	1.57E-01	8.66E-01	4.40E-01
Cobalt-60	10	2	6.75E-03	1.65E-01	2.29E-02	1.62E-02	5.25E-02	2.29E-02
Strontium-90	8	2	4.17E-01	1.81E+00	8.67E-01	1.67E-01	1.18E+00	7.40E-01
Technetium-99	8	5	1.62E+00	1.79E+02	2.93E+01	2.26E+01	7.21E+01	5.41E+00

Table B16 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Uranium-234	8	8	1.35E+00	8.35E+01	1.77E+01	1.01E+01	3.68E+01	5.25E+00
Uranium-235	8	8	6.55E-02	4.46E+00	8.82E-01	5.36E-01	1.90E+00	2.40E-01
Uranium-238	8	8	1.24E+00	5.77E+01	1.21E+01	7.00E+00	2.54E+01	2.97E+00
Subreach 3.03								
Cesium-137	10	9	1.05E-01	3.10E+00	9.49E-01	3.29E-01	1.55E+00	4.14E-01
Cobalt-60	10	0	5.78E-02	1.72E-01	.	.	.	.
Strontium-90	10	1	3.63E-01	2.24E+00	9.73E-01	.	.	9.73E-01
Technetium-99	10	9	3.55E+00	2.98E+01	9.56E+00	2.53E+00	1.42E+01	7.48E+00
Uranium-234	10	10	1.30E+00	1.39E+01	4.91E+00	1.20E+00	7.10E+00	4.17E+00
Uranium-235	10	10	4.54E-02	7.36E-01	2.46E-01	6.61E-02	3.68E-01	1.92E-01
Uranium-238	10	10	1.32E+00	1.02E+01	3.82E+00	8.75E-01	5.42E+00	3.52E+00
Subreach 3.04								
Americium-241	1	1	7.63E-02	7.63E-02	7.63E-02	.	.	7.63E-02
Cesium-137	12	12	3.24E-01	1.90E+01	6.21E+00	1.88E+00	9.59E+00	4.57E+00
Cobalt-60	12	3	4.07E-02	2.01E-01	5.44E-02	9.08E-03	7.07E-02	5.10E-02
Curium-243/244	1	1	1.11E-02	1.11E-02	1.11E-02	.	.	1.11E-02
Curium-245/246	1	1	1.25E-02	1.25E-02	1.25E-02	.	.	1.25E-02
Curium-248	1	1	2.58E-02	2.58E-02	2.58E-02	.	.	2.58E-02
Plutonium-238	1	1	9.63E-03	9.60E-03	9.63E-03	.	.	9.63E-03
Plutonium-239/240	1	1	1.00E-02	1.00E-02	1.00E-02	.	.	1.00E-02
Strontium-90	10	1	6.36E-02	1.94E+00	6.36E-02	.	.	6.36E-02
Technetium-99	8	3	1.23E+00	7.50E+00	3.78E+00	7.30E-01	5.16E+00	2.84E+00
Uranium-234	8	8	4.62E-01	1.05E+01	4.63E+00	1.37E+00	7.22E+00	3.83E+00
Uranium-235	10	9	4.18E-02	5.95E-01	2.14E-01	6.78E-02	3.38E-01	1.14E-01
Uranium-238	9	9	2.37E-01	8.68e+00	3.55e+00	1.11e+00	5.62e+00	2.17E+00
Subreach 4.01								
Americium-241	29	3	2.26E-02	2.20E-01	1.01E-01	5.21E-03	1.10E-01	9.46E-02
Beryllium-7	39	21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	66	66	1.62E-01	2.85E+01	3.63E+00	5.99E-01	4.63E+00	1.85E+00
Cobalt-60	67	56	1.48E-02	2.11E-01	6.89E-02	5.51E-03	7.81E-02	5.95E-02
Europium-152	39	0	1.59E-02	2.28E-01	.	.	.	.
Europium-154	30	0	7.68E-03	1.25E-01	.	.	.	.
Potassium-40	39	39	1.65E+00	1.69E+01	8.38E+00	4.97E-01	9.22E+00	7.41E+00
Strontium-90	10	0	9.66E-01	1.29E+00	.	.	.	.
Subreach 4.02								

Table B16 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Americium-241	16	0	9.17E-02	2.84E-01	.	.	.	.
Beryllium-7	17	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	33	33	1.73E-01	7.44E+00	3.13E+00	4.75E-01	3.93E+00	1.87E+00
Cobalt-60	34	27	2.00E-02	2.42E-01	1.04E-01	1.07E-02	1.22E-01	9.57E-02
Europium-152	17	0	8.37E-02	2.70E-01	.	.	.	.
Europium-154	17	0	3.62E-02	1.29E-01	.	.	.	.
Potassium-40	17	17	1.51E+00	1.66E+01	8.89E+00	1.35E+00	1.12E+01	8.98E+00
Strontium-90	6	0	1.11E+00	3.04E+00	.	.	.	.
Subreach 4.03								
Americium-241	5	0	1.61E-01	2.89E-01	.	.	.	.
Beryllium-7	6	2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	56	56	2.10E-01	3.61E+01	3.47E+00	7.73E-01	4.77E+00	1.44E+00
Cobalt-60	56	51	1.32E-02	3.79E-01	9.13E-02	1.17E-02	1.11E-01	5.49E-02
Europium-152	6	0	1.28E-01	2.87E-01	.	.	.	.
Europium-154	6	0	8.29E-02	1.44E-01	.	.	.	.
Potassium-40	6	6	6.45E+00	2.20E+01	1.37E+01	2.32E+00	1.84E+01	1.35E+01
Strontium-90	8	0	1.01E+00	1.38E+01	.	.	.	.
Subreach 4.04								
Americium-241	1	1	5.93E-02	5.93E-02	5.93E-02	.	.	5.93E-02
Cesium-137	37	37	2.76E-01	9.09E+00	3.71E+00	4.19E-01	4.42E+00	3.58E+00
Cobalt-60	37	30	1.34E-02	3.33E-01	1.09E-01	1.45E-02	1.34E-01	9.49E-02
Curium-243/244	1	1	3.42E-02	3.42E-02	3.42E-02	.	.	3.42E-02
Curium-245/246	1	1	1.95E-02	1.95E-02	1.95E-02	.	.	1.95E-02
Curium-248	1	1	1.80E-02	1.80E-02	1.80E-02	.	.	1.80E-02
Plutonium-238	1	1	1.28E-02	1.28E-02	1.28E-02	.	.	1.28E-02
Plutonium-239/240	1	1	1.33E-02	1.33E-02	1.33E-02	.	.	1.33E-02
Strontium-90	12	2	1.75E-01	2.31E+00	3.53E-01	2.40E-01	7.85E-01	1.75E-01
Uranium-234	1	1	1.71E+00	1.71E+00	1.71E+00	.	.	1.71E+00
Uranium-235	1	1	1.24E-01	1.24E-01	1.24E-01	.	.	1.24E-01
Uranium-238	1	1	1.57E+00	1.57E+00	1.57E+00	.	.	1.57E+00
Subreach 5								
Americium-241	50	2	5.03E-02	3.05E-01	6.36E-02	4.97E-03	7.19E-02	5.95E-02
Beryllium-7	283	104	0.00E+00	1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cesium-137	526	519	1.31E-02	9.35E+00	5.04E-01	3.47E-02	5.62E-01	2.18E-01
Cobalt-60	526	179	1.53E-03	1.63E-01	1.54E-02	1.03E-03	1.71E-02	7.86E-03

Table B16 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Curium-243/244	2	2	2.00E-02	2.23E-02	2.11E-02	1.15E-03	2.84E-02	2.11E-02
Curium-245/246	2	2	2.00E-02	0.0625	4.12E-02	2.13E-02	1.75E-01	4.12E-02
Curium-248	2	2	1.25E-02	0.0625	3.75E-02	2.50E-02	1.95E-01	3.75E-02
Europium-152	28	3	2.50E-02	0.3143	.	.	.	.
Europium-154	5	3	1.52E-02	0.1243	.	.	.	.
Plutonium-238	2	2	9.62E-03	0.0385	2.41E-02	1.45E-02	1.15E-01	2.41E-02
Plutonium-239/240	2	2	1.00E-02	0.0620	3.60E-02	2.60E-02	2.00E-01	3.60E-02
Potassium-40	283	283	7.88E-01	40.2263	1.15E+01	3.97E-01	1.21E+01	1.10E+01
Radium-226	3	3	4.28E-01	7.44e-01	5.66E-01	9.33E-02	8.39E-01	5.27E-01
Strontium-90	2	2	1.01E-01	1.51e-01	1.26E-01	2.51E-02	2.85E-01	1.26E-01
Thorium-232	3	3	2.40E-01	8.61e-01	5.20E-01	1.82E-01	1.05E+00	4.59E-01
Uranium-234	2	2	1.65E+00	1.93e+00	1.79E+00	1.41E-01	2.68E+00	1.79E+00
Uranium-235	2	2	3.00E-02	9.30e-02	6.15E-02	3.15E-02	2.61E-01	6.15E-02
Uranium-238	2	2	1.43E+00	1.62e+00	1.53E+00	9.51E-02	2.13E+00	1.53E+00
Subreach 6								
Cesium-137	31	31	4.85E-03	6.22E+00	9.26E-01	2.57E-01	1.36E+00	4.10E-01
Cobalt-60	30	15	7.89E-04	1.47E-01	2.46E-02	7.31E-03	3.70E-02	8.32E-03
Subreach 7.01								
Cesium-137	1	1	3.77E-01	3.77E-01	3.77E-01	.	.	3.77E-01
Cobalt-60	1	0	3.65E-01	3.65E-01	.	.	.	.
Strontium-90	1	1	5.17E+00	5.17E+00	5.17E+00	.	.	5.17E+00
Subreach 7.02								
Cesium-137	10	9	2.66E-02	4.36E-01	2.89E-01	3.00E-02	3.44E-01	2.95E-01
Cobalt-60	10	7	1.66E-02	2.86E-01	3.51E-02	6.30E-03	4.67E-02	2.91E-02
Strontium-90	1	0	8.68E-01	8.68E-01	.	.	.	.
Subreach 8								
Cesium-137	1	1	2.80E-01	2.80E-01	2.80E-01	.	.	2.80E-01
Cobalt-60	1	0	2.35E-01	2.35E-01	.	.	.	.
Strontium-90	1	0	1.39E+00	1.39E+00	.	.	.	.
Subreach 10								
Americium-241	9	1	3.69E-02	1.55E-01	4.43E-02	.	.	4.43E-02
Beryllium-7	8	4	0.00E+00	1.00E-05	1.00E-05	0.00E+00	1.00E-05	1.00E-05
Cesium-137	10	10	5.66E-02	4.12E-01	1.61E-01	3.28E-02	2.21E-01	1.39E-01
Cobalt-60	10	0	4.76E-03	9.97E-02	.	.	.	.
Curium-243/244	1	1	1.11E-02	1.11E-02	1.11E-02	.	.	1.11E-02

Table B16 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Curium-245/246	1	1	1.78E-02	1.78E-02	1.78E-02	.	.	1.78E-02
Curium-248	1	1	1.25E-02	1.25E-02	1.25E-02	.	.	1.25E-02
Europium-152	8	0	3.93E-02	1.54E-01	.	.	.	.
Europium-154	8	0	1.56E-02	8.72E-02	.	.	.	.
Plutonium-238	1	1	9.61E-03	9.61E-03	9.61E-03	.	.	9.61E-03
Plutonium-239/240	1	1	4.00E-02	4.00E-02	4.00E-02	.	.	4.00E-02
Potassium-40	8	8	2.25E+00	8.31E+00	4.71E+00	6.35E-01	5.91E+00	4.52E+00
Strontium-90	1	1	1.58E-01	1.58E-01	1.58E-01	.	.	1.58E-01
Uranium-234	1	1	1.22E+00	1.22E+00	1.22E+00	.	.	1.22E+00
Uranium-235	1	1	3.58E-02	3.58E-02	3.58E-02	.	.	3.58E-02
Uranium-238	1	1	1.27E+00	1.27E+00	1.27E+00	.	.	1.27E+00
Subreach 13								
Cesium-137	5	1	1.22E-01	3.69E-01	3.69E-01	.	.	3.69E-01
Cobalt-60	5	0	1.18E-01	1.56E-01	.	.	.	.
Strontium-90	5	0	1.16E+00	2.18E+00	.	.	.	.
Technetium-99	5	0	1.33E+00	1.95E+00	.	.	.	.
Uranium-234	5	5	3.02E-01	1.73E+00	8.08E-01	2.44E-01	1.33E+00	6.33E-01
Uranium-235	5	2	3.06E-02	1.51E-01	5.30E-02	2.66E-02	1.10E-01	3.13E-02
Uranium-238	5	5	3.03E-01	1.47E+00	7.64E-01	1.93E-01	1.18E+00	6.64E-01
Subreach 18								
Cesium-137	27	24	2.49E-02	4.64E-01	1.36E-01	2.37E-02	1.77E-01	7.31E-02
Cobalt-60	27	1	2.66E-03	1.72E-01	2.13E-02	.	.	2.13E-02
Strontium-90	4	1	1.21E+00	1.28E+00	1.28E+00	.	.	1.28E+00
Subreach 22								
Americium-241	1	1	2.30E+01	2.30E+01	2.30E+01	.	.	2.30E+01
Cesium-137	7	7	6.30E-02	2.23E+04	3.18E+03	3.18E+03	9.37E+03	4.22E-01
Cobalt-60	7	7	1.00E-02	8.90E+01	1.27E+01	1.27E+01	3.75E+01	1.90E-02
Curium-243/244	1	1	1.00E-03	0.00E+00	0.00E+00	.	.	1.00E-03
Curium-248	1	1	1.80E-02	2.00E-02	2.00E-02	.	.	1.80E-02
Plutonium-238	1	1	6.56E+00	6.56E+00	6.56E+00	.	.	6.56E+00
Plutonium-239/240	1	1	2.18E+02	2.18E+02	2.18E+02	.	.	2.18E+02
Strontium-90	1	1	8.73E+02	8.73E+02	8.73E+02	.	.	8.73E+02
Uranium-234	1	1	1.01E+01	1.01E+01	1.01E+01	.	.	1.01E+01
Uranium-235	1	1	3.84E-01	3.80E-01	3.80E-01	.	.	3.84E-01
Uranium-238	1	1	6.24E+00	6.24E+00	6.24E+00	.	.	6.24E+00

Table B17. Summary statistics for radionuclide concentrations (pCi/g), core weighted averages, by reach

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach 00								
Cesium-137	5	4	1.53E-01	3.73E-01	2.51E-01	4.29E-02	3.43E-01	2.26E-01
Cobalt-60	5	0	9.48E-02	1.68E-01	.	.	.	.
Strontium-90	5	0	1.08E+00	1.71E+00	.	.	.	.
Reach 1								
Cesium-137	3	3	1.61E-01	9.33E-01	6.00E-01	2.29E-01	1.27E+00	7.06E-01
Cobalt-60	3	2	6.34E-02	5.79E+00	2.05E+00	2.16E+00	8.36E+00	1.72E-01
Reach 2								
Americium-241	2	2	1.37E-01	1.87E-01	1.62E-01	2.52E-02	3.21E-01	1.62E-01
Cesium-137	10	8	9.85E-02	2.50E+01	5.67E+00	2.51E+00	1.03E+01	2.33E+00
Cobalt-60	10	3	5.44E-02	1.93E-01	8.86E-02	1.51E-02	1.16E-01	7.00E-02
Curium-243/244	2	2	1.11E-02	1.39E-02	1.25E-02	1.36E-03	2.11E-02	1.25E-02
Curium-245/246	1	1	1.47E-02	1.47E-02	1.47E-02	.	.	1.47E-02
Curium-248	1	1	2.89E-02	2.89E-02	2.89E-02	.	.	2.89E-02
Plutonium-238	2	2	1.41E-02	2.83E-02	2.12E-02	7.09E-03	6.60E-02	2.12E-02
Plutonium-239/240	2	2	1.85E-01	1.86E-01	1.86E-01	9.00E-04	1.91E-01	1.86E-01
Strontium-90	11	5	2.60E-01	3.51E+00	8.23E-01	3.36E-01	1.43E+00	3.22E-01
Technetium-99	1	0	1.52E+00	1.52E+00	.	.	.	.
Uranium-234	3	3	6.59E-01	1.35E+00	9.40E-01	2.11E-01	1.56E+00	8.10E-01
Uranium-235	3	2	2.45E-02	6.24E-02	4.44E-02	1.04E-02	7.48E-02	3.53E-02
Uranium-238	3	3	6.58E-01	1.23E+00	8.75E-01	1.78E-01	1.39E+00	7.41E-01
Reach 3								
Americium-241	1	1	1.06E-01	1.06E-01	1.06E-01	.	.	1.06E-01
Cesium-137	30	26	3.95E-02	7.92E+00	1.94E+00	4.60E-01	2.72E+00	7.65E-01
Cobalt-60	30	4	2.69E-02	2.04E-01	4.63E-02	7.21E-03	5.85E-02	4.38E-02
Curium-243/244	1	1	1.11E-02	1.10E-02	1.11E-02	.	.	1.11E-02
Curium-245/246	1	1	1.77E-02	1.80E-02	1.77E-02	.	.	1.77E-02
Curium-248	1	1	1.73E-02	1.70E-02	1.73E-02	.	.	1.73E-02
Plutonium-238	1	1	1.42E-02	1.40E-02	1.42E-02	.	.	1.42E-02
Plutonium-239/240	1	1	1.54E-02	1.50E-02	1.54E-02	.	.	1.54E-02
Strontium-90	27	7	6.78E-02	3.96E+00	5.86E-01	2.14E-01	9.51E-01	6.78E-02
Technetium-99	26	17	1.23E+00	2.58E+02	1.86E+01	9.99E+00	3.56E+01	4.00E+00
Uranium-234	27	27	4.62E-01	9.69E+01	9.00E+00	3.52E+00	1.50E+01	3.51E+00
Uranium-235	27	26	2.55E-02	4.89E+00	4.56E-01	1.81E-01	7.64E-01	1.67E-01
Uranium-238	27	27	2.37E-01	6.59E+01	6.26E+00	2.39E+00	1.03E+01	2.69E+00
Reach 4								
Americium-241	1	1	1.98E-01	1.98E-01	1.98E-01	.	.	1.98E-01
Cesium-137	37	37	1.02E-01	2.69E+01	7.56E+00	1.25E+00	9.67E+00	5.55E+00

Table B17 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Cobalt-60	37	19	3.51E-02	3.94E-01	1.52E-01	1.37E-02	1.75E-01	1.03E-01
Curium-243/244	1	1	1.96E-02	1.96E-02	1.96E-02	.	.	1.96E-02
Curium-245/246	1	1	2.91E-02	2.91E-02	2.91E-02	.	.	2.91E-02
Curium-248	1	1	2.69E-02	2.69E-02	2.69E-02	.	.	2.69E-02
Plutonium-238	1	1	2.12E-02	2.12E-02	2.12E-02	.	.	2.12E-02
Plutonium-239/240	1	1	2.59E-01	2.59E-01	2.59E-01	.	.	2.59E-01
Strontium-90	34	4	3.58E-01	3.41E+00	5.48E-01	1.26E-01	7.61E-01	3.58E-01
Uranium-234	1	1	2.22E+00	2.22E+00	2.22E+00	.	.	2.22E+00
Uranium-235	1	1	1.22E-01	1.22E-01	1.22E-01	.	.	1.22E-01
Uranium-238	1	1	1.88E+00	1.88E+00	1.88E+00	.	.	1.88E+00
Reach 5								
Americium-241	2	2	3.79E-02	1.02E-01	6.99E-02	3.20E-02	2.72E-01	6.99E-02
Cesium-137	9	5	2.52E-02	1.24E+01	7.22E+00	9.08E-01	8.91E+00	5.42E+00
Cobalt-60	9	5	2.64E-02	1.72E-01	1.11E-01	8.31E-03	1.27E-01	9.87E-02
Curium-243/244	2	2	1.34E-02	1.62E-02	1.48E-02	1.38E-03	2.35E-02	1.48E-02
Curium-245/246	2	2	3.49E-02	4.88E-02	4.19E-02	6.97E-03	8.59E-02	4.19E-02
Curium-248	2	2	2.22E-02	3.52E-02	2.87E-02	6.50E-03	6.98E-02	2.87E-02
Plutonium-238	2	2	2.28E-02	2.95E-02	2.62E-02	3.38E-03	4.75E-02	2.62E-02
Plutonium-239/240	2	2	1.00E-02	9.81E-02	5.41E-02	4.41E-02	3.32E-01	5.41E-02
Strontium-90	2	2	8.83E-02	1.30E-01	1.09E-01	2.07E-02	2.40E-01	1.09E-01
Uranium-234	2	2	1.91E+00	1.93E+00	1.92E+00	9.37E-03	1.97E+00	1.92E+00
Uranium-235	2	2	4.64E-02	8.86E-02	6.75E-02	2.11E-02	2.01E-01	6.75E-02
Uranium-238	2	2	1.60E+00	1.69E+00	1.65E+00	4.12E-02	1.91E+00	1.65E+00
Reach 7								
Cesium-137	2	2	3.40E-01	4.38E-01	3.89E-01	4.86E-02	6.96E-01	3.89E-01
Cobalt-60	2	0	1.24E-01	2.77E-01	.	.	.	.
Strontium-90	2	1	9.67E-01	2.14E+00	2.14E+00	.	.	2.14E+00
Reach 8								
Cesium-137	1	1	6.42E-01	6.42E-01	6.42E-01	.	.	6.42E-01
Cobalt-60	1	0	2.20E-01	2.20E-01	.	.	.	.
Strontium-90	1	0	1.65E+00	1.65E+00	.	.	.	.
Reach 10								
Americium-241	1	1	5.45E-02	5.45E-02	5.45E-02	.	.	5.45E-02
Cesium-137	1	1	9.16E-01	9.16E-01	9.16E-01	.	.	9.16E-01
Cobalt-60	1	0	8.83E-02	8.83E-02	.	.	.	.
Curium-243/244	1	1	1.22E-02	1.22E-02	1.22E-02	.	.	1.22E-02
Curium-245/246	1	1	1.84E-02	1.84E-02	1.84E-02	.	.	1.84E-02
Curium-248	1	1	3.55E-02	3.55E-02	3.55E-02	.	.	3.55E-02
Plutonium-238	1	1	9.61E-03	9.61E-03	9.61E-03	.	.	9.61E-03

Table B17 (continued)

Analyte	Obs	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Plutonium-239/240	1	1	2.80E-02	2.80E-02	2.80E-02	.	.	2.80E-02
Strontium-90	1	1	1.00E-01	1.00E-01	1.00E-01	.	.	1.00E-01
Uranium-234	1	1	1.20E+00	1.20E+00	1.20E+00	.	.	1.20E+00
Uranium-235	1	1	6.03E-02	6.03E-02	6.03E-02	.	.	6.03E-02
Uranium-238	1	1	1.32E+00	1.32E+00	1.32E+00	.	.	1.32E+00
Reach 13								
Cesium-137	5	1	1.22E-01	3.04E-01	3.04E-01	.	.	3.04E-01
Cobalt-60	5	0	1.20E-01	1.56E-01	.	.	.	.
Strontium-90	5	0	1.16E+00	2.56E+00	.	.	.	.
Technetium-99	5	0	1.26E+00	1.85E+00	.	.	.	.
Uranium-234	5	5	3.26E-01	1.44E+00	7.61E-01	1.93E-01	1.17E+00	6.33E-01
Uranium-235	5	2	2.99E-02	9.86E-02	4.48E-02	1.70E-02	8.10E-02	3.14E-02
Uranium-238	5	5	3.05E-01	9.66E-01	6.60E-01	1.17E-01	9.10E-01	7.70E-01
Reach 18								
Cesium-137	3	3	1.59E-01	3.44E-01	2.26E-01	5.89E-02	3.98E-01	1.76E-01
Cobalt-60	3	0	4.59E-02	1.55E-01	.	.	.	.
Strontium-90	3	1	1.14E+00	1.22E+00	1.14E+00	.	.	1.14E+00
Reach 22								
Americium-241	1	1	6.87E+00	6.87E+00	6.87E+00	.	.	6.87E+00
Cesium-137	1	1	7.89E+03	7.89E+03	7.89E+03	.	.	7.89E+03
Cobalt-60	1	1	3.26E+01	3.26E+01	3.26E+01	.	.	3.26E+01
Curium-243/244	1	1	0.00E+00	0.00E+00	0.00E+00	.	.	0.00E+00
Curium-245/246	1	1	6.00E-02	6.00E-02	6.00E-02	.	.	6.00E-02
Curium-248	1	1	2.00E-02	2.00E-02	2.00E-02	.	.	2.00E-02
Plutonium-238	1	1	1.63E+00	1.63E+00	1.63E+00	.	.	1.63E+00
Plutonium-239/240	1	1	7.41E+01	7.41E+01	7.41E+01	.	.	7.41E+01
Strontium-90	1	1	3.62E+02	3.62E+02	3.62E+02	.	.	3.62E+02
Uranium-234	1	1	5.42E+00	5.42E+00	5.42E+00	.	.	5.42E+00
Uranium-235	1	1	1.80E-01	1.80E-01	1.80E-01	.	.	1.80E-01
Uranium-238	1	1	3.87E+00	3.87E+00	3.87E+00	.	.	3.87E+00

Table B18. Summary statistics for radionuclide concentrations (pCi/g), core weighted averages, by subreach

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Subreach 00								
Cesium-137	5	4	1.53E-01	3.73E-01	2.51E-01	4.29E-02	3.43E-01	2.26E-01
Cobalt-60	5	0	9.48E-02	1.68E-01	.	.	.	.
Strontium-90	5	0	1.08E+00	1.71E+00	.	.	.	.
Subreach 1								
Cesium-137	3	3	1.61E-01	9.33E-01	6.00E-01	2.29E-01	1.27E+00	7.06E-01
Cobalt-60	3	2	6.34E-02	5.79E+00	2.05E+00	2.16E+00	8.36E+00	1.72E-01
Subreach 2.01								
Cesium-137	1	0	9.85E-02	9.85E-02	.	.	.	.
Cobalt-60	1	0	1.08E-01	1.08E-01	.	.	.	.
Strontium-90	1	0	1.09E+00	1.09E+00	.	.	.	.
Subreach 2.02								
Americium-241	1	1	1.87E-01	1.87E-01	1.87E-01	.	.	1.87E-01
Cesium-137	1	1	1.01E+01	1.01E+01	1.01E+01	.	.	1.01E+01
Cobalt-60	1	1	6.99E-02	6.99E-02	6.99E-02	.	.	6.99E-02
Curium-243/244	1	1	1.11E-02	1.11E-02	1.11E-02	.	.	1.11E-02
Plutonium-238	1	1	1.41E-02	1.41E-02	1.41E-02	.	.	1.41E-02
Plutonium-239/240	1	1	1.85E-01	1.85E-01	1.85E-01	.	.	1.85E-01
Strontium-90	1	1	2.60E-01	2.60E-01	2.60E-01	.	.	2.60E-01
Uranium-234	1	1	8.10E-01	8.10E-01	8.10E-01	.	.	8.10E-01
Uranium-235	1	1	3.53E-02	3.53E-02	3.53E-02	.	.	3.53E-02
Uranium-238	1	1	7.41E-01	7.41E-01	7.41E-01	.	.	7.41E-01
Subreach 2.03								
Cesium-137	1	0	1.09E-01	1.09E-01	.	.	.	.
Cobalt-60	1	0	1.18E-01	1.18E-01	.	.	.	.
Strontium-90	1	0	1.25E+00	1.25E+00	.	.	.	.
Subreach 2.04								
Americium-241	1	1	1.37E-01	1.37E-01	1.37E-01	.	.	1.37E-01
Cesium-137	7	7	2.39E-01	2.50E+01	6.59E+00	3.33E+00	1.31E+01	2.39E+00
Cobalt-60	7	2	5.44E-02	1.93E-01	1.06E-01	2.03E-02	1.45E-01	8.99E-02
Curium-243/244	1	1	1.39E-02	1.39E-02	1.39E-02	.	.	1.39E-02
Curium-245/246	1	1	1.47E-02	1.47E-02	1.47E-02	.	.	1.47E-02
Curium-248	1	1	2.89E-02	2.89E-02	2.89E-02	.	.	2.89E-02
Plutonium-238	1	1	2.83E-02	2.83E-02	2.83E-02	.	.	2.83E-02

Table B18 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Plutonium-239/240	1	1	1.86E-01	1.86E-01	1.86E-01	.	.	1.86E-01
Strontium-90	8	4	3.22E-01	3.51E+00	1.04E+00	4.45E-01	1.88E+00	3.22E-01
Technetium-99	1	0	1.52E+00	1.52E+00	.	.	.	.
Uranium-234	2	2	6.59E-01	1.35E+00	1.01E+00	3.47E-01	3.20E+00	1.01E+00
Uranium-235	2	1	2.45E-02	6.24E-02	6.24E-02	.	.	6.24E-02
Uranium-238	2	2	6.58E-01	1.23E+00	9.42E-01	2.85E-01	2.74E+00	9.42E-01
Subreach 3.01								
Cesium-137	2	1	9.85E-02	2.54E+00	2.54E+00	.	.	2.54E+00
Cobalt-60	2	0	1.12E-01	1.63E-01	.	.	.	.
Strontium-90	2	0	9.94E-01	1.28E+00	.	.	.	.
Technetium-99	2	0	1.52E+00	3.53E+00	.	.	.	.
Uranium-234	2	2	6.12E-01	3.48E+00	2.05E+00	1.43E+00	1.11E+01	2.05E+00
Uranium-235	2	1	2.55E-02	1.01E-01	1.01E-01	.	.	1.01E-01
Uranium-238	2	2	4.72E-01	2.01E+00	1.24E+00	7.68E-01	6.09E+00	1.24E+00
Subreach 3.02								
Cesium-137	11	9	3.95E-02	8.05E-01	3.22E-01	8.17E-02	4.70E-01	2.36E-01
Cobalt-60	11	1	2.69E-02	2.04E-01	3.45E-02	.	.	3.45E-02
Strontium-90	9	3	4.17E-01	3.96E+00	2.01E+00	3.11E-01	2.58E+00	1.63E+00
Technetium-99	9	6	1.60E+00	2.58E+02	4.14E+01	2.86E+01	9.45E+01	6.14E+00
Uranium-234	9	9	7.69E-01	9.69E+01	1.65E+01	1.03E+01	3.56E+01	3.69E+00
Uranium-235	9	9	4.55E-02	4.89E+00	8.07E-01	5.20E-01	1.77E+00	1.89E-01
Uranium-238	9	9	6.67E-01	6.59E+01	1.12E+01	7.02E+00	2.42E+01	2.69E+00
Subreach 3.03								
Cesium-137	9	8	1.05E-01	3.97E+00	1.29E+00	3.94E-01	2.02E+00	1.17E+00
Cobalt-60	9	0	6.60E-02	1.60E-01	.	.	.	.
Strontium-90	9	2	3.42E-01	2.05E+00	7.57E-01	2.15E-01	1.16E+00	5.96E-01
Technetium-99	9	8	3.55E+00	3.35E+01	1.07E+01	3.36E+00	1.70E+01	5.65E+00
Uranium-234	9	9	2.40E+00	1.56E+01	7.36E+00	1.75E+00	1.06E+01	5.96E+00
Uranium-235	9	9	1.01E-01	1.32E+00	4.13E-01	1.34E-01	6.62E-01	3.30E-01
Uranium-238	9	9	1.88E+00	1.08E+01	5.16E+00	1.10E+00	7.22E+00	4.74E+00
Subreach 3.04								
Americium-241	1	1	1.06E-01	1.06E-01	1.06E-01	.	.	1.06E-01
Cesium-137	8	8	2.92E-01	7.92E+00	5.07E+00	9.99E-01	6.96E+00	5.50E+00
Cobalt-60	8	3	4.38E-02	1.87E-01	6.91E-02	2.38E-02	1.14E-01	4.97E-02
Curium-243/244	1	1	1.11E-02	1.11E-02	1.11E-02	.	.	1.11E-02
Curium-245/246	1	1	1.77E-02	1.77E-02	1.77E-02	.	.	1.77E-02
Curium-248	1	1	1.73E-02	1.73E-02	1.73E-02	.	.	1.73E-02
Plutonium-238	1	1	1.42E-02	1.42E-02	1.42E-02	.	.	1.42E-02

Table B18 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Plutonium-239/240	1	1	1.54E-02	1.54E-02	1.54E-02	.	.	1.54E-02
Strontium-90	7	2	6.78E-02	2.23E+00	3.77E-01	4.05E-01	1.16E+00	6.78E-02
Technetium-99	6	3	1.23E+00	3.77E+00	2.32E+00	5.62E-01	3.46E+00	1.51E+00
Uranium-234	7	7	4.62E-01	6.08E+00	3.49E+00	8.08E-01	5.06E+00	3.10E+00
Uranium-235	7	7	4.18E-02	3.65E-01	1.69E-01	4.13E-02	2.49E-01	1.15E-01
Uranium-238	7	7	2.37E-01	5.21E+00	2.81E+00	7.84E-01	4.34E+00	2.00E+00
Subreach 4.01								
Cesium-137	11	11	1.02E-01	2.69E+01	7.53E+00	2.99E+00	1.29E+01	2.85E+00
Cobalt-60	11	4	3.51E-02	1.28E-01	9.80E-02	3.67E-03	1.05E-01	9.26E-02
Strontium-90	9	0	1.04E+00	1.32E+00	.	.	.	.
Subreach 4.02								
Cesium-137	6	6	3.26E-01	8.28E+00	2.21E+00	1.26E+00	4.75E+00	8.53E-01
Cobalt-60	6	1	1.04E-01	1.96E-01	1.96E-01	.	.	1.96E-01
Strontium-90	6	1	1.01E+00	3.41E+00	3.41E+00	.	.	3.41E+00
Subreach 4.03								
Cesium-137	8	8	2.93E+00	2.03E+01	9.71E+00	2.44E+00	1.43E+01	8.89E+00
Cobalt-60	8	5	7.77E-02	3.94E-01	1.97E-01	4.41E-02	2.81E-01	1.34E-01
Strontium-90	7	0	1.15E+00	3.25E+00	.	.	.	.
Subreach 4.04								
Americium-241	1	1	1.98E-01	1.98E-01	1.98E-01	.	.	1.98E-01
Cesium-137	12	12	1.88E+00	2.39E+01	8.83E+00	1.91E+00	1.23E+01	6.47E+00
Cobalt-60	12	9	1.30E-01	2.95E-01	2.00E-01	1.70E-02	2.31E-01	1.98E-01
Curium-243/244	1	1	1.96E-02	1.96E-02	1.96E-02	.	.	1.96E-02
Curium-245/246	1	1	2.91E-02	2.91E-02	2.91E-02	.	.	2.91E-02
Curium-248	1	1	2.69E-02	2.69E-02	2.69E-02	.	.	2.69E-02
Plutonium-238	1	1	2.12E-02	2.12E-02	2.12E-02	.	.	2.12E-02
Plutonium-239/240	1	1	2.59E-01	2.59E-01	2.59E-01	.	.	2.59E-01
Strontium-90	12	3	3.58E-01	1.61E+00	5.64E-01	1.63E-01	8.57E-01	3.58E-01
Uranium-234	1	1	2.22E+00	2.22E+00	2.22E+00	.	.	2.22E+00
Uranium-235	1	1	1.22E-01	1.22E-01	1.22E-01	.	.	1.22E-01
Uranium-238	1	1	1.88E+00	1.88E+00	1.88E+00	.	.	1.88E+00
Subreach 5								
Americium-241	2	2	3.79E-02	1.02E-01	6.99E-02	3.20E-02	2.72E-01	6.99E-02
Cesium-137	9	5	2.52E-02	1.24E+01	7.22E+00	9.08E-01	8.91E+00	5.42E+00
Cobalt-60	9	5	2.64E-02	1.72E-01	1.11E-01	8.31E-03	1.27E-01	9.87E-02

Table B18 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Curium-243/244	2	2	1.34E-02	1.62E-02	1.48E-02	1.38E-03	2.35E-02	1.48E-02
Curium-245/246	2	2	3.49E-02	4.88E-02	4.19E-02	6.97E-03	8.59E-02	4.19E-02
Curium-248	2	2	2.22E-02	3.52E-02	2.87E-02	6.50E-03	6.98E-02	2.87E-02
Plutonium-238	2	2	2.28E-02	2.95E-02	2.62E-02	3.38E-03	4.75E-02	2.62E-02
Plutonium-239/240	2	2	1.00E-02	9.81E-02	5.41E-02	4.41E-02	3.32E-01	5.41E-02
Strontium-90	2	2	8.83E-02	1.30E-01	1.09E-01	2.07E-02	2.40E-01	1.09E-01
Uranium-234	2	2	1.91E+00	1.93E+00	1.92E+00	9.37E-03	1.97E+00	1.92E+00
Uranium-235	2	2	4.64E-02	8.86E-02	6.75E-02	2.11E-02	2.01E-01	6.75E-02
Uranium-238	2	2	1.60E+00	1.69E+00	1.65E+00	4.12E-02	1.91E+00	1.65E+00
Subreach 7.01								
Cesium-137	1	1	3.40E-01	3.40E-01	3.40E-01	.	.	3.40E-01
Cobalt-60	1	0	1.24E-01	1.24E-01	.	.	.	.
Strontium-90	1	1	2.14E+00	2.14E+00	2.14E+00	.	.	2.14E+00
Subreach 7.02								
Cesium-137	1	1	4.38E-01	4.38E-01	4.38E-01	.	.	4.38E-01
Cobalt-60	1	0	2.77E-01	2.77E-01	.	.	.	.
Strontium-90	1	0	9.67E-01	9.67E-01	.	.	.	.
Subreach 8								
Cesium-137	1	1	6.42E-01	6.42E-01	6.42E-01	.	.	6.42E-01
Cobalt-60	1	0	2.20E-01	2.20E-01	.	.	.	.
Strontium-90	1	0	1.65E+00	1.65E+00	.	.	.	.
Subreach 10								
Americium-241	1	1	5.45E-02	5.45E-02	5.45E-02	.	1 .	5.45E-02
Cesium-137	1	1	9.16E-01	9.16E-01	9.16E-01	.	.	9.16E-01
Cobalt-60	1	0	8.83E-02	8.83E-02	.	.	.	.
Curium-243/244	1	1	1.22E-02	1.22E-02	1.22E-02	.	.	1.22E-02
Curium-245/246	1	1	1.84E-02	1.84E-02	1.84E-02	.	.	1.84E-02
Curium-248	1	1	3.55E-02	3.55E-02	3.55E-02	.	.	3.55E-02
Plutonium-238	1	1	9.61E-03	9.61E-03	9.61E-03	.	.	9.61E-03
Plutonium-239/240	1	1	2.80E-02	2.80E-02	2.80E-02	.	.	2.80E-02
Strontium-90	1	1	1.00E-01	1.00E-01	1.00E-01	.	.	1.00E-01
Uranium-234	1	1	1.20E+00	1.20E+00	1.20E+00	.	.	1.20E+00
Uranium-235	1	1	6.03E-02	6.03E-02	6.03E-02	.	.	6.03E-02
Uranium-238	1	1	1.32E+00	1.32E+00	1.32E+00	.	.	1.32E+00

Table B18 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Subreach 13								
Cesium-137	5	1	1.22E-01	3.04E-01	3.04E-01	.	.	3.04E-01
Cobalt-60	5	0	1.20E-01	1.56E-01	.	.	.	.
Strontium-90	5	0	1.16E+00	2.56E+00	.	.	.	.
Technetium-99	5	0	1.26E+00	1.85E+00	.	.	.	.
Uranium-234	5	5	3.26E-01	1.44E+00	7.61E-01	1.93E-01	1.17E+00	6.33E-01
Uranium-235	5	2	2.99E-02	9.86E-02	4.48E-02	1.70E-02	8.10E-02	3.14E-02
Uranium-238	5	5	3.05E-01	9.66E-01	6.60E-01	1.17E-01	9.10E-01	7.70E-01
Subreach 18								
Cesium-137	3	3	1.59E-01	3.44E-01	2.26E-01	5.89E-02	3.98E-01	1.76E-01
Cobalt-60	3	0	4.59E-02	1.55E-01	.	.	.	.
Strontium-90	3	1	1.14E+00	1.22E+00	1.14E+00	.	.	1.14E+00
Subreach 22								
Americium-241	1	1	6.87E+00	6.87E+00	6.87E+00	.	.	6.87E+00
Cesium-137	1	1	7.89E+03	7.89E+03	7.89E+03	.	.	7.89E+03
Cobalt-60	1	1	3.26E+01	3.26E+01	3.26E+01	.	.	3.26E+01
Curium-243/244	1	1	0.00E+00	0.00E+00	0.00E+00	.	.	0.00E+00
Curium-245/246	1	1	6.00E-02	6.00E-02	6.00E-02	.	.	6.00E-02
Curium-248	1	1	2.00E-02	2.00E-02	2.00E-02	.	.	2.00E-02
Plutonium-238	1	1	1.63E+00	1.63E+00	1.63E+00	.	.	1.63E+00
Plutonium-239/240	1	1	7.41E+01	7.41E+01	7.41E+01	.	.	7.41E+01
Strontium-90	1	1	3.62E+02	3.62E+02	3.62E+02	.	.	3.62E+02
Uranium-234	1	1	5.42E+00	5.42E+00	5.42E+00	.	.	5.42E+00
Uranium-235	1	1	1.80E-01	1.80E-01	1.80E-01	.	.	1.80E-01
Uranium-238	1	1	3.87E+00	3.87E+00	3.87E+00	.	.	3.87E+00

Table B19. Summary statistics for radionuclide concentrations in porewater (pCi/L) by reach

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach 1								
Cesium-137	5	0	5.09e+00	1.28e+01	0.00e+00	.	.	.
Cobalt-60	5	0	4.26e+00	1.02e+00	.	.	.	.
Strontium-90	5	0	1.69e+00	1.74e+01	.	.	.	.
Reach 2								
Cesium-137	7	0	4.79e+00	1.12e+01	.	.	.	.
Cobalt-60	7	0	4.60e+00	1.01e+01	.	.	.	.
Strontium-90	5	1	1.22e+00	9.79e+00	5.15e+00	.	.	5.15e+00
Uranium-234	1	1	1.48e-01	1.48e-01	1.48e-01	.	.	1.48e-01
Uranium-235	1	0	1.77e-01	1.77e-01	.	.	.	.
Uranium-238	1	1	8.38e-02	8.38e-02	8.39e-02	.	.	8.39e-02
Reach 3								
Cesium-137	24	0	4.78e+00	1.31e+01	.	.	.	.
Cobalt-60	24	0	4.51e+00	1.42e+01	.	.	.	.
Strontium-90	18	6	1.95e+00	1.97e+01	3.42e+00	1.05e+00	5.24e+00	1.97e+00
Uranium-234	25	24	1.80e-01	5.78e+01	6.14e+00	2.38e+00	1.02e+01	3.02e+00
Uranium-235	25	17	5.86e-02	3.20e+00	3.67e-01	1.34e-01	5.97e-01	1.43e-01
Uranium-238	25	24	3.45e-01	3.62e+01	4.09e+00	1.43e+00	6.55e+00	2.35e+00
Reach 4								
Cesium-137	29	0	5.00e+00	1.83e+01	.	.	.	.
Cobalt-60	29	0	3.97e+00	1.29e+01	.	.	.	.
Gross alpha activity	8	3	9.50e-01	2.40e+00	1.57e+00	1.36e-01	1.83e+00	1.45e+00
Gross beta activity	8	8	2.00e+00	1.11e+01	5.45e+00	9.46e-01	7.24e+00	5.03e+00
Strontium-90	30	3	1.18e+00	5.00e+00	2.06e+00	9.18e-02	2.21e+00	1.95e+00
Reach 7								
Cesium-137	2	0	5.44e+00	1.13e+01	.	.	.	.
Cobalt-60	2	0	4.53e+00	8.75e+00	.	.	.	.
Strontium-90	2	0	1.13e+00	2.09e+00	.	.	.	.
Reach 8								
Cesium-137	1	0	1.30e+01	1.30e+01	.	.	.	.
Cobalt-60	1	0	9.73e+00	9.73e+00	.	.	.	.
Strontium-90	1	0	2.97e+00	2.97e+00	.	.	.	.
Reach 13								
Cesium-137	5	0	5.17e+00	1.78e+01	.	.	.	.
Cobalt-60	5	0	5.70e+00	1.63e+01	.	.	.	.
Strontium-90	4	0	1.93e+00	2.41e+00	.	.	.	.
Uranium-234	4	4	3.33e-01	9.09e-01	5.09e-01	1.34e-01	8.25e-01	3.97e-01
Uranium-235	4	1	7.43e-02	1.94e-01	8.94e-02	.	.	8.94e-02
Uranium-238	4	4	3.08e-01	5.11e-01	4.28e-01	4.95e-02	5.44e-01	4.46e-01

Table B19 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Reach 18								
Cesium-137	2	0	1.01e+01	1.17e+01	.	.	.	.
Cobalt-60	2	0	7.49e+00	1.28e+01	.	.	.	.
Strontium-90	3	0	2.09e+00	2.53e+00	.	.	.	.

Appendix C

BIOTA CHARACTERIZATION

Table C1. Concentration of radionuclides in Clinch River fish (from ORNL 1966) (pc/kg fresh weight)

Fish Species	SamplePeriod	^{90}Sr		^{137}Cs		^{106}Ru		^{60}Co	
		Flesh	Total[a]	Flesh	Total[a]	Flesh	Total[a]	Flesh	Total[a]
Carp	1960–1962	(17)[b] 500±140	(40) 5100±1700	(71) 510±57	(39) 560±79	(69) 170±18	(39) 290±78	(67) 66±6.1	(39) 49±9.9
	1963	(20) 91±22		(20) 320±110					
Carpsucker	1960–1962	(18) 540±190	(39) 940±120	(122) 1200±460	(37) 640±67	(22) 120±30	(37) 56±16	(22) 120±19	(37) 32±6.8
	1963	(20) 22±4.4	(39) 4800[d]	(20) 460±82					
Buffalo	1960–1962	(3) 240±89	(30) 830±110	(5) 480±94	(30) 590±92	(5) 110±32	(30) 150±38	(5) 78±21	(30) 32±6.8
	1963	(20) 43±14		(21) 560±84					
Sight Feeders[c]	1960–1962	(109) 180±83		(126) 680±120		(127) 120±32		(127) 22±11	

Table C2. Comparison of mean values for various chemical parameters in fish in the lower Clinch River below Melton Hill Dam[a] (from TVA 1983)

Parameter	Bluegill	Largemouth Bass	Gizzard Shad	Lepomis	Approximate Range of Background Concentrations[c]	FDA Action Level
Mercury	0.30	0.23	0.05	0.37	0.05–0.20	1.0
Cadmium	0.01	0.01	0.01	0.01	0.02–0.07	—
Chromium	0.05	0.08	0.17	0.03	0.03–0.10	—
Copper	0.25	0.33	0.63	0.30	0.15–0.90	—
Lead	0.07	0.12	0.10	0.14	0.03–0.70	d
Nickel	0.72	0.55	0.51	0.60	0.20–0.60	—
Zinc	6.4	5.8	4.1	11.1	5–10	d
PCB	—	0.20	0.22	0.15	<0.10	5.0

[a] Numbers given are averages of the available data, 1976–1983.
[b] All concentrations given in $\mu g/g$ (ppm).
[c] Based primarily on the state-wide mean concentrations for trace metals in fish (Sinclair et al. 1979) and on average concentrations in Melton Hill Reservoir at CRM 52.2.
[d] The U.S. Food and Drug Administration (FDA) has no recommended action level for lead or zinc, but the Canadian Food and Drug Directorate has set standards of 10 and 100 ppm, respectively, for these metals.

Table C3. Comparison of average concentrations for selected parameters in fish from Poplar Creek[a] (fromTVA 1983)

Species	Mercury	Chromium	Nickel	PCB
Bluegill	0.31	0.16	0.78	0.17
Largemouth Bass	0.59	0.19	0.56	0.38
Gizzard Shad	0.04	0.07	1.28	0.27
Lepomis	0.43	0.03	0.66	0.30
Channel Catfish	0.39	0.33	1.42	1.6
Approximate Range of Background Concentrations[b]	(0.05–0.20)	(0.03–0.10)	(0.20–0.60)	<0.10

[a] Numbers given are averages of the available data, 1976–1983. All concentrations given in $\mu g/g$ (ppm).
[b] Based primarily on state-wide mean concentrations for trace metals in fish (Sinclair et al. 1979) and on average concentrations in Melton Hill Reservoir at CRM 52.2.

Table C4. Instream contaminant study – task 4, total PCBs in fish flesh samples from 16 sites in the vicinity of Oak Ridge, Tennessee (from TVA 1985)**

						Individuals						
Sample Site	Species	1	2	3	4	5	6	7	8	9	10	Mean
Scarboro Creek	Channel catfish	U	U	U	U	U	U	U	U	U	U	–
McCoy Branch	Channel catfish Yellow bullhead	U U	1.0	U	U	U	U	U	U	U		0.1 –
Melton Hill Dam	Channel catfish Yellow bullhead	U U	U U	4.7* U	U							1.6 –
White Oak Creek Mile 0.2	Channel catfish Black bullhead	3.0* U	2.4 U	2.2	5.6*	2.7	3.5*	2.8	2.8			3.1* –
White Oak Lake	Common carp	U	0.2	0.6	U	1.0	U	U	0.4			0.3
Clinch River Mile 11.0	Channel catfish	1.1	1.5	0.3	2.1	0.9	0.4	1.7	0.7	0.5	U	0.9
Clinch River Mile 6.0	Channel catfish	0.4	0.6	1.1	0.2	0.6	0.5	0.6	1.6	0.8	1.0	0.7
Clinch River Mile 2.0	Channel catfish	0.3	0.4	0.9	0.6	0.7	1.5	0.6	0.7	0.7	U	0.6
Emory River Mile 1.0	Channel catfish	0.6	1.0	0.8	1.4	0.9	U	U	0.5	0.3	U	0.6
TRM 572	Channel catfish	U	0.3	U	0.2	0.2	0.5	U	0.4	0.4	0.3	0.2
TRM 558	Channel catfish	1.3	0.2	U	0.6	1.4	1.1	0.8	0.5	0.3	U	0.6
EFPC Mile 13.8	Bluegill Largemouth bass Common carp	U U 3.1*	U 0.5 3.7*	0.9 2.0								– 0.5 2.9
EFPC Mile 8.8	Rock bass	U	U	U	U	U	U	U	U	U	U	–
EFPC Mile 4.0	Channel catfish Spotted sucker Northern hog sucker	0.6 U U										0.6 – –
Bear Creek Mile 0.4	Rock bass	U	U	U	U	U	U	U	U	U	0.2	Trace
Poplar Creek Mile 0.2	Channel catfish	U	U	2.1	U	U	U	0.7	1.8	2.5	3.4*	1.1

U – Undetectable level; * – Above FDA action level; ** – Total concentrations obtained by summing detectable levels.

Table C5. Instream contaminant study – task 4, significant maximum concentrations for radioisotopes in fish flesh samples – pCi/g, dry weight (from TVA 1985)

Analysis/Isotope	NRC Reporting Level[a]	Tennessee River[b]	Lower Limit of Detection[c]	Clinch River	East Fork Poplar Creek	White Oak Lake	White Oak Embayment	Bear Creek
Gross Alpha	d	5	0.1	.07	.9	.05	.07	.02
Gross Beta	d	45	0.1	64	74	76	40	29
Sr-89	d	1.2	0.5	.1	.2	.2	-1.6[e]	f
Sr-90	d	0.3	0.3	.01	.06	.25	1.3	f
Gamma Spectral Analysis[g]								
Co-60	40	.03	.01	–	.03	.12	.07	–
Cs-134	4	–	.08	–	.11	.04	–	–
Cs-137	8	.2	.02	18	2.6	26	9.7	.4
K-40	d	20	1.00	18	22	17	14	18

a – Reporting levels for radioactivity concentrations in environmental samples as outlined in Draft NUREG-0472, Rev. 3, *Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors*, January 1983.
b – Maximum concentrations reported by TVA in fish samples collected from the Tennessee River from 1981–1983.
c – Lower limit of detection as determined by the method developed by Pasternack and Harley and described in HASL-300 and Nucl. Instr. Methods 91. 533-4- (1971).
d – No reporting level given.
e – Negative value is an artifact of counting statistics and does not infer a negative activity.
f – Analysis not performed.
g – dash indicates isotope not identified in gamma spectral analysis.

Table C6. Summary of inorganic and organic contaminant analysis of sport fish fillets by site, year, and species

INORGANICS

ANALYTE	TAXON	COMPOSITE	SITE	YEAR	N	# DETECTS	MIN	MAX	MEAN	STDERR	UCB
Arsenic	BLUGIL	N	CRM 1.0	1993	20	5	0.016	0.12	0.04592	0.00711	0.0582
Arsenic	BLUGIL	N	CRM 1.0	1994	10	9	0.006	0.042	0.0174	0.00396	0.0247
Arsenic	BLUGIL	N	CRM 10.0	1994	10	6	0.006	0.14	0.036	0.01407	0.0618
Arsenic	BLUGIL	N	CRM 125.0	1993	20	2	0.006	0.14	0.121	0.00138	0.1234
Arsenic	BLUGIL	N	CRM 125.0	1994	10	7	0.006	0.14	0.0852	0.01319	0.1094
Arsenic	BLUGIL	N	CRM 20.0	1993	20	3	0.006	0.13	0.0287	0.0088	0.0439
Arsenic	BLUGIL	N	CRM 20.0	1994	10	0	0.006	0.086	.	.	.
Arsenic	BLUGIL	N	CRM 21.5	1994	10	0	0.018	0.092	.	.	.
Arsenic	BLUGIL	N	PCM 1.0	1993	20	8	0.006	0.16	0.08464	0.00593	0.0949
Arsenic	BLUGIL	N	PCM 4.6	1994	10	9	0.026	0.12	0.06715	0.01048	0.0864
Arsenic	BLUGIL	N	PCM 5.3	1994	9	8	0.02	0.23	0.14222	0.0132	0.1668
Arsenic	BLUGIL	N	PRM 30.0	1993	20	15	0.006	0.18	0.06662	0.01431	0.0914
Arsenic	BLUGIL	N	TRM 555.0	1993	20	5	0.026	0.12	0.1105	0.00054	0.1114
Arsenic	BLUGIL	N	TRM 570.0	1993	20	4	0.014	0.07	0.02061	0.00388	0.0273
Arsenic	CHNCAT	N	CRM 1.0	1993	15	5	0.014	0.11	0.06347	0.00436	0.0712
Arsenic	CHNCAT	N	CRM 10.0	1994	10	1	0.006	0.012	0.012	.	.
Arsenic	LMBASS	N	CRM 1.0	1993	20	20	0.17	0.49	0.2655	0.01718	0.2952
Arsenic	LMBASS	N	CRM 1.0	1994	10	10	0.008	0.3	0.1748	0.02799	0.2261
Arsenic	LMBASS	N	CRM 10.0	1994	10	10	0.13	0.51	0.237	0.03621	0.3034
Arsenic	LMBASS	N	CRM 125.0	1993	20	20	0.012	0.33	0.2173	0.01986	0.2516
Arsenic	LMBASS	N	CRM 125.0	1994	10	10	0.16	0.42	0.246	0.02432	0.2906
Arsenic	LMBASS	N	CRM 20.0	1993	13	13	0.1	0.43	0.28462	0.025	0.3292
Arsenic	LMBASS	N	CRM 20.0	1994	5	5	0.19	0.38	0.302	0.03597	0.3787
Arsenic	LMBASS	N	CRM 21.5	1994	8	8	0.17	0.45	0.3	0.03311	0.3627
Arsenic	LMBASS	N	PCM 1.0	1993	20	20	0.084	0.42	0.2182	0.01976	0.2524
Arsenic	LMBASS	N	PCM 4.6	1994	7	6	0.052	0.32	0.14095	0.04374	0.2259
Arsenic	LMBASS	N	PCM 5.3	1994	2	1	0.052	0.12	0.12	.	.
Arsenic	LMBASS	N	PRM 30.0	1993	20	20	0.034	0.51	0.2516	0.0352	0.3125
Arsenic	LMBASS	N	TRM 555.0	1993	20	19	0.01	0.35	0.1721	0.01495	0.198
Arsenic	LMBASS	N	TRM 570.0	1993	20	19	0.01	0.38	0.238	0.01295	0.2604
Beryllium	BLUGIL	N	CRM 1.0	1993	20	0	0.0006	0.002	.	.	.
Beryllium	BLUGIL	N	CRM 1.0	1994	10	10	0.002	0.006	0.0032	0.00044	0.004
Beryllium	BLUGIL	N	CRM 10.0	1994	10	0	0.0008	0.0008	.	.	.
Beryllium	BLUGIL	N	CRM 125.0	1993	20	0	0.0008	0.0008	.	.	.
Beryllium	BLUGIL	N	CRM 125.0	1994	10	7	0.0008	0.01	0.0072	0.00055	0.0082
Beryllium	BLUGIL	N	CRM 20.0	1993	20	2	0.0006	0.004	0.0021	0.00014	0.0023
Beryllium	BLUGIL	N	CRM 20.0	1994	10	0	0.0008	0.0008	.	.	.
Beryllium	BLUGIL	N	CRM 21.5	1994	10	5	0.0008	0.004	0.004	0	0.004
Beryllium	BLUGIL	N	PCM 1.0	1993	20	5	0.0006	0.004	0.0021	0.00011	0.0023
Beryllium	BLUGIL	N	PCM 4.6	1994	10	6	0.004	0.01	0.009	0.00035	0.0096
Beryllium	BLUGIL	N	PCM 5.3	1994	9	9	0.004	0.01	0.00622	0.00078	0.0077
Beryllium	BLUGIL	N	PRM 30.0	1993	20	7	0.0008	0.016	0.0028	0.00074	0.0041
Beryllium	BLUGIL	N	TRM 555.0	1993	20	0	0.0006	0.0008	.	.	.
Beryllium	BLUGIL	N	TRM 570.0	1993	20	9	0.0006	0.004	0.0024	0.00019	0.0027
Beryllium	CHNCAT	N	CRM 1.0	1993	15	1	0.0008	0.002	0.002	.	.
Beryllium	CHNCAT	N	CRM 10.0	1994	10	3	0.0008	0.006	0.0042	0.00023	0.0046
Beryllium	LMBASS	N	CRM 1.0	1993	20	0	0.0008	0.0008	.	.	.
Beryllium	LMBASS	N	CRM 1.0	1994	10	0	0.0008	0.0008	.	.	.
Beryllium	LMBASS	N	CRM 10.0	1994	10	0	0.0008	0.006	.	.	.
Beryllium	LMBASS	N	CRM 125.0	1993	20	0	0.0006	0.0008	.	.	.
Beryllium	LMBASS	N	CRM 125.0	1994	10	10	0.002	0.006	0.0036	0.0005	0.0045
Beryllium	LMBASS	N	CRM 20.0	1993	13	3	0.0008	0.004	0.00215	0.00018	0.0025
Beryllium	LMBASS	N	CRM 20.0	1994	5	3	0.0008	0.002	0.002	0	0.002
Beryllium	LMBASS	N	CRM 21.5	1994	8	0	0.0008	0.0008	.	.	.
Beryllium	LMBASS	N	PCM 1.0	1993	20	6	0.0006	0.004	0.0024	0.0002	0.0027
Beryllium	LMBASS	N	PCM 4.6	1994	7	0	0.0008	0.008	.	.	.
Beryllium	LMBASS	N	PCM 5.3	1994	2	2	0.006	0.008	0.007	0.001	0.0133
Beryllium	LMBASS	N	PRM 30.0	1993	20	8	0.0006	0.004	0.002	0	0.002
Beryllium	LMBASS	N	TRM 555.0	1993	20	10	0.0008	0.004	0.0028	0.00023	0.0032
Beryllium	LMBASS	N	TRM 570.0	1993	20	20	0.002	0.006	0.0036	0.00023	0.004
Copper	BLUGIL	N	CRM 1.0	1994	10	1	0.254	2.8	2.8	.	.

Table C6 (continued)

Copper	BLUGIL	N	CRM 10.0	1994	10	3	0.17	0.6	0.51	0.01162	0.5313
Copper	BLUGIL	N	CRM 125.0	1993	2	1	0.29	0.416	0.29	.	.
Copper	BLUGIL	N	CRM 125.0	1994	10	0	0.012	0.472	.	.	.
Copper	BLUGIL	N	CRM 20.0	1994	10	10	0.092	1.1	0.2858	0.09695	0.4635
Copper	BLUGIL	N	CRM 21.5	1994	10	2	0.196	55	6.04	7.29853	19.419
Copper	BLUGIL	N	PCM 4.6	1994	10	1	0.166	1.2	1.2	.	.
Copper	BLUGIL	N	PCM 5.3	1994	9	2	0.012	1.4	0.86667	0.08889	1.032
Copper	BLUGIL	N	TRM 555.0	1993	18	9	0.186	0.6	0.30287	0.03007	0.3552
Copper	CHNCAT	N	CRM 1.0	1993	15	4	0.22	0.7	0.528	0.02017	0.5635
Copper	CHNCAT	N	CRM 10.0	1994	10	7	0.192	7.4	0.9599	0.73347	2.3044
Copper	LMBASS	N	CRM 1.0	1994	10	10	0.19	10	2.5314	1.16672	4.6701
Copper	LMBASS	N	CRM 10.0	1994	10	1	0.196	0.7	0.7	.	
Copper	LMBASS	N	CRM 125.0	1994	10	0	0.226	0.394	.	.	.
Copper	LMBASS	N	CRM 20.0	1994	5	0	0.174	0.274	.	.	.
Copper	LMBASS	N	CRM 21.5	1994	8	0	0.156	0.386	.	.	.
Copper	LMBASS	N	PCM 4.6	1994	7	0	0.182	0.494	.	.	.
Copper	LMBASS	N	PCM 5.3	1994	2	0	0.234	0.244	.	.	.
Copper	LMBASS	N	TRM 555.0	1993	20	3	0.25	0.8	0.52	0.01857	0.5521
Mercury	BLUGIL	N	CRM 1.0	1993	20	11	0.03	0.6	0.09631	0.02941	0.1472
Mercury	BLUGIL	N	CRM 1.0	1994	10	0	0.1	0.16	.	.	.
Mercury	BLUGIL	N	CRM 10.0	1994	10	10	0.078	0.45	0.1858	0.03184	0.2442
Mercury	BLUGIL	N	CRM 125.0	1993	20	9	0.015	0.11	0.04493	0.00735	0.0576
Mercury	BLUGIL	N	CRM 125.0	1994	10	10	0.05	0.15	0.0938	0.01042	0.1129
Mercury	BLUGIL	N	CRM 20.0	1993	20	19	0.028	0.21	0.08531	0.01134	0.1049
Mercury	BLUGIL	N	CRM 20.0	1994	10	4	0.06	0.21	0.15	0.00766	0.164
Mercury	BLUGIL	N	CRM 21.5	1994	10	0	0.017	0.082	.	.	.
Mercury	BLUGIL	N	PCM 1.0	1993	20	19	0.1	0.81	0.3015	0.03925	0.3694
Mercury	BLUGIL	N	PCM 4.6	1994	10	10	0.21	0.43	0.34	0.02305	0.3822
Mercury	BLUGIL	N	PCM 5.3	1994	9	7	0.18	0.68	0.42556	0.05137	0.5211
Mercury	BLUGIL	N	PRM 30.0	1993	20	5	0.015	0.088	0.03036	0.00184	0.0335
Mercury	BLUGIL	N	TRM 555.0	1993	20	4	0.053	0.13	0.10056	0.00062	0.1016
Mercury	BLUGIL	N	TRM 570.0	1993	20	4	0.04	0.099	0.045	0.00305	0.0503
Mercury	CHNCAT	N	CRM 1.0	1993	15	14	0.015	0.76	0.26153	0.05238	0.3538
Mercury	CHNCAT	N	CRM 10.0	1994	10	5	0.1	0.56	0.193	0.04991	0.2845
Mercury	LMBASS	N	CRM 1.0	1993	20	17	0.11	0.77	0.292	0.03064	0.345
Mercury	LMBASS	N	CRM 1.0	1994	10	5	0.22	0.74	0.404	0.04047	0.4782
Mercury	LMBASS	N	CRM 10.0	1994	10	10	0.068	0.7	0.2947	0.05756	0.4002
Mercury	LMBASS	N	CRM 125.0	1993	20	19	0.05	0.85	0.3415	0.03913	0.4092
Mercury	LMBASS	N	CRM 125.0	1994	10	10	0.16	0.56	0.274	0.03757	0.3429
Mercury	LMBASS	N	CRM 20.0	1993	13	8	0.015	0.64	0.24631	0.05207	0.3391
Mercury	LMBASS	N	CRM 20.0	1994	5	4	0.015	0.66	0.348	0.09118	0.5424
Mercury	LMBASS	N	CRM 21.5	1994	8	6	0.052	0.4	0.20375	0.04278	0.2848
Mercury	LMBASS	N	PCM 1.0	1993	20	20	0.28	1.61	0.569	0.08519	0.7163
Mercury	LMBASS	N	PCM 4.6	1994	7	7	0.3	1.47	0.74857	0.16752	1.0741
Mercury	LMBASS	N	PCM 5.3	1994	2	2	0.69	1.87	1.28	0.59	5.0051
Mercury	LMBASS	N	PRM 30.0	1993	20	20	0.11	0.64	0.308	0.03477	0.3681
Mercury	LMBASS	N	TRM 555.0	1993	20	19	0.12	0.5	0.251	0.01975	0.2851
Mercury	LMBASS	N	TRM 570.0	1993	20	20	0.15	0.44	0.265	0.01941	0.2986
Selenium	BLUGIL	N	CRM 1.0	1993	20	20	0.3	0.6	0.42	0.02471	0.4627
Selenium	BLUGIL	N	CRM 1.0	1994	10	10	0.2	0.6	0.4	0.03651	0.4669
Selenium	BLUGIL	N	CRM 10.0	1994	10	9	0.012	0.9	0.46	0.07823	0.6034
Selenium	BLUGIL	N	CRM 125.0	1993	20	16	0.008	0.5	0.285	0.02224	0.3235
Selenium	BLUGIL	N	CRM 125.0	1994	10	9	0.012	0.7	0.3884	0.07438	0.5247
Selenium	BLUGIL	N	CRM 20.0	1993	20	19	0.008	0.4	0.3	0.01624	0.3281
Selenium	BLUGIL	N	CRM 20.0	1994	10	10	0.146	0.5	0.2574	0.03682	0.3249
Selenium	BLUGIL	N	CRM 21.5	1994	10	9	0.194	0.8	0.49	0.0436	0.5699
Selenium	BLUGIL	N	PCM 1.0	1993	20	20	0.124	0.4	0.2712	0.01735	0.3012
Selenium	BLUGIL	N	PCM 4.6	1994	10	8	0.158	0.5	0.31	0.04395	0.3906
Selenium	BLUGIL	N	PCM 5.3	1994	9	9	0.2	0.7	0.48889	0.05122	0.5841
Selenium	BLUGIL	N	PRM 30.0	1993	20	20	0.2	0.8	0.475	0.03067	0.528
Selenium	BLUGIL	N	TRM 555.0	1993	20	20	0.2	0.5	0.31	0.01906	0.343
Selenium	BLUGIL	N	TRM 570.0	1993	20	15	0.158	0.4	0.255	0.01862	0.2872
Selenium	CHNCAT	N	CRM 1.0	1993	15	9	0.012	0.156	0.06221	0.01245	0.0841
Selenium	CHNCAT	N	CRM 10.0	1994	9	3	0.012	0.074	0.04022	0.00635	0.052
Selenium	LMBASS	N	CRM 1.0	1993	20	20	0.2	0.7	0.33	0.02524	0.3736
Selenium	LMBASS	N	CRM 1.0	1994	10	10	0.3	0.6	0.48	0.0359	0.5458

Table C6 (continued)

Selenium	LMBASS	N	CRM 10.0	1994	10	5	0.024	0.5	0.33	0.02264	0.3715
Selenium	LMBASS	N	CRM 125.0	1993	20	20	0.4	0.6	0.48	0.01717	0.5097
Selenium	LMBASS	N	CRM 125.0	1994	10	10	0.184	0.7	0.3484	0.04831	0.437
Selenium	LMBASS	N	CRM 20.0	1993	13	13	0.3	0.4	0.35385	0.01439	0.3795
Selenium	LMBASS	N	CRM 20.0	1994	5	5	0.3	0.6	0.44	0.06	0.5679
Selenium	LMBASS	N	CRM 21.5	1994	8	8	0.2	0.5	0.3375	0.03239	0.3989
Selenium	LMBASS	N	PCM 1.0	1993	20	17	0.198	0.5	0.285	0.02097	0.3213
Selenium	LMBASS	N	PCM 4.6	1994	7	3	0.1	0.3	0.22857	0.02091	0.2692
Selenium	LMBASS	N	PCM 5.3	1994	2	1	0.16	0.2	0.2	.	.
Selenium	LMBASS	N	PRM 30.0	1993	20	13	0.4	0.6	0.45176	0.01582	0.4791
Selenium	LMBASS	N	TRM 555.0	1993	20	20	0.168	0.4	0.2734	0.0148	0.299
Selenium	LMBASS	N	TRM 570.0	1993	20	16	0.012	0.3	0.2245	0.01007	0.2419

ORGANICS(Semivolatiles)

ANALYTE	TAXON	COMPOSITE	SITE	YEAR	N	# DETECTS	MIN	MAX	MEAN	STDERR	UCB
1,2,4-Trichlorobenzene	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
1,2-Dichlorobenzene	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
1,3-Dichlorobenzene	CHNCAT	N	PCM 1.0	1994	10	0	0.13	0.13	.	.	.
1,4-Dichlorobenzene	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
2,2'-oxybis(1-chloropropane)	CHNCAT	N	PCM 1.0	1994	10	0	0.033	0.033	.	.	
2,4,5-Trichlorophenol	CHNCAT	N	PCM 1.0	1994	10	0	1.7	1.7	.	.	.
2,4,6-Trichlorophenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
2,4-Dichlorophenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
2,4-Dimethylphenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
2,4-Dinitrophenol	CHNCAT	N	PCM 1.0	1994	10	0	1.7	1.7	.	.	.
2,4-Dinitrotoluene	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
2,6-Dinitrotoluene	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
2-Chloronaphthalene	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
2-Chlorophenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
2-Methyl-4,6-dinitrophenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
2-Methylnaphthalene	CHNCAT	N	PCM 1.0	1994	10	0	0.13	0.13	.	.	.
2-Methylphenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
2-Nitroaniline	CHNCAT	N	PCM 1.0	1994	10	0	1.7	1.7	.	.	.
2-Nitrophenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
3,3'-Dichlorobenzidine	CHNCAT	N	PCM 1.0	1994	9	0	0.13	0.13	.	.	.
3-Nitroaniline	CHNCAT	N	PCM 1.0	1994	10	0	1.7	1.7	.	.	.
4-Bromophenyl phenyl ether	CHNCAT	N	PCM 1.0	1994	10	0	0.13	0.13	.	.	.
4-Chloro-3-methylphenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
4-Chlorobenzenamine	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
4-Chlorophenylphenyl ether	CHNCAT	N	PCM 1.0	1994	10	0	0.13	0.13	.	.	.
4-Methylphenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
4-Nitroaniline	CHNCAT	N	PCM 1.0	1994	10	0	1.7	1.7	.	.	.
4-Nitrophenol	CHNCAT	N	PCM 1.0	1994	10	0	1.7	1.7	.	.	.
Acenaphthene	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
Acenaphthylene	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
Anthracene	CHNCAT	N	PCM 1.0	1994	10	0	0.033	0.033	.	.	.
Benzo(a)anthracene	CHNCAT	N	PCM 1.0	1994	9	0	0.033	0.033	.	.	.
Benzo(a)pyrene	CHNCAT	N	PCM 1.0	1994	1	0	0.033	0.033	.	.	.
Benzo(b)fluoranthene	CHNCAT	N	PCM 1.0	1994	1	0	0.033	0.033	.	.	.
Benzo(ghi)perylene	CHNCAT	N	PCM 1.0	1994	1	0	0.033	0.033	.	.	.
Benzo(k)fluoranthene	CHNCAT	N	PCM 1.0	1994	1	0	0.033	0.033	.	.	.
Benzoic acid	CHNCAT	N	PCM 1.0	1994	1	0	0.67	0.67	.	.	.
Benzyl alcohol	CHNCAT	N	PCM 1.0	1994	1	0	0.33	0.33	.	.	.
Bis(2-chloroethoxy)methane	CHNCAT	N	PCM 1.0	1994	10	0	0.13	0.13	.	.	.
Bis(2-chloroethyl) ether	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
Bis(2-ethylhexyl)phthalate	CHNCAT	N	PCM 1.0	1994	9	0	0.033	0.12	.	.	.
Butylbenzylphthalate	CHNCAT	N	PCM 1.0	1994	9	0	0.033	0.033	.	.	.
Carbazole	CHNCAT	N	PCM 1.0	1994	10	0	0.033	0.033	.	.	.
Chrysene	CHNCAT	N	PCM 1.0	1994	9	0	0.033	0.033	.	.	.
Di-n-butylphthalate	CHNCAT	N	PCM 1.0	1994	10	0	0.033	0.081	.	.	.
Di-n-octylphthlate	CHNCAT	N	PCM 1.0	1994	1	0	0.13	0.13	.	.	.
Dibenz(a,h)anthracene	CHNCAT	N	PCM 1.0	1994	1	0	0.033	0.033	.	.	.
Dibenzofuran	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
Diethylphthalate	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
Dimethylphthalate	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.

Table C6 (continued)

Fluoranthene	CHNCAT	N	PCM 1.0	1994	10	0	0.033	0.033	.		
Fluorene	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.		.
Hexachlorobenzene	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.		.
Hexachlorobutadiene	CHNCAT	N	PCM 1.0	1994	10	0	0.13	0.13	.	.	.
Hexachlorocyclopentadiene	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	
Hexachloroethane	CHNCAT	N	PCM 1.0	1994	10	0	0.13	0.13	.	.	.
Indeno(1,2,3-cd)pyrene	CHNCAT	N	PCM 1.0	1994	1	0	0.033	0.033	.	.	.
Isophorone	CHNCAT	N	PCM 1.0	1994	10	0	0.033	0.033	.	.	.
N-Nitroso-di-n-propylamine	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
N-Nitrosodiphenylamine	CHNCAT	N	PCM 1.0	1994	10	0	0.067	0.067	.	.	.
Naphthalene	CHNCAT	N	PCM 1.0	1994	10	3	0.028	0.033	0.029333	.00088192	0.03095
Nitrobenzene	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
Pentachlorophenol	CHNCAT	N	PCM 1.0	1994	10	0	1.7	1.7	.	.	.
Phenanthrene	CHNCAT	N	PCM 1.0	1994	10	0	0.033	0.033	.	.	.
Phenol	CHNCAT	N	PCM 1.0	1994	10	0	0.33	0.33	.	.	.
Pyrene	CHNCAT	N	PCM 1.0	1994	9	0	0.033	0.033	.	.	.

ORGANICS (PCBs/pesticides)

ANALYTE	TAXON	COMPOSITE	SITE	YEAR	N	# DETECTS	MIN	MAX	MEAN	STDERR	UCB
Chlordane, total	BLUGIL	Y	CRM 1.0	1992	1	1	0.057	0.057	0.057	.	.
Chlordane, total	CHNCAT	N	CRM 1.0	1991	10	10	0.11	0.44	0.223	0.03145	0.2806
Chlordane, total	CHNCAT	N	CRM 1.0	1992	19	19	0.06	0.28	0.1168	0.01236	0.1383
Chlordane, total	CHNCAT	N	CRM 1.0	1993	25	24	0.06	0.24	0.1162	0.00915	0.1318
Chlordane, total	CHNCAT	N	CRM 10.0	1993	10	10	0.06	0.18	0.0955	0.01109	0.1158
Chlordane, total	CHNCAT	N	CRM 10.0	1994	10	10	0.057	0.14	0.0837	0.00898	0.1002
Chlordane, total	CHNCAT	N	CRM 125.0	1992	20	18	0.06	0.13	0.0765	0.00413	0.0836
Chlordane, total	CHNCAT	N	CRM 125.0	1993	10	10	0.053	0.14	0.0832	0.00892	0.0996
Chlordane, total	CHNCAT	N	CRM 20.0	1993	20	20	0.1	0.32	0.1705	0.01589	0.198
Chlordane, total	CHNCAT	Y	CRM 51.0	1993	3	3	0.09	0.12	0.1067	0.00832	0.1324
Chlordane, total	CHNCAT	Y	ERM 1.0	1993	3	3	0.1	0.2	0.1417	0.03005	0.2294
Chlordane, total	CHNCAT	N	PCM 1.0	1992	20	20	0.054	0.19	0.0895	0.00785	0.1031
Chlordane, total	CHNCAT	Y	PCM 4.6	1993	3	3	0.052	0.112	0.0807	0.01737	0.1314
Chlordane, total	CHNCAT	N	PCM 5.3	1993	10	10	0.062	0.22	0.1162	0.0155	0.1446
Chlordane, total	CHNCAT	N	PRM 30.0	1991	10	9	0.07	0.11	0.0871	0.00471	0.0958
Chlordane, total	CHNCAT	N	PRM 30.0	1992	20	14	0.06	0.15	0.0783	0.00521	0.0873
Chlordane, total	CHNCAT	Y	TRM 520.0	1993	3	3	0.075	0.1	0.09	0.00764	0.1123
Chlordane, total	CHNCAT	N	TRM 530.0	1991	10	10	0.064	0.23	0.128	0.01569	0.1568
Chlordane, total	CHNCAT	N	TRM 530.0	1993	10	10	0.08	0.19	0.131	0.0137	0.1561
Chlordane, total	CHNCAT	N	TRM 545.0	1992	20	16	0.06	0.16	0.092	0.00707	0.1042
Chlordane, total	CHNCAT	N	TRM 561.0	1991	10	9	0.08	0.33	0.1867	0.03066	0.2429
Chlordane, total	CHNCAT	N	TRM 570.0	1991	10	10	0.064	0.38	0.1523	0.02843	0.2044
Chlordane, total	CHNCAT	N	TRM 570.0	1992	20	16	0.06	0.72	0.1489	0.0384	0.2152
Chlordane, total	COCARP	Y	CRM 1.0	1992	1	1	0.06	0.06	0.06	.	.
Chlordane, total	LMBASS	N	CRM 1.0	1991	10	10	0.062	0.137	0.0801	0.00719	0.0933
Chlordane, total	LMBASS	N	CRM 1.0	1993	20	20	0.054	0.11	0.0703	0.00346	0.0762
Chlordane, total	LMBASS	N	CRM 1.0	1994	10	9	0.054	0.1	0.065	0.00228	0.0692
Chlordane, total	LMBASS	N	CRM 10.0	1994	10	10	0.052	0.075	0.0621	0.00257	0.0668
Chlordane, total	LMBASS	N	CRM 125.0	1993	20	19	0.047	0.08	0.0615	0.00258	0.0659
Chlordane, total	LMBASS	N	CRM 125.0	1994	10	0	0.08	0.08	.	.	.
Chlordane, total	LMBASS	N	CRM 20.0	1993	13	13	0.054	0.09	0.0652	0.00293	0.0705
Chlordane, total	LMBASS	N	CRM 20.0	1994	5	3	0.075	0.09	0.078	0.00318	0.0848
Chlordane, total	LMBASS	N	CRM 21.5	1994	8	5	0.056	0.082	0.0695	0.00396	0.077
Chlordane, total	LMBASS	N	PCM 1.0	1993	20	20	0.055	0.11	0.0686	0.00372	0.075
Chlordane, total	LMBASS	N	PCM 4.6	1994	7	6	0.071	0.145	0.085	0.01029	0.105
Chlordane, total	LMBASS	N	PCM 5.3	1994	2	1	0.075	0.08	0.075	.	.
Chlordane, total	LMBASS	N	PRM 30.0	1991	10	7	0.074	0.08	0.0761	0.00051	0.0771
Chlordane, total	LMBASS	N	PRM 30.0	1993	20	20	0.052	0.079	0.0688	0.00203	0.0723
Chlordane, total	LMBASS	N	TRM 530.0	1991	10	9	0.065	0.08	0.0727	0.00158	0.0756
Chlordane, total	LMBASS	N	TRM 555.0	1993	20	16	0.06	0.08	0.0655	0.00171	0.0685
Chlordane, total	LMBASS	N	TRM 561.0	1991	10	10	0.061	0.09	0.0743	0.0025	0.0789
Chlordane, total	LMBASS	N	TRM 570.0	1991	10	9	0.052	0.087	0.0707	0.00356	0.0772
Chlordane, total	LMBASS	N	TRM 570.0	1993	20	20	0.059	0.1	0.0694	0.00279	0.0742
Chlordane, total	STBASS	N	CRM 1.0	1992	15	15	0.059	0.12	0.1009	0.00441	0.1086
Chlordane, total	STBASS	N	CRM 20.0	1993	15	15	0.1	0.17	0.1387	0.00424	0.1461
Chlordane, total	STBASS	N	PRM 30.0	1992	15	10	0.056	0.08	0.0609	0.00179	0.0641

Table C6 (continued)

Chlordane, total	STBASS	N	TRM 545.0	1992	15	14	0.06	0.21	0.1147	0.0077	0.1282
Chlordane, total	WHCRAP	Y	CRM 1.0	1992	1	1	0.059	0.059	0.059		.
Lipids	BLUGIL	Y	CRM 1.0	1992	1	1	6.9	6.9	6.9	.	.
Lipids	CHNCAT	N	CRM 1.0	1991	10	10	1.5	14	6.48	1.20183	8.6831
Lipids	CHNCAT	N	CRM 1.0	1992	19	19	0.8	21	6.5263	1.19765	8.6031
Lipids	CHNCAT	N	CRM 1.0	1993	25	25	1.3	14	6.56	0.63346	7.6438
Lipids	CHNCAT	N	CRM 10.0	1993	10	10	2.3	9.4	6.53	0.76566	7.9335
Lipids	CHNCAT	N	CRM 10.0	1994	10	10	1.1	8.6	4.83	0.84512	6.3792
Lipids	CHNCAT	N	CRM 125.0	1992	20	20	0.6	13	5.6	0.64015	6.7069
Lipids	CHNCAT	N	CRM 125.0	1993	10	10	2.6	13	6.53	1.03977	8.436
Lipids	CHNCAT	N	CRM 20.0	1993	20	20	3.2	12	8.03	0.56871	9.0134
Lipids	CHNCAT	Y	CRM 51.0	1993	3	3	5.9	7.3	6.7667	0.43716	8.0432
Lipids	CHNCAT	Y	ERM 1.0	1993	3	3	3.2	6.8	4.8333	1.05251	7.9066
Lipids	CHNCAT	N	PCM 1.0	1992	20	20	0.7	7.3	4.1	0.43286	4.8435
Lipids	CHNCAT	Y	PCM 4.6	1993	3	3	2.2	4.4	3.4333	0.64893	5.3282
Lipids	CHNCAT	N	PCM 5.3	1993	10	10	1.9	7	3.93	0.46381	4.7802
Lipids	CHNCAT	N	PRM 30.0	1991	10	10	1.1	8.8	4.95	0.75369	6.3316
Lipids	CHNCAT	N	PRM 30.0	1992	20	20	1	13	4.445	0.82738	5.8756
Lipids	CHNCAT	Y	TRM 520.0	1993	3	3	12	18	14.6667	1.76383	19.817
Lipids	CHNCAT	N	TRM 530.0	1991	10	10	1.6	11	5.33	1.01281	7.1866
Lipids	CHNCAT	N	TRM 530.0	1993	10	10	0.6	10	4.23	0.85245	5.7926
Lipids	CHNCAT	N	TRM 545.0	1992	20	20	1.4	10	4.66	0.49828	5.5216
Lipids	CHNCAT	N	TRM 561.0	1991	10	10	0.4	20	7.18	1.68099	10.2614
Lipids	CHNCAT	N	TRM 570.0	1991	10	10	1	15	5.65	1.17948	7.8121
Lipids	CHNCAT	N	TRM 570.0	1992	20	20	0.3	18	4.445	0.91696	6.0305
Lipids	COCARP	Y	CRM 1.0	1992	1	1	24	24	24	.	.
Lipids	LMBASS	N	CRM 1.0	1991	10	10	0.2	5	1.61	0.46343	2.4595
Lipids	LMBASS	N	CRM 1.0	1993	20	20	0.9	9	2.23	0.37085	2.8713
Lipids	LMBASS	N	CRM 1.0	1994	10	10	1	2.5	1.85	0.17717	2.1748
Lipids	LMBASS	N	CRM 10.0	1994	10	10	1	2.7	1.68	0.19368	2.035
Lipids	LMBASS	N	CRM 125.0	1993	20	19	0.1	3	1.51	0.19411	1.8456
Lipids	LMBASS	N	CRM 125.0	1994	10	10	0.4	1.8	1.22	0.14742	1.4902
Lipids	LMBASS	N	CRM 20.0	1993	13	13	0.5	3.4	1.5308	0.21554	1.9149
Lipids	LMBASS	N	CRM 20.0	1994	5	5	0.6	3.5	1.64	0.49659	2.6987
Lipids	LMBASS	N	CRM 21.5	1994	8	8	0.5	3.9	1.9875	0.47035	2.8786
Lipids	LMBASS	N	PCM 1.0	1993	20	20	0.2	2.3	1.19	0.09971	1.3624
Lipids	LMBASS	N	PCM 4.6	1994	7	7	0.2	2.4	1.2286	0.29335	1.7986
Lipids	LMBASS	N	PCM 5.3	1994	2	1	0.1	0.7	0.7	.	.
Lipids	LMBASS	N	PRM 30.0	1991	10	10	0.5	4.2	1.89	0.3391	2.5116
Lipids	LMBASS	N	PRM 30.0	1993	20	20	0.1	3.8	1.27	0.21473	1.6413
Lipids	LMBASS	N	TRM 530.0	1991	10	10	0.2	2.7	1.82	0.26026	2.2971
Lipids	LMBASS	N	TRM 555.0	1993	20	20	0.1	2.7	1.06	0.16	1.3367
Lipids	LMBASS	N	TRM 561.0	1991	10	10	0.5	4	1.94	0.35938	2.5988
Lipids	LMBASS	N	TRM 570.0	1991	10	10	0.4	3.9	1.81	0.40728	2.5566
Lipids	LMBASS	N	TRM 570.0	1993	20	20	0.3	9.1	2.775	0.55625	3.7368
Lipids	STBASS	N	CRM 1.0	1992	15	15	2.6	12	8.4133	0.90015	9.9988
Lipids	STBASS	N	CRM 20.0	1993	15	15	7.5	13	10.24	0.43881	11.0129
Lipids	STBASS	N	PRM 30.0	1992	15	13	0.1	14	8.6133	0.99924	10.3733
Lipids	STBASS	N	TRM 545.0	1992	15	15	2.5	21	10.4733	1.15521	12.508
Lipids	WHCRAP	Y	CRM 1.0	1992	1	1	0.6	0.6	0.6	.	.
PCB-1254	BLUGIL	Y	CRM 1.0	1992	1	1	0.2	0.2	0.2	.	.
PCB-1254	CHNCAT	N	CRM 1.0	1991	10	10	0.7	2	1.18	0.13888	1.4346
PCB-1254	CHNCAT	N	CRM 1.0	1992	19	19	0.1	1.8	0.5947	0.08966	0.7502
PCB-1254	CHNCAT	N	CRM 1.0	1993	25	24	0.1	1.1	0.4451	0.05084	0.5321
PCB-1254	CHNCAT	N	CRM 10.0	1993	10	10	0.15	0.9	0.422	0.07083	0.5518
PCB-1254	CHNCAT	N	CRM 10.0	1994	10	10	0.08	0.7	0.328	0.06588	0.4488
PCB-1254	CHNCAT	N	CRM 125.0	1992	20	13	0.05	0.2	0.0765	0.00804	0.0904
PCB-1254	CHNCAT	N	CRM 125.0	1993	10	9	0.05	0.1	0.0722	0.00401	0.0796
PCB-1254	CHNCAT	N	CRM 20.0	1993	20	20	0.4	1.5	0.7	0.06844	0.8183
PCB-1254	CHNCAT	Y	CRM 51.0	1993	3	3	0.12	0.16	0.1367	0.01202	0.1718
PCB-1254	CHNCAT	Y	ERM 1.0	1993	3	3	0.33	0.68	0.4767	0.10493	0.7831
PCB-1254	CHNCAT	N	PCM 1.0	1992	20	20	0.07	2	0.5335	0.09449	0.6969
PCB-1254	CHNCAT	Y	PCM 4.6	1993	3	3	0.27	0.46	0.3567	0.05548	0.5187
PCB-1254	CHNCAT	N	PCM 5.3	1993	10	10	0.12	0.59	0.351	0.05229	0.4469
PCB-1254	CHNCAT	N	PRM 30.0	1991	10	0	0.1	0.1	.	.	.
PCB-1254	CHNCAT	N	PRM 30.0	1992	20	10	0.05	0.3	0.0805	0.01298	0.103

Table C6 (continued)

PCB-1254	CHNCAT	Y	TRM 520.0	1993	3	3	0.5	0.67	0.5933	0.04978	0.7387
PCB-1254	CHNCAT	N	TRM 530.0	1991	10	10	0.2	0.8	0.47	0.05385	0.5687
PCB-1254	CHNCAT	N	TRM 530.0	1993	10	10	0.31	1.1	0.636	0.0868	0.7951
PCB-1254	CHNCAT	N	TRM 545.0	1992	20	20	0.1	1.2	0.425	0.05798	0.5253
PCB-1254	CHNCAT	N	TRM 561.0	1991	10	10	0.1	1.3	0.75	0.12225	0.9741
PCB-1254	CHNCAT	N	TRM 570.0	1991	10	10	0.2	0.9	0.58	0.07272	0.7133
PCB-1254	CHNCAT	N	TRM 570.0	1992	20	20	0.1	1.46	0.518	0.06911	0.6375
PCB-1254	COCARP	Y	CRM 1.0	1992	1	1	0.2	0.2	0.2	.	.
PCB-1254	LMBASS	N	CRM 1.0	1991	10	10	0.05	0.4	0.212	0.03915	0.2838
PCB-1254	LMBASS	N	CRM 1.0	1993	20	20	0.1	0.5	0.21	0.02283	0.2495
PCB-1254	LMBASS	N	CRM 1.0	1994	10	9	0.1	0.3	0.1756	0.01668	0.2061
PCB-1254	LMBASS	N	CRM 10.0	1994	10	10	0.08	0.4	0.178	0.03326	0.239
PCB-1254	LMBASS	N	CRM 125.0	1993	20	3	0.05	0.05	0.05	0	0.05
PCB-1254	LMBASS	N	CRM 125.0	1994	10	0	0.1	0.1	.	.	.
PCB-1254	LMBASS	N	CRM 20.0	1993	13	13	0.01	0.6	0.1862	0.04309	0.263
PCB-1254	LMBASS	N	CRM 20.0	1994	5	0	0.2	0.4	.	.	.
PCB-1254	LMBASS	N	CRM 21.5	1994	8	3	0.077	0.3	0.1079	0.02419	0.1537
PCB-1254	LMBASS	N	PCM 1.0	1993	20	19	0.05	0.7	0.335	0.03997	0.4041
PCB-1254	LMBASS	N	PCM 4.6	1994	7	7	0.05	0.6	0.3071	0.06764	0.4386
PCB-1254	LMBASS	N	PCM 5.3	1994	2	1	0.08	0.1	0.08	.	.
PCB-1254	LMBASS	N	PRM 30.0	1991	10	2	0.05	0.1	0.05	0	0.05
PCB-1254	LMBASS	N	PRM 30.0	1993	20	4	0.05	0.06	0.051	0.00077	0.0523
PCB-1254	LMBASS	N	TRM 530.0	1991	10	9	0.06	0.2	0.121	0.01798	0.154
PCB-1254	LMBASS	N	TRM 555.0	1993	20	20	0.07	0.4	0.1785	0.02162	0.2159
PCB-1254	LMBASS	N	TRM 561.0	1991	10	10	0.03	0.3	0.143	0.02504	0.1889
PCB-1254	LMBASS	N	TRM 570.0	1991	10	10	0.07	0.4	0.197	0.03445	0.2602
PCB-1254	LMBASS	N	TRM 570.0	1993	20	20	0.04	0.4	0.1915	0.02214	0.2298
PCB-1254	STBASS	N	CRM 1.0	1992	15	15	0.3	0.6	0.4533	0.02153	0.4913
PCB-1254	STBASS	N	CRM 20.0	1993	15	15	0.4	0.8	0.56	0.02895	0.611
PCB-1254	STBASS	N	PRM 30.0	1992	15	4	0.05	0.1	0.0573	0.00504	0.0662
PCB-1254	STBASS	N	TRM 545.0	1992	15	15	0.4	1	0.5067	0.03838	0.5743
PCB-1254	WHCRAP	Y	CRM 1.0	1992	1	1	0.06	0.06	0.06	.	.
PCB-1260	BLUGIL	Y	CRM 1.0	1992	1	1	0.4	0.4	0.4	.	.
PCB-1260	CHNCAT	N	CRM 1.0	1991	10	10	0.2	1.9	1.01	0.16763	1.3173
PCB-1260	CHNCAT	N	CRM 1.0	1992	19	19	0.3	3.2	1.0737	0.14865	1.3314
PCB-1260	CHNCAT	N	CRM 1.0	1993	25	25	0.1	1.9	0.6252	0.09525	0.7882
PCB-1260	CHNCAT	N	CRM 10.0	1993	10	10	0.15	1.1	0.557	0.09137	0.7245
PCB-1260	CHNCAT	N	CRM 10.0	1994	10	10	0.06	1.3	0.431	0.11594	0.6435
PCB-1260	CHNCAT	N	CRM 125.0	1992	20	20	0.1	0.7	0.31	0.0362	0.3726
PCB-1260	CHNCAT	N	CRM 125.0	1993	10	8	0.06	0.42	0.199	0.04142	0.2749
PCB-1260	CHNCAT	N	CRM 20.0	1993	20	20	0.05	2.4	1.0575	0.13714	1.2946
PCB-1260	CHNCAT	Y	CRM 51.0	1993	3	3	0.41	0.54	0.4733	0.03756	0.583
PCB-1260	CHNCAT	Y	ERM 1.0	1993	3	3	1.1	1.8	1.5	0.20817	2.1078
PCB-1260	CHNCAT	N	PCM 1.0	1992	20	20	0.2	2.4	1.03	0.133	1.26
PCB-1260	CHNCAT	Y	PCM 4.6	1993	3	3	0.21	0.82	0.52	0.17616	1.0344
PCB-1260	CHNCAT	N	PCM 5.3	1993	10	10	0.23	0.9	0.531	0.05517	0.6321
PCB-1260	CHNCAT	N	PRM 30.0	1991	10	10	0.1	0.5	0.22	0.04163	0.2963
PCB-1260	CHNCAT	N	PRM 30.0	1992	20	16	0.01	1.2	0.215	0.0567	0.313
PCB-1260	CHNCAT	Y	TRM 520.0	1993	3	3	0.12	0.2	0.15	0.02517	0.2235
PCB-1260	CHNCAT	N	TRM 530.0	1991	10	10	0.2	1.7	0.86	0.1529	1.1403
PCB-1260	CHNCAT	N	TRM 530.0	1993	10	10	0.3	1.4	0.918	0.11958	1.1372
PCB-1260	CHNCAT	N	TRM 545.0	1992	20	20	0.3	1.9	0.815	0.09741	0.9834
PCB-1260	CHNCAT	N	TRM 561.0	1991	10	10	0.4	2.2	1.19	0.19576	1.5489
PCB-1260	CHNCAT	N	TRM 570.0	1991	10	10	0.2	1.6	0.83	0.14146	1.0893
PCB-1260	CHNCAT	N	TRM 570.0	1992	20	20	0.3	1.9	1.015	0.09981	1.1876
PCB-1260	COCARP	Y	CRM 1.0	1992	1	1	0.5	0.5	0.5	.	.
PCB-1260	LMBASS	N	CRM 1.0	1991	10	10	0.08	0.4	0.218	0.03669	0.2853
PCB-1260	LMBASS	N	CRM 1.0	1993	20	20	0.08	0.9	0.2185	0.04229	0.2916
PCB-1260	LMBASS	N	CRM 1.0	1994	10	9	0.1	0.51	0.2108	0.04136	0.2866
PCB-1260	LMBASS	N	CRM 10.0	1994	10	9	0.06	0.4	0.161	0.03612	0.2272
PCB-1260	LMBASS	N	CRM 125.0	1993	20	6	0.04	0.1	0.047	0.0038	0.0536
PCB-1260	LMBASS	N	CRM 125.0	1994	10	0	0.1	0.1	.	.	.
PCB-1260	LMBASS	N	CRM 20.0	1993	13	12	0.01	0.3	0.1685	0.03065	0.2231
PCB-1260	LMBASS	N	CRM 20.0	1994	5	1	0.1	0.6	0.6	.	.
PCB-1260	LMBASS	N	CRM 21.5	1994	8	3	0.065	0.31	0.1007	0.03472	0.1665
PCB-1260	LMBASS	N	PCM 1.0	1993	20	19	0.01	0.9	0.341	0.06322	0.4503

Table C6 (continued)

PCB-1260	LMBASS	N	PCM 4.6	1994	7	7	0.1	0.5	0.2286	0.05654	0.3384
PCB-1260	LMBASS	N	PCM 5.3	1994	2	1	0.08	0.1	0.08	.	.
PCB-1260	LMBASS	N	PRM 30.0	1991	10	10	0.05	0.1	0.068	0.00533	0.0778
PCB-1260	LMBASS	N	PRM 30.0	1993	20	6	0.02	0.05	0.03	0.00365	0.0363
PCB-1260	LMBASS	N	TRM 530.0	1991	10	9	0.06	0.2	0.131	0.01942	0.1666
PCB-1260	LMBASS	N	TRM 555.0	1993	20	19	0.02	0.5	0.1444	0.03209	0.1999
PCB-1260	LMBASS	N	TRM 561.0	1991	10	10	0.09	0.4	0.159	0.03078	0.2154
PCB-1260	LMBASS	N	TRM 570.0	1991	10	10	0.07	0.4	0.255	0.04485	0.3372
PCB-1260	LMBASS	N	TRM 570.0	1993	20	19	0.01	0.5	0.1763	0.03195	0.2315
PCB-1260	STBASS	N	CRM 1.0	1992	15	15	0.4	0.9	0.6933	0.0396	0.7631
PCB-1260	STBASS	N	CRM 20.0	1993	15	15	0.2	0.6	0.3867	0.02737	0.4349
PCB-1260	STBASS	N	PRM 30.0	1992	15	3	0.05	0.1	0.0567	0.00537	0.0661
PCB-1260	STBASS	N	TRM 545.0	1992	15	15	0.6	1.4	0.8067	0.04827	0.8917
PCB-1260	WHCRAP	Y	CRM 1.0	1992	1	1	0.2	0.2	0.2	.	.

Table C7. Analysis of variance results for the inorganic contaminants in sportfish

Source	DF	F	P
Mercury			
Site	10	24.61	0.0001
Year	1	0.16	0.6908
Site*year	2	0.39	0.6754
Species	2	98.61	0.0001
Year*species	10	3.80	0.0001
Site*species	1	0.02	0.8956
Site*year*species	2	1.17	0.3122
Arsenic			
Site	10	2.40	0.0089
Year	1	0.03	0.8666
Site*year	2	6.86	0.0012
Species	2	217.41	0.0001
Year*species	10	6.56	0.0001
Site*species	1	1.17	0.2806
Site*year*species	2	0.84	0.4337
Beryllium			
Site	10	18.52	0.0001
Year	1	51.21	0.0001
Site*year	2	23.94	0.0001
Species	2	3.16	0.0434
Year*species	10	8.96	0.0001
Site*species	1	5.41	0.0205
Site*year*species	2	3.76	0.0242
Copper			
Site	7	0.96	0.4651
Year	1	0.00	0.9758
Site*year	0	–	–

Table C7 (continued)

Source	DF	F	P
Species	2	0.27	0.7667
Year*species	6	1.44	0.2006
Site*species	0	–	–
Site*year*species	0	–	–
Selenium			
Site	10	12.04	0.0001
Year	1	2.02	0.1560
Site*year	2	1.04	0.3537
Species	2	56.93	0.0001
Year*species	10	5.74	0.0001
Site*species	1	0.07	0.7934
Site*year*species	2	11.60	0.0001

Table C8. Analysis of variance results for total PCB and total chlordane in sportfish

Source	DF	F	P
Total PCB			
Site	13	136.20	0.0001
Year	3	0.32	0.8090
Site*year	8	0.86	0.5473
Species	3	17.92	0.0001
Year*species	10	2.01	0.0301
Site*species	2	3.13	0.0445
Site*year*species	0	–	–
Total Chlordane			
Site	13	3.33	0.0001
Year	3	2.75	0.0422
Site*year	8	2.68	0.0069
Species	1	55.79	0.0001
Year*species	6	4.46	0.0002
Site*species	1	12.27	0.0005
Site*year*species	0	–	–

Table C9. Total number of analyses, detectable results, minimum, maximum, mean, standard error, and upper 95% confidence bound for the 44 PCB congeners analyzed from fish tissue samples

ANALYTE	N	# DETECTS	MIN	MAX	MEAN	STDERR	UCB
PCB169T	326	1	0.010	0.01	0.010000	.	.
PCB018T	326	3	0.010	0.01	0.010000	0.000000	0.010000
PCB166T	326	3	0.010	0.07	0.010337	0.000293	0.010820
PCB076T	326	9	0.010	0.01	0.010000	0.000000	0.010000
PCB070T	326	21	0.005	0.01	0.005919	0.000292	0.006402
PCB167T	326	22	0.010	0.05	0.010337	0.000156	0.010594
PCB157T	326	38	0.005	0.20	0.007745	0.000816	0.009092
PCB126T	326	54	0.006	0.07	0.009411	0.000738	0.010628
PCB028T	326	61	0.010	0.01	0.010000	0.000000	0.010000
PCB031T	326	61	0.010	0.01	0.010000	0.000000	0.010000
PCB189T	326	61	0.005	0.02	0.006681	0.000230	0.007061
PCB044T	326	69	0.005	0.03	0.007290	0.000464	0.008056
PCB037T	326	91	0.005	0.04	0.007697	0.000402	0.008359
PCB158T	326	92	0.005	0.07	0.009763	0.000618	0.010782
PCB049T	326	98	0.005	0.07	0.010318	0.000537	0.011204
PCB195T	326	98	0.005	0.05	0.007730	0.000623	0.008758
PCB201T	326	99	0.005	0.10	0.011694	0.000770	0.012965
PCB128T	326	111	0.005	0.08	0.010798	0.000704	0.011959
PCB052T	326	113	0.006	0.10	0.012096	0.000710	0.013266
PCB099T	326	113	0.009	0.45	0.030291	0.002820	0.034943
PCB146T	326	129	0.006	0.11	0.015337	0.000946	0.016898
PCB194T	326	129	0.005	0.06	0.009824	0.000444	0.010556
PCB151T	326	142	0.006	0.11	0.014018	0.000834	0.015394
PCB183T	326	148	0.007	0.11	0.014356	0.000871	0.015792
PCB170T	326	169	0.007	0.20	0.013644	0.001027	0.015339
PCB101T	326	170	0.005	0.32	0.021701	0.001646	0.024416
PCB196T	326	194	0.006	0.10	0.014977	0.000893	0.01645
PCB114T	326	195	0.005	0.12	0.016226	0.000869	0.017658
PCB118T	326	213	0.005	0.30	0.030539	0.002131	0.034054
PCB138T	326	224	0.007	0.58	0.040282	0.003832	0.046603
PCB105T	326	261	0.006	0.05	0.009742	0.000218	0.010101
PCB095T	326	264	0.005	0.14	0.013320	0.000720	0.014508
PCB180T	326	269	0.01	0.40	0.045491	0.003435	0.051156
PCB087T	326	279	0.005	0.21	0.011701	0.000777	0.012983
PCB153T	326	283	0.01	0.48	0.055433	0.004337	0.062586
PCB171T	326	287	0.005	0.13	0.012910	0.000635	0.013958
PCB077T	326	293	0.006	0.35	0.024301	0.001880	0.027402
PCB081T	326	300	0.005	0.20	0.013337	0.000846	0.014734
PCB156T	326	302	0.005	0.09	0.013332	0.000586	0.014298
PCB066T	326	304	0.005	0.04	0.010675	0.000237	0.011065
PCB149T	326	307	0.005	0.12	0.015331	0.000819	0.016682
PCB123T	326	308	0.005	0.20	0.018597	0.001241	0.020644
PCB110T	326	310	0.006	0.18	0.021557	0.001283	0.023672
PCB132T	326	313	0.006	0.10	0.010176	0.000283	0.010644

Table C10. Summary of PCB congener detection percentage for catfish from 11 site/year samples in Watts Bar Reservoir. "o", "+", "-", and "." indicate 75–100%, 50–74%, 25–49%, and 0–24% detection, respectively. The sites are (1) CRM1, F(fall)92; (2) PCM1, F92; (3) TRM 545, F92; (4) TRM 570, F92; (5) CRM 1 S(spring)93; (6) Crm 20, S93; (7) CRM 10, F93; (8) CRM 1, F93; (9) PRM 5.3, F93; (10) TRM 530, F93; (11) CRM 10, S94.

	1	2	3	4	5	6	7	8	9	10	11
PCB018T	.	.	.	.	.	.	.	.	.	.	.
PCB028T	o	o	o	o	.	.	.	.	.	.	.
PCB031T	o	o	o	o	.	.	.	.	.	.	.
PCB037T	-	.	.	-	+	+	.	-	.	-	.
PCB044T	-	.	.	.	+	+	.	.	.	.	.
PCB049T	-	.	.	.	-	-	.	-	-	+	.
PCB052T	-	-	.	.	-	+	.	-	-	-	.
PCB066T	+	o	+	+	o	o	o	o	o	o	o
PCB070T	.	.	.	.	.	.	.	.	.	.	.
PCB076T	.	.	.	.	.	.	.	.	.	.	.
PCB077T	+	o	o	-	o	o	o	o	o	o	o
PCB081T	+	+	+	+	o	o	o	o	o	o	o
PCB087T	-	-	.	.	o	o	o	o	o	o	o
PCB095T	+	+	-	-	+	+	o	o	o	o	o
PCB099T	o	o	o	-	.	.	.	.	.	.	.
PCB101T	+	+	+	-	.	.	o	o	o	o	-
PCB105T	.	-	.	.	o	o	o	o	o	o	o
PCB110T	o	o	o	o	o	o	o	o	o	o	o
PCB114T	o	+	o	o	+	o	-	+	o	o	-
PCB118T	o	o	o	-	-	o	+	o	o	o	+
PCB123T	o	+	+	o	o	o	o	o	o	o	o
PCB126T	-	-	.	.	-	+	.	-	.	+	.
PCB128T	+	+	+	.	-	-	-	+	-	o	.
PCB132T	o	o	o	o	o	o	o	o	o	o	o
PCB138T	o	o	+	-	o	o	o	o	o	o	.
PCB146T	+	+	+	-	.	+	+	o	o	o	.
PCB149T	o	o	+	+	o	o	o	o	o	o	o
PCB151T	+	+	+	-	-	o	-	o	o	o	
PCB153T	o	o	o	o	o	o	o	o	o	o	+
PCB156T	o	+	o	o	o	o	o	o	o	o	o
PCB157T	+	-	+	+	.	.	.	.	.	-	.
PCB158T	-	+	.	.	-	+	-	+	-	o	.
PCB166T	.	.	.	.	.	.	.	.	.	.	.
PCB167T	.	.	.	.	.	-	.	.	.	o	.
PCB169T	.	.	.	.	.	.	.	.	.	.	.
PCB170T	o	o	o	+	o	o	.	.	.	.	.
PCB171T	o	-	+	+	o	o	o	o	o	o	o
PCB180T	o	o	o	-	o	o	o	o	o	o	+
PCB183T	+	+	+	-	+	o	+	+	o	o	-
PCB189T	-	.	+	-	-	+	.	.	.	o	.
PCB194T	o	o	o	+	.	-	.	-	-	o	.
PCB195T	o	o	o	-	.	.	-	-	.	+	.
PCB196T	o	o	o	-	+	o	-	+	o	o	-
PCB201T	-	+	-	-	-	+	-	+	+	o	.

Table C11. Mean concentrations of total chlordane (mg/kg), PCBs (Aroclors 1254 and 1260, mg/kg) and lipids (% body weight) in mayflies and shad. No chlordanes were detected in any mayfly samples.

ANALYTE	TAXON	COMPOSITE	SITE	YEAR	N	# DETECTS	MIN	MAX	MEAN	STDERR	UCB
Chlordane, total	GIZZRD	N	CRM 1.0	1991	12	10	0.067	0.09	0.0762	0.00197	0.0797
Chlordane, total	GIZZRD	Y	CRM 1.0	1991	2	2	0.065	0.08	0.0725	0.0075	0.1199
Chlordane, total	GIZZRD	Y	CRM 1.0	1992	2	1	0.057	0.06	0.057	.	.
Chlordane, total	GIZZRD	N	CRM 1.0	1993	12	11	0.05	0.065	0.0555	0.00121	0.0576
Chlordane, total	GIZZRD	Y	CRM 10.0	1993	3	3	0.054	0.058	0.056	0.00115	0.0594
Chlordane, total	GIZZRD	Y	CRM 10.0	1994	3	3	0.054	0.069	0.0597	0.0047	0.0734
Chlordane, total	GIZZRD	N	CRM 125.0	1992	12	2	0.08	0.08	0.08	0	0.08
Chlordane, total	GIZZRD	Y	CRM 125.0	1993	3	3	0.067	0.074	0.0707	0.00203	0.0766
Chlordane, total	GIZZRD	N	CRM 20.0	1992	12	10	0.049	0.074	0.0603	0.0024	0.0646
Chlordane, total	GIZZRD	Y	CRM 20.0	1994	3	3	0.075	0.077	0.0763	0.00067	0.0783
Chlordane, total	GIZZRD	Y	CRM 51.0	1993	3	3	0.068	0.09	0.0753	0.00733	0.0967
Chlordane, total	GIZZRD	Y	ERM 1.0	1993	3	3	0.053	0.058	0.056	0.00153	0.0605
Chlordane, total	GIZZRD	Y	PCM 1.0	1992	2	2	0.07	0.1	0.085	0.015	0.1797
Chlordane, total	GIZZRD	N	PCM 1.0	1993	12	11	0.051	0.13	0.066	0.00636	0.0774
Chlordane, total	GIZZRD	Y	PRM 30.0	1991	2	2	0.062	0.067	0.0645	0.0025	0.0803
Chlordane, total	GIZZRD	Y	PRM 30.0	1992	2	0	0.08	0.08	.	.	.
Chlordane, total	GIZZRD	Y	TRM 530.0	1991	2	2	0.065	0.067	0.066	0.001	0.0723
Chlordane, total	GIZZRD	Y	TRM 530.0	1993	3	3	0.056	0.064	0.0593	0.0024	0.0664
Chlordane, total	GIZZRD	Y	TRM 545.0	1992	2	0	0.06	0.06	.	.	.
Chlordane, total	GIZZRD	Y	TRM 561.0	1991	2	1	0.068	0.07	0.068	.	.
Chlordane, total	GIZZRD	Y	TRM 570.0	1991	2	2	0.066	0.066	0.066	0	0.066
Chlordane, total	GIZZRD	N	TRM 570.0	1992	12	8	0.054	0.08	0.0601	0.00228	0.0642
Chlordane, total	GIZZRD	Y	TRM 570.0	1993	3	3	0.055	0.058	0.0567	0.00088	0.0592
Lipids	GIZZRD	N	CRM 1.0	1991	12	12	1	14	7.05	1.06902	8.9698
Lipids	GIZZRD	Y	CRM 1.0	1991	2	2	9.2	10	9.6	0.4	12.1255
Lipids	GIZZRD	Y	CRM 1.0	1992	2	2	19	21	20	1	26.3138
Lipids	GIZZRD	N	CRM 1.0	1993	12	12	0.5	7.5	4.2167	0.6708	5.4213
Lipids	GIZZRD	Y	CRM 10.0	1993	3	3	2.7	4.4	3.7333	0.52387	5.263
Lipids	GIZZRD	Y	CRM 10.0	1994	3	3	1.4	2	1.6	0.2	2.184
Lipids	GIZZRD	N	CRM 125.0	1992	12	12	3.6	13	7.4833	0.82681	8.9682
Lipids	GIZZRD	Y	CRM 125.0	1993	3	3	6.1	11	8.2333	1.44952	12.4659
Lipids	GIZZRD	N	CRM 20.0	1992	12	12	1.2	33	15.175	3.45716	21.3837
Lipids	GIZZRD	Y	CRM 20.0	1994	3	3	1.5	2.2	1.9333	0.21858	2.5716
Lipids	GIZZRD	Y	CRM 51.0	1993	3	3	2.8	4.4	3.4667	0.48074	4.8704
Lipids	GIZZRD	Y	ERM 1.0	1993	3	3	3.3	5.1	4.2	0.51962	5.7173
Lipids	GIZZRD	Y	PCM 1.0	1992	2	2	7	8.6	7.8	0.8	12.851
Lipids	GIZZRD	N	PCM 1.0	1993	12	12	0.3	6.4	3.55	0.52678	4.496
Lipids	GIZZRD	Y	PRM 30.0	1991	2	2	9.6	14	11.8	2.2	25.6903
Lipids	GIZZRD	Y	PRM 30.0	1992	2	2	0.1	10	5.05	4.95	36.3031
Lipids	GIZZRD	Y	TRM 530.0	1991	2	2	5.9	6	5.95	0.05	6.2657
Lipids	GIZZRD	Y	TRM 530.0	1993	3	3	0.4	2.8	1.8667	0.74237	4.0344
Lipids	GIZZRD	Y	TRM 545.0	1992	2	2	8.1	25	16.55	8.45	69.9012
Lipids	GIZZRD	Y	TRM 561.0	1991	2	2	4.4	7.1	5.75	1.35	14.2736
Lipids	GIZZRD	Y	TRM 570.0	1991	2	2	6.2	6.6	6.4	0.2	7.6628
Lipids	GIZZRD	N	TRM 570.0	1992	12	12	0.3	17	7.9667	1.83234	11.2573
Lipids	GIZZRD	Y	TRM 570.0	1993	3	3	1.6	2.3	1.8667	0.21858	2.5049
PCB-1254	GIZZRD	N	CRM 1.0	1991	12	11	0.05	0.2	0.0855	0.01169	0.1065
PCB-1254	GIZZRD	Y	CRM 1.0	1991	2	2	0.1	0.2	0.15	0.05	0.4657
PCB-1254	GIZZRD	Y	CRM 1.0	1992	2	2	0.07	0.08	0.075	0.005	0.1066
PCB-1254	GIZZRD	N	CRM 1.0	1993	12	12	0.1	0.19	0.1217	0.00903	0.1379
PCB-1254	GIZZRD	Y	CRM 10.0	1993	3	3	0.2	0.28	0.2267	0.02667	0.3045
PCB-1254	GIZZRD	Y	CRM 10.0	1994	3	3	0.1	0.3	0.2	0.05774	0.3686
PCB-1254	GIZZRD	N	CRM 125.0	1992	12	0	0.05	0.05	.	.	.
PCB-1254	GIZZRD	Y	CRM 125.0	1993	3	2	0.05	0.1	0.055	0.005	0.0696
PCB-1254	GIZZRD	N	CRM 20.0	1992	12	11	0.05	0.3	0.1233	0.02092	0.1609
PCB-1254	GIZZRD	Y	CRM 20.0	1994	3	0	0.1	0.1	.	.	.
PCB-1254	GIZZRD	Y	CRM 51.0	1993	3	3	0.06	0.08	0.07	0.00577	0.0869
PCB-1254	GIZZRD	Y	ERM 1.0	1993	3	3	0.14	0.16	0.15	0.00577	0.1669
PCB-1254	GIZZRD	Y	PCM 1.0	1992	2	2	0.4	0.4	0.4	0	0.4
PCB-1254	GIZZRD	N	PCM 1.0	1993	12	11	0.07	0.42	0.1717	0.03022	0.2259
PCB-1254	GIZZRD	Y	PRM 30.0	1991	2	0	0.1	0.1	.	.	.
PCB-1254	GIZZRD	Y	PRM 30.0	1992	2	0	0.05	0.05	.	.	.
PCB-1254	GIZZRD	Y	TRM 530.0	1991	2	2	0.06	0.3	0.18	0.12	0.9377

Table C11 (continued)

PCB-1254	GIZZRD	Y	TRM 530.0	1993	3	3	0.06	0.15	0.1133	0.02728	0 193
PCB-1254	GIZZRD	Y	TRM 545.0	1992	2	2	0 01	0.1	0.055	0.045	0.3391
PCB-1254	GIZZRD	Y	TRM 561.0	1991	2	2	0.1	0.2	0.15	0.05	0.4657
PCB-1254	GIZZRD	Y	TRM 570.0	1991	2	2	0.1	0.2	0.15	0.05	0.4657
PCB-1254	GIZZRD	N	TRM 570.0	1992	12	10	0.05	0.2	0.1233	0.01691	0.1537
PCB-1254	GIZZRD	Y	TRM 570.0	1993	3	2	0.08	0.1	0.085	0.005	0.0996
PCB-1260	GIZZRD	N	CRM 1.0	1991	12	12	0.07	0.2	0.1725	0.01452	0.1986
PCB-1260	GIZZRD	Y	CRM 1.0	1991	2	2	0.1	0.2	0.15	0.05	0.4657
PCB-1260	GIZZRD	Y	CRM 1.0	1992	2	2	0.1	0.2	0.15	0.05	0.4657
PCB-1260	GIZZRD	N	CRM 1.0	1993	12	7	0.1	0.29	0.1492	0.02331	0.191
PCB-1260	GIZZRD	Y	CRM 10.0	1993	3	3	0.1	0.33	0.21	0.06658	0.4044
PCB-1260	GIZZRD	Y	CRM 10.0	1994	3	2	0.1	0.11	0.1033	0.00385	0.1146
PCB-1260	GIZZRD	N	CRM 125.0	1992	12	0	0.05	0.05	.	.	
PCB-1260	GIZZRD	Y	CRM 125.0	1993	3	0	0.1	0.1	.	.	..
PCB-1260	GIZZRD	N	CRM 20.0	1992	12	10	0.05	0.6	0.1692	0 04567	0.2512
PCB-1260	GIZZRD	Y	CRM 20.0	1994	3	0	0.1	0.1	.	.	.
PCB-1260	GIZZRD	Y	CRM 51.0	1993	3	3	0.07	0.21	0.14	0.04041	0.258
PCB-1260	GIZZRD	Y	ERM 1.0	1993	3	2	0.1	0.15	0.1167	0.01925	0.1729
PCB-1260	GIZZRD	Y	PCM 1.0	1992	2	2	0.6	0.7	0.65	0.05	0.9657
PCB-1260	GIZZRD	N	PCM 1.0	1993	12	7	0.08	1.2	0.2121	0.09543	0.3835
PCB-1260	GIZZRD	Y	PRM 30.0	1991	2	0	0.1	0.1	.	.	.
PCB-1260	GIZZRD	Y	PRM 30.0	1992	2	0	0.05	0.05	.	.	.
PCB-1260	GIZZRD	Y	TRM 530.0	1991	2	2	0.1	0.1	0.1	0	0.1
PCB-1260	GIZZRD	Y	TRM 530.0	1993	3	1	0.06	0.1	0.06	.	.
PCB-1260	GIZZRD	Y	TRM 545.0	1992	2	2	0.1	0.2	0.15	0.05	0.4657
PCB-1260	GIZZRD	Y	TRM 561.0	1991	2	2	0.1	0.2	0.15	0.05	0.4657
PCB-1260	GIZZRD	Y	TRM 570.0	1991	2	2	0.1	0.1	0.1	0	0.1
PCB-1260	GIZZRD	N	TRM 570.0	1992	12	9	0.05	0.5	0.2333	0.03819	0.3019
PCB-1260	GIZZRD	Y	TRM 570.0	1993	3	1	0.05	0.1	0.05	.	.
PCB-1254	MAYFL Y	Y	CRM 1.0	1993	2	2	0.12	0.13	0.125	0.005	0.15657
PCB-1254	MAYFL Y	Y	CRM 1.0	1994	1	1	0.14	0.14	0.14	.	.
PCB-1254	MAYFL Y	Y	PCM 1.0	1993	2	2	0.085	0.097	0.091	0.006	0.12888
PCB-1254	MAYFL Y	Y	PCM 1.0	1994	1	1	0.1	0.1	0.1	.	.
PCB-1254	MAYFL Y	Y	TRM 570.0	1993	3	3	0.13	0.16	0.14	0.01	0.1692
PCB-1260	MAYFL Y	Y	CRM 1.0	1993	2	0	0.08	0.08	.	.	.
PCB-1260	MAYFL Y	Y	CRM 1.0	1994	1	0	0.08	0.08	.	.	.
PCB-1260	MAYFL Y	Y	PCM 1.0	1993	2	0	0.08	0.08	.	.	.
PCB-1260	MAYFL Y	Y	PCM 1.0	1994	1	0	0.08	0.08	.	.	.
PCB-1260	MAYFL Y	Y	TRM 570.0	1993	3	0	0.08	0.08	.	.	.

Table C12. Mean ± SE (N) concentrations (ppm, wet wt) of elements and Aroclor 1260[1] from homogenized fish[2] collected from great blue heron colonies located[3] on and off the Oak Ridge Reservation

	ON ORR	OFF ORR	P[5]
Mercury	0.06±0.02 (13)	0.02±0.00 (15)	0.030
Arsenic	0.30±0.05 (13)	0.23±0.03 (15)	0.238
Chromium	1.52±0.54 (12)	0.37±0.08 (15)	0.030
Aroclor 1260	0.20±0.04 (13)	0.15±0.03 (15)	0.269

[1]All congeners concentration were <20 ppb.
[2]Various fish species collected from active nest or stomachs of collected great blue heron chicks.
[3]Includes the K25 and Melton Hill colonies.
[4]Includes the Long Island and Looney Island colonies.
[5]T-test P value.

Table C15. Mean ± SE (N) Aroclor 1260 and congener concentrations[1] (ppm, wet wt) in great blue heron eggs collected from colonies located on[2] and off[3] the Oak Ridge Reservation

	ON ORR	OFF ORR	P[4]
Aroclor 1260	1.68±0.48 (24)	0.27±0.08 (34)	0.008
CB 81	0.13±0.04 (16)	0.08±0.02 (26)	0.365
CB 99	0.09±0.03 (16)	0.02±0.01 (26)	0.030
CB 101	0.04±0.02 (16)	0.00±0.00 (26)	0.018
CB 118	0.17±0.04 (16)	0.08±0.02 (26)	0.062
CB 123	0.11±0.04 (16)	0.01±0.00 (26)	0.015
CB 138	0.29±0.05 (16)	0.14±0.03 (26)	0.025
CB 146	0.09±0.03 (16)	0.03±0.01 (26)	0.036
CB 149	0.09±0.05 (8)	0.03±0.01 (14)	0.288
CB 153	0.37±0.07 (16)	0.16±0.04 (26)	0.019
CB 158	0.04±0.02 (16)	0.06±0.02 (26)	0.128
CB 167	0.05±0.01 (16)	0.01±0.00 (26)	0.008
CB 170	0.09±0.02 (16)	0.04±0.01 (26)	0.012
CB 180	0.27±0.06 (16)	0.11±0.02 (26)	0.021
CB 183	0.06±0.01 (16)	0.02±0.00 (26)	0.020
CB 194	0.04±0.01 (16)	0.02±0.00 (26)	0.076
CB 196	0.07±0.02 (16)	0.03±0.01 (26)	0.059

[1]Concentrations of CBs 66, 76, 77, 95, 105, 110, 114, 126, 128, 132, 151, 156, 171, and 201 were <30 ppb and are not included.
[2]Includes the K25 colony.
[3]Includes the Long Island and Looney Island colonies.
[4]T-test P value.

Table C16. Mean ± SE (N) Aroclor 1260 and congener concentrations (ppm, wet wt) in abdominal fat from great blue heron chicks collected from colonies located on[1] and off[2] the Oak Ridge Reservation

	ON ORR	OFF ORR	P[3]
Aroclor 1260	48.63±11.71 (16)	15.70±2.64 (24)	0.014
CB 66	1.21±0.75 (16)	0.23±0.03 (24)	0.210
CB 76	0.78±0.55 (16)	0.12±0.02 (24)	0.250
CB 77	0.27± 0.10 (16)	0.20±0.04 (24)	0.556
CB 81	1.54±0.44 (16)	1.28±0.30 (24)	0.761
CB 95	0.84±0.54 (16)	0.14±0.04 (24)	0.216
CB 99	2.70±1.36 (16)	0.56±0.15 (24)	0.138
CB 101	2.65±1.37 (16)	0.47±0.15 (24)	0.134
CB 105	0.73±0.36 (16)	0.13±0.02 (24)	0.115
CB 110	2.40±1.16 (16)	0.49±0.10 (24)	0.122
CB 114	0.07±0.04 (16)	0.00±0.00 (24)	0.999
CB 118	1.95±0.82 (16)	0.79±0.11 (24)	0.182
CB 123	2.53±1.09 (16)	0.63±0.11 (24)	0.102
CB 126	0.54±0.13 (16)	0.33±0.08 (24)	0.195
CB 128	0.95±0.37 (16)	0.19±0.02 (24)	0.058
CB 132	0.76±0.41 (16)	0.14±0.02 (24)	0.146
CB 138	5.13±1.44 (16)	1.70±0.23 (24)	0.032
CB 146	1.70±0.37 (16)	0.75±0.11 (24)	0.024
CB 149	2.76±0.54 (7)	1.04±0.24 (12)	0.018
CB 151	0.98±0.35 (16)	0.33±0.06 (24)	0.084
CB 153	6.24±1.35 (16)	2.47±0.45 (24)	0.016
CB 156	0.31±0.09 (16)	0.12±0.02 (24)	0.043
CB 158	0.19±0.14 (16)	0.21±0.08 (24)	0.905
CB 167	0.86±0.30 (16)	0.29±0.04 (24)	0.078
CB 170	1.57±0.34 (16)	0.54±0.07 (24)	0.010
CB 171	0.22±0.09 (16)	0.17±0.05 (24)	0.621
CB 180	4.27±0.95 (16)	1.37±0.25 (24)	0.009
CB 183	0.88±0.25 (16)	0.35±0.05 (24)	0.054
CB 194	0.63±0.12 (16)	0.38±0.05 (31)	0.078
CB 196	0.93±0.21 (16)	0.37±0.06 (24)	0.018
CB 201	0.53±0.11 (16)	0.22±0.03 (24)	0.012

[1]Includes the K25 colony.
[2]Includes the Long Island and Looney Island colonies.
[3]T-test P value.

Table C17. Mean ± SE (N) Aroclor 1260 and congener concentrations[1] (ppm, wet wt) in liver tissue from great blue heron chicks collected from colonies located on[2] and off[3] the Oak Ridge Reservation

	ON ORR	OFF ORR	P[4]
Aroclor 1260	0.77±0.23 (18)	0.23±0.03 (22)	0.029
CB 110	0.06±0.02 (18)	0.02±0.00 (22)	0.050
CB 118	0.05±0.02 (18)	0.01±0.00 (22)	0.049
CB 138	0.07±0.03 (18)	0.02±0.00 (22)	0.077
CB 149	0.06±0.03 (8)	0.02±0.00 (10)	0.209
CB 151	0.04±0.02 (18)	0.01±0.00 (22)	0.048
CB 153	0.10±0.03 (18)	0.03±0.00 (22)	0.017
CB 180	0.07±0.02 (18)	0.02±0.00 (22)	0.021

[1]Concentrations of CBs 66, 76, 77, 95, 99, 101, 105, 114, 123, 126, 128, 132, 146, 156, 158, 167, 170, 171, 183, 194, 196, and 201 were <30 ppb and are not included.
[2]Includes the K25 colony.
[3]Includes the Long Island and Looney Island colonies.
[4]T-test P value.

Table C18. Mean ± SE (N) Aroclor 1260 and congener concentrations[1] (ppm, wet wt) in muscle tissue from great blue heron chicks collected from colonies located on[2] and off[3] the Oak Ridge Reservation

	ON ORR	OFF ORR	P[4]
Aroclor 1260	1.05±0.25 (18)	0.35±0.08 (24)	0.015
CB 81	0.04±0.01 (18)	0.04±0.02 (24)	0.795
CB 110	0.06±0.02 (18)	0.01±0.00 (24)	0.027
CB 118	0.06±0.01 (18)	0.02±0.01 (24)	0.015
CB 138	0.09±0.02 (18)	0.04±0.01 (24)	0.033
CB 149	0.09±0.03 (8)	0.03±0.01 (12)	0.086
CB 153	0.16±0.03 (18)	0.05±0.01 (24)	0.009
CB 180	0.10±0.02 (18)	0.03±0.01 (24)	0.008

[1]Concentrations of CBs 66, 76, 77, 95, 99, 101, 105, 114, 123, 126, 128, 132, 146, 151, 156, 167, 170, 171, 183, 194, 196, and 201 were <30 ppb and are not included.
[2]Includes the K25 colony.
[3]Includes the Long Island and Looney Island colonies.
[4]T-test P value, based on lipid adjusted concentrations.

Table C19. Reproductive, physiological, and biomarker measurements [Mean ± SE (N)] in great blue heron from colonies located on[1] and off[2] the Oak Ridge Reservation during 1992–1994

	ON ORR	OFF ORR
Mean eggs/nest	3.5±0.2 (26)	3.2±0.2 (27)
Egg shell thickness (mm)	0.427±0.01 (33)	0.410±0.01 (34)
Egg weight (g)[3]	69.16±0.97 (33)	66.36±0.97 (34)
Mean chicks/nest	2.7±0.1 (55)	2.7±0.2 (30)
Chick weight/length ratio	2.06±0.05 (38)	2.12±0.06 (35)
Liver somatic index	4.50±0.16 (38)	4.64±0.23 (35)
Liver EROD activity[4]	31.9±2.7 (12)	41.3±3.2 (12)
DNA double-strandedness (F)[5]	73±0.03 (26)	84±0.02 (27)
Hematocuit	32±0.8 (38)	31±0.7 (26)

[1]Includes K25 and Melton Hill colonies.
[2]Includes Long Island and Looney Island colonies.
[3]Means significantly different (T-test, P=0.048).
[4]1994 data; ethoxyresorufin-o-deethylase activity (pmole/mq protein/min); means significantly different (T-test, P=0.033).
[5]Means signficantly different (T-test, P=0.006), F = fraction of double-stranded DNA.

Table C20. Percent by weight of the most common fish species collected from the Oak Ridge Reservation and Clinch River above Melton Hill Dam

Common Name	ORR %	Weight Kg	Clinch River %	Weight Kg
Sucker	17	280	3	12
Carp	20	330	24	97
Catfish	15	248	13	53
Shad	7	116	6	24
Buffalo	17	280	42	170
Other Species	24	396	12	49
TOTALS	100	1,650	100	405

Table C21. Mean mercury concentrations (ppm, wet wt) in homogenized fish[1] collected on the Oak Ridge Reservation[2], Clinch River above the Oak Ridge Reservation[3], and from the ocean[4] and diets fed to mink

	N[5]	MEAN[6]	SE	MIN	MAX
LOCATION					
On the ORR	10	0.35[a]	0.03	0.17	0.43
Clinch River	10	0.07[b]	0.00	0.05	0.09
Ocean	10	0.03[c]	0.00	0.02	0.04
DIET					
A[7]	10	0.02[a]	0.00	0.02	0.03
B[8]	10	0.05[b]	0.00	0.04	0.06
C[9]	10	0.09[c]	0.00	0.08	0.11
D[10]	10	0.15[d]	0.01	0.12	0.18
E[11]	10	0.22[e]	0.01	0.16	0.24

[1]Various fish species.
[2]Poplar Creek between East Fork Poplar Creek and confluence with the Clinch River.
[3]Above Melton Hill Dam near Bull Run Power Plant.
[4]Mackerel purchased from commercial supplier.
[5]Number of aliquots analyzed.
[6]Means followed by different letters are significantly different, $P<0.05$.
[7]75% ocean fish, 25% ranch mink diet.
[8]75% fish collected from the Clinch River above the Oak Ridge Reservation (ORR), 25% ranch mink diet.
[9]25% fish collected from Poplar Creek on the ORR, 50% ocean fish, 25% ranch mink diet.
[10]50% fish collected from Poplar Creek on the ORR, 25% ocean fish, 25% ranch mink diet.
[11]75% fish collected from Poplar Creek on the ORR, 25% ranch mink diet.

Table C22. Mercury concentration (ppm, wet wt) in tissues from female mink fed (n=8/diet) various diets[1] and their 6-week old kits

		Diet A	Diet B	Diet C	Diet D	Diet E
ADULT FEMALE MINK						
Liver Hg	Mean[2]	0.41[a]	0.61[a]	1.06[a]	1.93[b]	3.67[c]
	SE	0.07	0.06	0.10	0.15	0.32
	Range	0.17-0.8	0.47-0.87	0.74-1.49	1.26-2.47	2.52-5.20
Kidney Hg	Mean	0.84[a]	1.25[ab]	2.22[bc]	3.47[cd]	4.35[d]
	SE	0.13	0.18	0.35	0.52	0.34
	Range	0.25-1.46	0.53-1.96	1.24-4.22	2.38-7.00	3.33-6.25
Hair Hg	Mean	3.79[a]	7.43[b]	7.71[b]	13.44[c]	19.03[d]
	SE	0.26	0.55	0.63	0.79	0.57
	Range	2.20-4.61	5.05-9.70	4.38-9.62	10.2-15.6	16.8-21.4
KITS						
Carcass	Mean	0.02[a]	0.03[a]	0.05[a]		0.20[b]
	SE	0.004	0.003	0.003		0.02
	Range	0.01-0.05	0.02-0.05	0.04-0.06		0.10-0.30
	N	9	9	8		9
Kidney Hg	Mean	0.03[a]	0.03[a]	0.06[a]		0.19[b]
	SE	0.001	0.003	0.003		0.02
	Range	0.02-0.04	0.02-0.04	0.05-0.07		0.11-0.31
	N	9	9	8		9

[1]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

[2]Means with different superscripts are significantly different, $P<0.05$.

Table C23. Mean[1] ± SE lipid adjusted Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in homogenized fish[2] collected on the Oak Ridge Reservation[3], Clinch River above the Oak Ridge Reservation[4], and from the ocean[5]

	Ocean	Clinch River	ORR
CB 77	0.022^{a}±0.000 (10)	0.039^{b}±0.001 (10)	0.190^{c}±0.004 (10)
CB 81	0.053^{a}±0.001 (10)	0.592^{b}±0.062 (10)	1.419^{c}±0.262 (9)
CB 99	0.022^{a}±0.000 (10)	0.076^{b}±0.011 (10)	0.894^{c}±0.015 (10)
CB 101	0.022^{a}±0.000 (10)	0.142^{b}±0.022 (10)	0.609^{c}±0.010 (10)
CB 118	0.022^{a}±0.000 (10)	0.468^{ab}±0.219 (10)	1.150^{b}±0.030 (9)
CB 123	0.022^{a}±0.000 (10)	0.039^{ab}±0.001 (10)	0.051^{b}±0.010 (10)
CB 126	0.022^{a}±0.000 (10)	0.039^{b}±0.001 (10)	0.041^{b}±0.001 (10)
CB 128	0.022^{a}±0.000 (10)	0.178^{b}±0.003 (10)	0.636^{c}±0.012 (10)
CB 138	0.022^{a}±0.000 (10)	0.706^{b}±0.014 (10)	1.611^{c}±0.052 (9)
CB 146	0.022^{a}±0.000 (10)	0.388^{b}±0.007 (10)	0.822^{c}±0.023 (10)
CB 151	0.039^{a}±0.002 (10)	0.496^{b}±0.008 (10)	1.731^{c}±0.048 (10)
CB 153	0.074^{a}±0.002 (10)	2.813^{b}±0.082 (10)	4.733^{c}±0.123 (9)
CB 156	0.022^{a}±0.000 (10)	0.039^{b}±0.001 (10)	0.078^{b}±0.037 (10)
CB 167	0.022^{a}±0.000 (10)	0.044^{b}±0.003 (10)	0.193^{c}±0.003 (10)
CB 170	0.022^{a}±0.000 (10)	0.455^{b}±0.010 (10)	1.315^{c}±0.025 (10)
CB 171	0.022^{a}±0.000 (10)	0.039^{b}±0.001 (10)	0.041^{b}±0.001 (10)
CB 180	0.022^{a}±0.000 (10)	3.021^{b}±0.099 (10)	3.592^{c}±0.088 (10)
CB 183	0.022^{a}±0.000 (10)	0.690^{b}±0.012 (10)	1.000^{c}±0.016 (10)
CB 189	0.022^{a}±0.000 (10)	0.039^{b}±0.001 (10)	0.041^{b}±0.001 (10)
CB 194	0.022^{a}±0.000 (10)	0.376^{b}±0.009 (10)	0.430^{c}±0.006 (10)
CB 195	0.022^{a}±0.000 (10)	0.042^{b}±0.002 (10)	0.043^{b}±0.002 (10)
CB 196	0.022^{a}±0.000 (10)	0.570^{b}±0.014 (10)	1.660^{c}±0.041 (10)
CB 201	0.022^{a}±0.000 (10)	0.486^{b}±0.009 (10)	0.605^{c}±0.008 (10)
Aroclor 1260	0.379^{a}±0.008 (10)	21.917^{b}±0.681 (10)	28.997^{c}±0.659 (10)

[1]Means with different superscripts are significantly different, $P<0.05$.
[2]Various fish species.
[3]Poplar Creek between East Fork Poplar Creek and confluence with the Clinch River.
[4]Above Melton Hill Dam near Bull Run Power Plant.
[5]Mackerel purchased from commercial supplier.

Table C24. Mean ± SE lipid adjusted Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in mink diets[1] (n=10/diet)

	Diet A	Diet B	Diet C	Diet D	Diet E
CB 77	0.025±0.000	0.037±0.001	0.046±0.003	0.102±0.002	0.116±0.005
CB 81	0.027±0.002	0.337±0.051	0.507±0.011	0.873±0.022	1.158±0.033
CB 99	0.025±0.000	0.037±0.001	0.276±0.011	0.531±0.014	0.520±0.013
CB 101	0.031±0.004	0.239±0.032	0.288±0.009	0.585±0.012	0.396±0.020
CB 118	0.025±0.000	0.117±0.010	0.192±0.007	0.405±0.007	0.668±0.021
CB 123	0.025±0.000	0.037±0.001	0.212±0.008	0.446±0.008	0.076±0.003
CB 126	0.025±0.000	0.037±0.001	0.027±0.001	0.038±0.003	0.033±0.001
CB 128	0.025±0.000	0.085±0.003	0.104±0.004	0.228±0.005	0.351±0.013
CB 138	0.080±0.002	0.791±0.087	0.331±0.011	0.690±0.009	1.048±0.020
CB 146	0.025±0.000	0.037±0.001	0.141±0.006	0.335±0.007	0.501±0.015
CB 151	0.025±0.000	0.314±0.010	0.254±0.009	0.555±0.009	1.058±0.039
CB 153	0.025±0.000	1.862±0.025	0.766±0.029	1.772±0.026	3.126±0.056
CB 156	0.025±0.000	0.139±0.013	0.065±0.002	0.094±0.015	0.033±0.001
CB 167	0.025±0.000	0.037±0.001	0.027±0.001	0.061±0.003	0.103±0.004
CB 170	0.025±0.000	1.847±0.964	0.154±0.007	0.346±0.008	0.798±0.016
CB 171	0.025±0.000	0.037±0.001	0.061±0.002	0.127±0.003	0.033±0.001
CB 180	0.025±0.000	1.011±0.266	0.507±0.019	1.091±0.018	2.292±0.040
CB 183	0.025±0.000	0.276±0.053	0.170±0.006	0.355±0.007	0.573±0.019
CB 189	0.025±0.000	0.037±0.001	0.027±0.001	0.031±0.000	0.033±0.001
CB 194	0.025±0.000	0.058±0.022	0.072±0.008	0.149±0.020	0.245±0.009
CB 195	0.025±0.000	0.039±0.003	0.027±0.001	0.033±0.002	0.033±0.001
CB 196	0.025±0.000	1.081±0.084	0.184±0.008	0.415±0.008	1.071±0.024
CB 201	0.025±0.000	0.230±0.034	0.060±0.002	0.131±0.003	0.338±0.010
Aroclor 1260	0.169±0.002	11.440±0.327	4.697±0.174	10.405±0.250	20.670±0.458

[1]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table C25. Mean ± SE lipid adjusted Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in liver tissue from female mink (n=8/diet) for various diets[1]

	Diet A	Diet B	Diet C	Diet D	Diet E
CB 77	0.048±0.016	0.081±0.010	0.033±0.004	0.095±0.040	0.028±0.005
CB 81	0.048±0.016	0.054±0.010	0.033±0.004	0.095±0.040	0.197±0.117
CB 99	0.048±0.016	0.117±0.014	0.420±0.061	0.962±0.123	0.823±0.215
CB 101	0.048±0.016	0.053±0.011	0.033±0.004	0.145±0.019	0.154±0.015
CB 118	0.141±0.008	0.590±0.040	1.066±0.153	2.157±0.406	1.656±0.332
CB 123	0.048±0.016	0.041±0.006	0.033±0.004	0.095±0.040	1.598±0.228
CB 126	0.048±0.016	0.224±0.023	0.033±0.004	0.095±0.040	1.703±0.251
CB 128	0.048±0.016	0.174±0.023	0.151±0.024	0.353±0.054	0.691±0.097
CB 138	0.136±0.023	2.063±0.479	2.083±0.224	4.816±0.915	5.649±0.465
CB 146	0.059±0.015	0.627±0.051	0.545±0.055	1.188±0.113	0.604±0.111
CB 153	0.206±0.020	5.075±0.445	3.858±0.365	8.063±1.195	7.242±1.658
CB 156	0.048±0.016	0.228±0.074	0.193±0.037	0.480±0.102	0.648±0.102
CB 167	0.048±0.016	0.125±0.013	0.166±0.020	0.244±0.077	0.776±0.100
CB 170	0.057±0.015	2.249±0.219	0.774±0.144	1.971±0.444	1.878±0.194
CB 171	0.048±0.016	0.041±0.006	0.093±0.013	0.217±0.027	0.774±0.065
CB 180	0.131±0.015	6.576±0.772	3.117±0.390	6.980±1.296	7.752±0.815
CB 183	0.048±0.016	0.412±0.032	0.229±0.024	0.479±0.097	0.527±0.086
CB 189	0.048±0.016	0.044±0.007	0.042±0.007	0.137±0.038	0.106±0.013
CB 194	0.050±0.016	1.887±0.208	0.803±0.086	1.795±0.202	1.218±0.174
CB 195	0.048±0.016	0.041±0.006	0.192±0.018	0.457±0.035	0.115±0.015
CB 196	0.068±0.015	2.998±0.302	0.033±0.004	0.095±0.040	1.863±0.985
CB 201	0.048±0.016	2.085±0.261	0.245±0.084	1.448±0.459	2.794±0.356
Aroclor 1260	0.344±0.132	0.270±0.039	0.230±0.021	0.723±0.329	79.486±8.112

[1]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table C26. Mean ± SE Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in fat tissue from female mink (n=8/diet) fed various diets[1]

	Diet A	Diet B	Diet C	Diet D	Diet E
CB 77	0.011±0.005	0.035±0.006	0.046±0.006	0.083±0.019	0.138±0.011
CB 81	0.120±0.042	0.339±0.061	0.280±0.052	0.429±0.023	0.696±0.078
CB 99	0.050±0.018	0.169±0.029	0.786±0.168	1.447±0.265	1.708±0.272
CB 101	0.016±0.006	0.098±0.020	0.107±0.018	0.263±0.029	0.311±0.037
CB 118	0.163±0.066	0.464±0.089	1.461±0.276	2.943±0.388	3.175±0.299
CB 123	0.130±0.036	0.458±0.088	0.033±0.006	0.063±0.006	2.375±0.330
CB 126	0.064±0.029	1.171±0.212	0.196±0.032	0.481±0.035	1.511±0.160
CB 128	0.033±0.020	0.299±0.048	0.352±0.059	0.781±0.080	1.210±0.097
CB 138	0.267±0.135	2.800±0.609	3.464±0.638	9.543±1.036	9.925±0.833
CB 146	0.041±0.015	0.500±0.104	0.600±0.097	1.421±0.111	1.771±0.179
CB 153	0.405±0.230	5.538±1.069	5.195±0.988	15.714±1.686	15.375±1.349
CB 156	0.009±0.003	0.469±0.084	0.409±0.073	0.914±0.086	1.188±0.077
CB 167	0.040±0.019	0.350±0.055	0.621±0.109	1.347±0.126	1.500±0.125
CB 170	0.093±0.051	2.278±0.471	0.800±0.157	2.043±0.238	3.013±0.168
CB 171	0.035±0.017	0.521±0.093	0.488±0.086	1.083±0.100	1.393±0.084
CB 180	0.290±0.188	7.175±1.544	5.264±1.034	14.571±1.325	14.750±1.161
CB 183	0.019±0.012	0.559±0.102	0.368±0.069	0.899±0.073	1.114±0.143
CB 189	0.005±0.001	0.090±0.019	0.041±0.006	0.130±0.015	0.186±0.018
CB 194	0.060±0.035	2.103±0.475	0.918±0.174	2.386±0.201	2.688±0.351
CB 195	0.011±0.007	0.419±0.078	0.033±0.006	0.063±0.006	0.133±0.021
CB 196	0.021±0.014	0.778±0.163	0.426±0.091	1.064±0.105	1.645±0.295
CB 201	0.031±0.019	0.889±0.151	0.477±0.080	1.226±0.101	1.813±0.178
Aroclor 1260	3.169±1.849	61.250±12.560	0.261±0.044	105.86±11.26	128.63±7.73

[1]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table C27. Mean[1] ± SE Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in liver tissue from 6 week old mink kits from dams fed diets of fish collected from various sources[2]

	Diet A	Diet B	Diet C	Diet E
CB 77	0.003±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 81	0.004±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.007±0.001 (9)
CB 99	0.003[a]±0.000 (9)	0.006[a]±0.001 (9)	0.016[a]±0.005 (8)	0.049[b]±0.012 (9)
CB 101	0.004±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 118	0.012[a]±0.001 (9)	0.012[a]±0.002 (9)	0.068[b]±0.014 (8)	0.138[c]±0.025 (9)
CB 123	0.008±0.001 (9)	0.007±0.000 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 126	0.003[a]±0.000 (9)	0.007[a]±0.001 (9)	0.007[a]±0.001 (8)	0.014[b]±0.003 (9)
CB 128	0.003[a]±0.000 (9)	0.006[a]±0.001 (9)	0.020[a]±0.005 (8)	0.092[b]±0.034 (9)
CB 138	0.015[a]±0.002 (9)	0.058[a]±0.011 (9)	0.141[a]±0.033 (8)	0.547[b]±0.200 (9)
CB 146	0.004[a]±0.000 (9)	0.011[a]±0.002 (9)	0.033[a]±0.006 (8)	0.143[b]±0.042 (9)
CB 151	0.004±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 153	0.011[a]±0.002 (9)	0.065[a]±0.010 (9)	0.157[a]±0.039 (8)	0.509[b]±0.137 (9)
CB 156	0.003±0.000 (9)	0.008±0.001 (9)	0.009±0.001 (8)	0.006±0.001 (9)
CB 167	0.004[a]±0.000 (9)	0.007[a]±0.001 (9)	0.009[a]±0.002 (8)	0.028[b]±0.007 (9)
CB 170	0.004[a]±0.000 (9)	0.054[a]±0.009 (9)	0.078[b]±0.014 (8)	0.294[b]±0.118 (9)
CB 171	0.003±0.000 (9)	0.008±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 180	0.006[a]±0.001 (9)	0.109[a]±0.018 (9)	0.194[b]±0.040 (8)	0.629[b]±0.235 (9)
CB 183	0.004[a]±0.000 (9)	0.007[a]±0.000 (9)	0.013[a]±0.004 (8)	0.035[b]±0.009 (9)
CB 189	0.003±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.008±0.002 (9)
CB 194	0.004[a]±0.000 (9)	0.019[a]±0.003 (9)	0.041[b]±0.008 (8)	0.146[b]±0.055 (9)
CB 195	0.003±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 196	0.004[a]±0.000 (9)	0.052[a]±0.011 (9)	0.084[b]±0.015 (8)	0.319[b]±0.128 (9)
CB 201	0.003[a]±0.000 (9)	0.014[a]±0.002 (9)	0.027[a]±0.005 (8)	0.142[b]±0.032 (9)
Aroclor 1260	0.099±0.016 (9)	0.151±0.099 (9)	0.058±0.009 (8)	0.048±0.008 (9)

[1]Means with different superscripts are significantly different, $P \leq 0.05$.

[2]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table C28. Mean[1] ± SE Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in carcass[2] of 6 week old mink kits from dams fed diets of fish collected from various sources[3]

	Diet A	Diet B	Diet C	Diet E
CB 77	0.003±0.000 (9)	0.003±0.000 (9)	0.003±0.000 (8)	0.003±0.000 (9)
CB 81	0.003±0.000 (9)	0.003±0.000 (9)	0.003±0.000 (8)	0.005±0.001 (9)
CB 99	0.003^{a}±0.000 (9)	0.009^{a}±0.003 (9)	0.017^{a}±0.003 (8)	0.096^{b}±0.023 (9)
CB 101	0.003^{a}±0.000 (9)	0.004^{a}±0.001 (9)	0.006^{a}±0.001 (8)	0.017^{b}±0.002 (9)
CB 118	0.008^{a}±0.001 (9)	0.030^{a}±0.009 (9)	0.071^{a}±0.018 (7)	0.245^{b}±0.036 (9)
CB 123	0.003±0.000 (9)	0.011±0.005 (9)	0.003±0.000 (8)	0.008±0.001 (9)
CB 126	0.003±0.000 (9)	0.011±0.001 (9)	0.005±0.001 (8)	0.003±0.000 (9)
CB 128	0.003^{a}±0.000 (9)	0.011^{a}±0.004 (9)	0.012^{a}±0.002 (8)	0.054^{b}±0.007 (9)
CB 138	0.008^{a}±0.001 (9)	0.112^{a}±0.016 (9)	0.106^{a}±0.021 (7)	0.634^{b}±0.110 (9)
CB 146	0.003^{a}±0.000 (9)	0.013^{a}±0.002 (9)	0.019^{a}±0.003 (8)	0.103^{b}±0.017 (9)
CB 151	0.003±0.000 (9)	0.003±0.000 (9)	0.003±0.000 (8)	0.005±0.001 (9)
CB 153	0.009^{a}±0.001 (9)	0.141^{a}±0.024 (9)	0.119^{a}±0.025 (7)	0.619^{b}±0.096 (9)
CB 156	0.003^{a}±0.000 (9)	0.017^{ab}±0.003 (9)	0.022^{b}±0.003 (8)	0.058^{c}±0.008 (9)
CB 167	0.003^{a}±0.000 (9)	0.014^{bc}±0.002 (9)	0.010^{ab}±0.002 (8)	0.022^{c}±0.003 (9)
CB 170	0.003^{a}±0.000 (9)	0.073^{a}±0.012 (9)	0.047^{a}±0.007 (8)	0.238^{b}±0.036 (9)
CB 171	0.003^{a}±0.000 (9)	0.021^{a}±0.003 (9)	0.008^{a}±0.004 (8)	0.017^{b}±0.002 (9)
CB 180	0.004^{a}±0.000 (9)	0.203^{a}±0.026 (9)	0.121^{a}±0.019 (7)	0.611^{b}±0.080 (9)
CB 183	0.003^{a}±0.000 (9)	0.011^{a}±0.001 (9)	0.007^{a}±0.002 (8)	0.031^{b}±0.005 (9)
CB 189	0.003±0.000 (9)	0.003±0.000 (9)	0.003±0.000 (8)	0.008±0.001 (9)
CB 194	0.003^{a}±0.000 (9)	0.025^{a}±0.003 (9)	0.019^{a}±0.004 (8)	0.089^{b}±0.010 (9)
CB 195	0.003^{a}±0.000 (9)	0.003^{a}±0.000 (9)	0.004^{a}±0.001 (8)	0.023^{b}±0.003 (9)
CB 196	0.003±0.000 (9)	0.014±0.002 (9)	0.005±0.002 (8)	0.005±0.001 (9)
CB 201	0.003^{a}±0.000 (9)	0.013^{a}±0.002 (9)	0.012^{a}±0.002 (8)	0.050^{b}±0.009 (9)
Aroclor 1260	0.082±0.005 (9)	1.791±0.282 (9)	0.353±0.245 (8)	0.049±0.006 (9)

[1]Means with different superscripts are significantly different, $P<0.05$. Diet groups were separated based on lipid adjusted concentrations.

[2]Whole body minus liver tissue.

[3]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table C29. Reproductive performance of female mink fed diets of 75% fish from various sources[1]

	Diet A	Diet B	Diet C	Diet D	Diet E
Females Whelping	6	7	4	6	8
Female Weights					
December[2]	1269±64[3]	1245±63	1374±64	1258±64	1230±64
June[4]	1168±84[a]	1016±81	1134±81	1020±81	935±81[b]
Gestation (days)	44.6	46.4	44.3	47.5	44.9
Kit Wts (6 wks)	328±14	311±10	333±20	307±12	295±11
Females	296±38				268±37
Males	376±42[a]				312±44[b]
Litter Size[5]	6.9[a]	7.3[a]	7.8[a]	6.0[ab]	4.3[b]
EROD[6]	51±13[a]	134±26[ab]	124±32[ab]	276±33[b]	262.54±31[b]

[1]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.
[2]Beginning of study.
[3]Means followed by different superscripts are significantly different, $P<0.05$.
[4]End of study.
[5]Kits/female.
[6]Ethoxyresorufin-o-deethylase, pmoles/mg protein/min.

Table C30. Mean ± SE for bioindicators measured in female bluegill sunfish collected from various sites in the Clinch River, Poplar Creek, and Tennessee River

	CRM 1.0		CRM 20.0		PCM 1.0		TRM 570.0		TRM 555.0		CRM 125.0	
	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
EROD	4.78	0.82	8.18	1.62	4.25	0.92	7.74	1.34	5.67	0.85	4.70	0.37
MPRO	19.49	1.43	22.55	1.87	21.35	2.47	17.16	2.67	17.63	3.29	20.98	1.99
CDFC	1.84	0.03	1.92	0.04	1.95	0.06	1.95	0.05	1.88	0.05	1.85	0.04
LSI	1.43 B	0.08	1.29 B	0.06	1.76	0.09	1.48	0.07	1.37 B	0.08	1.64	0.07
VSI	3.76	0.09	2.62 B	0.13	3.05	0.14	4.09 B	0.20	3.74	0.19	3.30	0.20
VEIP	4.00	0.00	3.94	0.06	3.92	0.08	4.00	0.00	4.00	0.00	4.00	0.00
SSI	0.06	0.01	0.10 B	0.01	0.08 B	0.01	0.06	0.00	0.07	0.01	0.05	0.00
PSTO	95.00 B	5.00	24.69	5.73	28.75	9.54	72.50	7.48	79.58 B	10.84	47.31	7.59
PINT	33.00	6.02	45.31	5.01	25.00	6.48	42.92	5.62	20.42 B	3.04	41.92	6.78
LMACA	0.19	0.12	1.62 B	0.40	0.16	0.05	1.13 B	0.26	0.42	0.12	0.28	0.14
LPARS	3.45	2.24	1.28	0.79	9.20	6.04	1.48	0.59	2.88	1.90	0.00	0.00
SMACA	4.18	1.59	2.13	0.50	3.23	1.46	4.70	1.36	5.58	2.18	4.35	0.45
SPARS	0.43	0.43	1.93	1.93	8.73	8.73	0.00	0.00	1.75	0.74	0.00	0.00
LNPMA	0.58	0.38	1.25	0.60	0.12	0.07	2.95	0.92	0.50	0.33	0.25	0.25

Table C31. Mean ± SE for bioindicators measured in male bluegill sunfish collected from various sites in the Clinch River, Poplar Creek, and Tennessee River

	CRM 1.0		CRM 10.0		CRM 20.0		CRM 21.5		PCM 1.0		PCM 4.6		PCM 5.3		TRM 570.0		TRM 555.0		TRM 530.0		CRM 125.0	
	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
EROD	9.38	0.81	7.57	1.85	21.02 AB	2.95	11.34	2.80	13.20	1.57	19.53	6.21	16.19	1.78	11.77	1.95	11.72	2.64	8.11	2.96	9.44	1.79
MPRO	17.77 AB	1.21	13.46	1.13	15.70 A	0.88	15.14	0.66	14.12	1.16	16.37 A	0.65	15.69	0.83	16.02	1.66	18.49 AB	2.32	11.27	0.92	13.57	1.13
ALB	0.72 B	0.03	0.91	0.04	0.84	0.05	0.86	0.06	1.63 A	0.28	0.78	0.03	0.99	0.09	1.06 A	0.16	1.24 A	0.15	0.708 B	0.05	1.05 A	0.09
ALT	12.71	3.35	19.42	3.51	14.08	2.36	23.80	5.66	42.00 AB	5.71	8.64	1.36	10.00	2.34	31.40 A	8.05	32.46 A	5.85	11.25	1.38	23 63	4.67
AST	65.52	6.94	183.33 A	37.90	82.75	12.71	152.80	46.06	119.00	14.41	122.64	22.73	74.57	14.90	167.33	37.98	94.50	16.50	79.83	10.57	129.74	16.41
BPRO	2.34 B	0.10	2.83 B	0.12	3.03 B	0.15	3.04 B	0.09	3.74 A	0.28	2.78 B	0.10	3.37	0.11	2.72 B	0.14	3.96 A	0.21	2.90 B	0.14	3.83 A	0.25
BUN	1.24 AB	0.13	1.80 B	0.15	1.38 AB	0.14	0.89 AB	0.12	3.19	0.64	1.95 B	0.28	1.65 B	0.22	1.20 AB	0.25	2.74	0.26	2.41 B	0.19	3.47 A	0.38
CREAT	0.13	0.03	0.18	0.07	0.11	0.01	0.09	0.02	0.22 B	0.07	0.12	0.01	0.13	0.05	0.21	0.03	0.11	0.01	0.15	0.02	0.10	0.01
CDFC	1.99	0.04	1.93	0.06	2.10	0.05	2.00	0.04	2.13	0.04	1.88	0.03	1.75 B	0.02	2.05	0.03	1.95	0.04	1.96	0.06	1.97	0.05
LSI	0.98	0.06	0.80	0.06	1.12	0.08	0.99	0.09	1.06	0.08	0.89	0.06	0.88	0.03	0.86	0.04	0.91	0.07	1.08	0.08	0.99	0.05
VSI	4.23 B	0.13	3.73	0.21	3.251 A	0.15	3.22 A	0.19	3.20 A	0.09	4.29	0.22	3.68	0.10	3.92	0.16	3.45 A	0.15	4.26	0 20	3.67	0.13
VEIP	3.86	0.08	3.92	0.08	3.60	0.11	3.20 B	0.29	3.82	0.12	3.55	0.16	3.67	0.17	4.00 A	0.00	4.00 A	0.00	3.38	0 22	3.85	0.11
SSI	0.07	0.01	0.10 B	0.01	0.10 B	0.01	0.097 B	0.02	0.07	0.01	0.08	0.01	0.11 B	0.02	0.04	0.00	0.08	0.02	0.07	0.01	0.05	0.00
PSTO	45.91	9.94	18.75 A	9.05	25.21 A	5.25	4.50 AB	3.45	10.46 AB	7.02	17.73 A	6.01	10.56 AB	4.89	74.55	8.75	46.82	12.03	60.83	12.83	50.50	8.58
PINT	25.00 B	4.31	40.83	9.94	39.38	5.07	13.00 B	4.10	10.46 AB	3.72	15.91 B	6.21	40.56	11.56	40.46	7.15	31.36	5.40	42.08	8.71	52.75	6.92
BTRI	281.62 A	34.71	143.25 A	19.45	563.29 B	61.54	436.70	105.34	205.91 A	40.55	322.00	65.48	175.00 A	27.00	328.20	46.25	220.36 A	80.77	517.42	82.31	366 26	51.14
LMACA	0.20	0.09	0.69	0.19	0.28	0.11	0.27	0.09	0.46	0.22	1.92	1.67	0.90	0.60	0 26	0.11	0.58	0.27	0 35	0 20	0 35	0 08
LPARS	1.91	0.82	12.07 A	4.86	7.61	1.57	0.00	0.00	2.78	1.67	13.40 AB	4.53	10.13	2.71	0.22	0.14	1.58	1.58	0.48	0 44	3 24	1 42
SMACA	4.35	0.65	2.56	0.93	1.74	0.29	1.49	0.49	3.20	0.97	2.32	0.40	1.52	0.41	2.78	1.09	4.90	2 82	3.06	0 82	2 57	0 81
SPARS	1.32	0.74	2.51	1.43	4.02	1.64	1.11	1.03	4.16	2.97	4.46	2.01	7.26	2.87	2.82	1.74	0.00	0.00	1 26	0 86	1 72	1.11
LNPMA	0.74	0.38	2.01	1.22	0.72	0.27	0.37	0 24	1.06	0.57	1.84	1.18	2.43	2.03	7.98 AB	7.13	0 45	0 22	0 11	0 11	0 57	0 28

Table C32. Mean ± SE for bioindicators measured in female largemouth bass collected from various sites in the Clinch River, Poplar Creek, and Tennessee River

	CRM 1.0		CRM 10.0		CRM 20.0		CRM 21.5		PCM 1.0		PCM 4.6		PCM 5.3		TRM 570.0		TRM 555.0		TRM 530.0		CRM 125.0	
	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
EROD	3.10	0.59	8.80	1.48	13.45 B	3.11	7.73	1.34	13.41 B	2.03	27.61 B	10.31	28.14 B	9.22	5.94	1.66	3.15	0.52	11.40	5.86	2.53	0.30
MPRO	34.86	2.07	23.48 B	0.94	29.27 B	1.92	24.64 B	1.34	26.73 B	1.04	24.43 B	3.24	24.21 B	2.58	32.25	1.76	38.81 A	1.70	22.29 B	3.14	36.62 A	1.75
ALB	1.43	0.05	.	.	0.83	0.03	.	.	0.49	0.03	1.05	0.15	.	.	1.23	0.13	.	.	.	.	.	.
ALT	7.00	1.83	.	.	11.67	7.17	.	.	9.44	2.26	5.50	0.50	.	.	5.33	2.33	.	.	.	.	.	.
AST	31.00	5.67	.	.	45.33	32.90	.	.	30.67	8.58	42.00	1.00	.	.	52.00	36.02	.	.	.	.	.	.
BPRO	3.88	0.20	.	.	3.33	0.13	.	.	1.79	0.06	3.65	0.55	.	.	3.93	0.35	.	.	.	.	.	.
BUN	2.62	0.35	.	.	1.10	0.18	.	.	0.87	0.13	2.03	0.71	.	.	1.76	0.19	.	.	.	.	.	.
CREAT	0.20	0.05	.	.	0.26	0.04	.	.	0.21	0.01	0.26	0.01	.	.	0.11	0.01	.	.	.	.	.	.
CDFC	1.54 B	0.04	1.61 B	0.08	1.41	0.05	1.46 B	0.07	1.48 B	0.03	1.39	0.10	1.41	0.07	1.43 B	0.03	1.49 B	0.05	1.62 B	0.06	1.27 A	0.03
LSI	1.31	0.04	1.56 B	0.11	1.27	0.14	1.24	0.04	1.34	0.06	0.97 A	0.04	0.79 A	0.10	1.44 B	0.05	1.30	0.04	1.63 B	0.17	1.16 A	0.06
VSI	5.04 B	0.22	5.77 B	0.55	5.36 B	0.38	4.63 B	0.65	4.66 B	0.18	4.16	0.26	4.08	0.33	4.56 B	0.18	3.86	0.15	5.22 B	0.15	3.31 A	0.15
VEIP	1.64 B	0.12	2.10	0.25	2.50	0.21	2.25	0.25	2.62	0.16	3.07 A	0.39	3.00	0.27	2.91 A	0.17	3.25 A	0.17	1.50	0.29	2.74	0.28
SSI	0.09	0.01	0.10	0.01	0.16 B	0.05	0.10	0.02	0.10	0.01	0.07	0.01	0.14	0.04	0.09	0.01	0.11	0.02	0.11	0.02	0.08	0.01
PSTO	2.14	1.46	1.00	1.00	21.25	8.66	0.00	0.00	26.15 B	7.74	1.43	0.92	9.00	6.60	14.05	6.85	2.08	2.08	21.67	21.67	0.00	0.00
PINT	1.43	1.43	5.00	2.74	12.92	7.14 B	0.83	0.83	6.15	2.50	5.71	2.54	12.00	6.25	7.62	3.27	0.00	0.00	5.00	5.00	0.00	0.00
BTRI	348.25	48.40	.	.	381.67	153.04	.	.	138.00	17.24	205.50	43.50	.	.	477.00	170.56	.	.	.	.		.
LMACA	0.85	0.25	0.90	.	0.81	0.33	0.64	0.20	0.90	0.31	0.96	0.55	1.35	1.35	0.63	0.20	0.90	0.32	0.65	0.45	1.60	0.60
LPARS	0.13	0.09	0.00	.	0.83	0.28	0.40	0.40	1.08	0.44	1.16	1.02	0.00	0.00	0.28	0.21	0.26	0.26	0.00	0.00	0.03	0.03
SMACA	3.53	0.62	4.20	.	4.33	1.16	2.08	0.37	2.82	0.42	4.48	2.15	0.70	0.70	2.00	0.74	3.60	1.35	2.55	0.85	.	.
SPARS	0.80	0.80	9.60	.	1.91	1.70	0.62	0.43	4.78	3.41	3.88	1.58	8.35	8.35	8.66	7.56	2.00	1.85	0.00	0.00	.	.
LNPMA	1.03	0.65	0.70	.	0.84	0.30	0.20	0.13	0.51	0.20	1.04	0.38	0.85	0.85	0.41	0.18	0.00	0.00	0.05	0.05	0.30	0.30

Table C33. Mean ± SE for bioindicators measured in male largemouth bass collected from various sites in the Clinch River, Poplar Creek, and Tennessee River

	CRM 1.0		CRM 10.0		CRM 20.0		CRM 21.5		PCM 1.0		PCM 4.6		PCM 5.3		TRM 570.0		TRM 555.0		TRM 530.0		CRM 125.0	
	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
EROD	12.24	2.65	23.91 B	4.04	17.03	2.32	23.96	3.04	39.67 AB	5.32	43.68 AB	18.00	31.73	.	11.19	2.78	6.68	1.49	17.05	3.06	9.64	1.64
MPRO	22.00 A	1.47	14.36	1.19	24.77 A	1.84	16.59	1.43	21.08 A	1.03	15.94	4.78	25.78	.	16.55	1.80	26.37 AB	1.33	12.38 B	1.25	19.59 A	1.06
ALB	1.05	0.02	0.97	0.06	0.85 B	0.03	0.90	.	0.91	0.04	1.00	0.10	.	.	1.02	0.02	1.18 A	0.04	0.93	0.04	1.04	0.05
ALT	10.79 A	2.25	12.11	2.70	19.44	9.60	15.00	.	9.13	3.18	4.50	1.50	.	.	7.06 A	2.07	5.60 A	1.63	26.33 B	6.73	10.05 A	2.63
AST	59.58	7.89	65.33	16.09	70.44	25.57	42.00	.	36.13	11.66	46.00	23.00	.	.	65.06	18.85	30.50	4.06	89.67	24.53	37.84	10.25
BPRO	4.24	0.13	3.87	0.31	3.44 AB	0.13	4.10	.	3.83 A	0.32	3.75	0.45	.	.	4.04	0.13	4.68	0.14	4.67	0.15	4.25	0.14
BUN	1.48	0.16	1.70	0.27	1.89	0.25	0.95	.	2.29	0.43	2.61	0.67	.	.	1.66	0.21	2.69	0.31	1.67	0.13	1.90	0.16
CREAT	0.20	0.02	0.18	0.03	0.20	0.03	0.25	.	0.30 AB	0.08	0.25	0.09	.	.	0.18	0.01	0.26 AB	0.03	0.12	0.02	0.12	0.01
CDFC	1.47 B	0.03	1.40	0.03	1.34 A	0.05	1.32	0.16	1.42 B	0.03	1.44	0.03	1.34	.	1.45 B	0.04	1.35 A	0.05	1.53 B	0.04	1.27 A	0.01
LSI	0.79 A	0.04	1.42 B	0.14	0.90 A	0.08	0.80 A	0.12	0.97 A	0.09	1.07	0.23	0.49 A	.	1.25 AB	0.09	0.77 A	0.06	1.62 B	0.16	0.70 A	0.04
VSI	5.24 B	0.25	5.00 B	0.40	4.94 B	0.39	4.42	1.51	5.25 B	0.30	4.24	0.67	3.50	.	5.27 B	0.24	4.29 B	0.17	5.14 B	0.23	3.12 A	0.12
VEIP	1.66	0.14	1.85	0.17	2.12	0.22	2.75	1.25	1.75	0.15	2.00	0.50	4.00 A	.	2.21	0.18	3.10 AB	0.27	1.50	0.17	2.15	0.20
SSI	0.13	0.02	0.14	0.01	0.16 B	0.03	0.14	0.08	0.11	0.02	0.07	0.01	0.04	.	0.12	0.01	0.10	0.01	0.14	0.01	0.09	0.01
PSTO	0.00	0.00	0.50	0.50	2.69	2.69	32.50	32.50	6.50	6.50	2.50	2.50	0.00	.	18.53	8.47	20.00	13.33	10.00	9.39	0.00	0.00
PINT	0.00	0.00	2.00	1.53	1.15	1.15	17.50	17.50	2.00	1.53	2.50	2.50	0.00	.	6.47	2.87	10.00	10.00	3.33	1.67	2.75	1.87
BTRI	220.21 B	30.47	204.78	26.61	216.11 B	79.76	1210.00 AB	.	354.88 B	83.22	138.00	30.00	.	.	211.77 B	26.68	189.20	39.65	219.56 B	25.08	68.11 A	4.96
LMACA	2.02 AB	0.69	0.41	0.12	0.33	0.16	0.65	0.15	0.71	0.28	0.10	0.10	.	.	0.30	0.08	0.80	0.26	0.26	0.14	0.54	0.11
LPARS	0.64	0.38	2.49 AB	1.13	0.77	0.35	0.00	0.00	0.13	0.08	0.30	0.10	.	.	1.31	0.73	0.00	0.00	0.00	0.00	0.08	0.07
SMACA	3.82	0.87	2.38	0.44	3.43	0.59	1.10	0.50	3.43	0.90	1.40	0.30	.	.	2.60	0.65	5.08	1.83	2.68	0.84	5.03	0.88
SPARS	0.95	0.73	5.89	2.91	0.50	0.47	0.00	0.00	3.40	1.72	24.20 AB	12.70	.	.	9.18 AB	3.71	0.43	0.39	0.24	0.24	0.16	0.16
LNPMA	1.06	0.52	1.46	0.41	1.40	0.96	1.05	0.75	0.49	0.20	0.00	0.00	.	.	0.69	0.39	0.00	0.00	1.04	0.51	0.29	0.19

Table C34. Relative rankings of the severity of histopathological lesions in the liver and spleen of bluegill sunfish at collection sites in the Clinch River, Poplar Creek, and the reference site, Norris Reservoir (CRM 125). The overall rank for each site is the average of all liver and spleen lesions at that site. Lower ranks represent higher lesion rate.

	CRM 125	CRM 21.5	CRM 20.0	CRM 10.0	CRM 1.0	TRM 530	PCM 5.3	PCM 4.6
LIVER								
Glycogen Depletion	7	6	8	3	4	5	1.5	1.5
Vacuolated Hepatocytes	2.5	4	8	2.5	5	6	1	7
Macrophage Aggregates	4	1	8	2	3	6	5	7
Focal Necrosis	3.5	1	5	6	7.5	7.5	3.5	2
Granulomas	0	0	1	0	0	0	0	0
Parasites	5	6	3	4	7	8	2	1
SPLEEN								
Macrophage Aggregates	8	7	4	5	6	1	2.5	2.5
Parasites	5	7	2	6	1	8	3.5	3.5
Total	4.4	4.4	4.88	3.6	4.2	5.56	2.3	3.06
Overall Rank	6	4	7	3	5	8	1	2

Table C35. Relative rankings of the severity of histopathological lesions in the liver and spleen of largemouth bass at collection sites in the Clinch River, Poplar Creek, Tennessee River, and the reference site, Norris Reservoir (CRM 125). The overall rank for each site is the average of all liver and spleen lesions at that site. Lower ranks represent higher lesion rate.

	CRM 125	CRM 21.5	CRM 20.0	CRM 10.0	CRM 1.0	TRM 570	TRM 530	PCM 5.3	PCM 4.6	PCM 1.0
LIVER										
Glycogen Depletion	5.5	2	5.5	10	5.5	9	7	5.5	1	8
Vacuolated Hepatorytes	3	5	7.5	4	2	7.5	7.5	7.5	1	7.5
Macrophase Aggregates	9	10	7.5	5	3	1	7.5	4	6	2
Focal Necrosis	7.5	3	2	7.5	7.5	7.5	7.5	7.5	1	7.5
Granulomas	9.5	2	1	5	3	6	7	9.5	4	8
Parasites	8.5	6	1	5	8.5	3	2	4	7	8.5
SPLEEN										
Macrophase Aggregates	1	9	2	3	4	8	7	10	6	5
Focal Necrosis	8.5	3.5	9	2	8.5	6	10	1	3.5	7
Granulomas	6	4	1.5	5	3	8	9.5	7.5	1.5	7
Parasites	10	8	7	2.5	6	5	9	2.5	2.5	4
Total	6.85	5.30	4.40	4.90	5.10	6.10	7.40	5.1	3.35	6.45
Overall Rank	9	6	2	3	4.5	7	10	4.5	1	8

Table C36. Reproductive status of male largemouth bass collected at the beginning of the 1993 breeding season from sites in Poplar Creek, Clinch River, Tennessee River, and Norris Lake

Site[a]	GSI[b]	Plasma Testosterone (pg/ml)	Plasma Estradiol (pg/ml)	Testes Stage[c]
CRM 125	0.586±0.046 (9)	2441±662 (9)	89±39 (9)	4.1±0.1 (9)
PRM 30	0.534±0.035 (11)	2056±652 (11)	162±48 (11)	4.0±0 (11)
PCM 1	0.409±0.058 (5)	1071±476 (5)	50±0 (5)	4.0±0 (5)
CRM 20	0.439±0.050 (8)	1240±438 (8)	327±42 (8)	4.1±0.1 (8)
CRM 0.5	0.483±0.028 (13)	1971±348 (13)	292±47 (13)	3.9±0.1 (13)
TRM 570	0.463±0.023 (10)	2581±343 (10)	50±0 (10)	4.1±0 (10)
TRM 557	0.451±0.032 (10)	2015±494 (10)	170±49 (10)	4.0±0.1 (10)

[a] CRM = Clinch River Mile, PRM = Powell River (Norris Lake) Mile, PCM = Poplar Creek Mile, and TRM = Tennessee River Mile

[b] GSI = Gonadal-Somatic Index ([gonad wt./body wt.]*100)

[c] Stage 0 = no obvious germ cell tissue; stage 1 = primarily spermatogonia (may be some degenerating sperm); stage 2 = spermatogonia and spermatocytes; stage 3 = some spermatids and spermatozoa present as well; stage 4 = tubules filled with sperm, still active spermatogenesis; stage 5 = only sperm and possibly scattered spermatogenic cysts

Table C37. Reproductive status of female largemouth bass collected at the beginning of the 1993 breeding season from sites in Poplar Creek, Clinch River, Tennessee River, and Norris Lake

Site[a]	GSI[b]	Atretic[c] Oocytes (oocytes/g)	Ovary Parasites (cysts/g)	Vitellogenic Oocytes (oocytes/g)	Batch[d] Fecundity (oocytes/g)	Fecundity[e] (oocytes/g)	Plasma Estradiol (pg/ml)	Plasma Testosterone (pg/ml)
CRM125	4.90±0.47 (14)	1.29±0.40 (14)	0 (14)	60.2±10.7 (14)	22.3 ±2.7 (10)	58.1 ±10.6 (14)	4600±552 (14)	4635±1455 (14)
PRM 30	4.41±0.24 (12)	0.70±0.22 (12)	0 (12)	55.3±3.9 (12)	17.0 ±1.7 (12)	56.1 ±3.2 (12)	5810±1062 (12)	5454±942 (12)
PCM 1	4.20±0.62 (17)	2.20±1.39 (15)	0.01±0.01 (15)	59.2±12.1 (15)	18.1 ±2.9 (8)	44. 2±6.5 (15)	4082±1088 (15)	4103±1065 (15)
CRM 20	4.65±0.63 (5)	8.18±4.33 (5)	0 (5)	41.5 ±5.2 (5)	16.0 ±0.6 (4)	46.1 ±7.2 (5)	2041±756 (5)	3892±2648 (5)
CRM 0.5	6.34±0.70 (10)	0.98±0.53 (10)	0 (10)	54.9 ±6.9 (10)	17.2 ±2.7 (9)	57.0 ±6.1 (10)	2962±376 (10)	1063±119 (10)
TRM 570	6.42±0.34 (18)	0.84±0.22 (18)	0 (18)	60.6 ±3.6 (18)	17.0 ±1.4 (13)	60.0 ±2.3 (18)	3729±404 (18)	5479±1070 (14)
TRM 557	7.23±0.52 (8)	1.27±0.23 (8)	0 (8)	55.4 ±4.1 (8)	16.6 ±1.6 (6)	56.3 ±2.6 (8)	3704±818 (8)	3758±1297 (8)

[a] CRM = Clinch River Mile, PRM = Powell River (Norris Lake) Mile, PCM = Poplar Creek Mile, and TRM = Tennessee River Mile
[b] GSI = Gonadal-Somatic Index ([gonad wt./body wt.]*100)
[c] Atretic oocytes are dead and/or reabsorbing oocytes
[d] Batch fecundity is the enumeration of obviously maturing oocytes, mature eggs, and/or shed follicles in fish collected immediately prior to or during a spawn
[e] Fecundity is the enumeration of all oocytes and/or shed follicles in an ovary regardless of gamete developmental stage

Table C38. Reproductive status of male bluegill sunfish collected at the beginning of the 1993 breeding season from sites in Poplar Creek, Clinch River, Tennessee River, and Norris Lake

Site[a]	GSI[b]	Plasma Testosterone (pg/ml)	Plasma Estradiol (pg/ml)	Testes Stage[c]	Testes Composition[d]			
					Spermatagonia	Spermatocytes	Sperm	Duct
CRM 125	0.993±0.230 (10)	2399±550 (10)	71±22 (10)	3.6±0.2 (10)	0.47±0.30 (10)	8.37±1.90 (10)	3.07±0.68 (10)	0.43±0.09 (10)
CRM 0.5	0.616±0.138 (12)	1529±298 (11)	50±0 (11)	3.3±0.2 (12)	0.31±0.18 (12)	7.81±0.69 (12)	1.47±0.32 (12)	0.31±0.09 (12)
PRM 30	0.979±0.277 (10)	3777±906 (10)	50±0 (10)	3.7±0.1 (10)	0.63±0.25 (10)	7.67±1.48 (10)	3.40±0.65 (10)	0.30±0.12 (10)
TRM 570	1.000±0.131 (11)	3829±805 (10)	50±0 (10)	3.6±0.1 (11)	0.09±0.06 (11)	11.00±1.02 (11)	2.42±0.41 (11)	0.27±0.15 (11)
PCM 1	1.353±0.096 (11)	5475±5712 (10)	65±11 (10)	3.7±0.1 (11)	0.03±0.03 (11)	12.15±0.69 (11)	3.61±0.44 (11)	0.55±0.23 (11)
TRM 557	1.244±0.185 (11)	5430±928 (11)	192±52 (11)	3.7±0.1 (11)	0.15±0.15 (11)	9.39±0.53 (11)	3.55±0.48 (11)	0.06±0.06 (11)
CRM 20	0.748±0.125 (13)	3837±693 (12)	155±55 (12)	3.4±0.2 (13)	0.56±0.24 (13)	8.97±1.30 (13)	2.23±0.50 (13)	0.18±0.08 (13)

[a] CRM = Clinch River Mile, PRM = Powell River (Norris Lake) Mile, PCM = Poplar Creek Mile, and TRM = Tennessee River Mile

[b] GSI = Gonadal-Somatic Index ([gonad wt./body wt.]*100)

[c] Stage 0 = no obvious germ cell tissue; stage 1 = primarily spermatogonia (may be some degenerating sperm); stage 2 = spermatogonia and spermatocytes; stage 3 = some spermatids and spermatozoa present as well; stage 4 = tubules filled with sperm, still active spermatogenesis; stage 5 = only sperm and possibly scattered spermatogenic cysts

[d] mean relative units occupied by various spermatogenic stages measured along the diameters of three cross-sections through a testis

Table C39. Reproductive status of female bluegill sunfish collected at the beginning of the 1993 breeding season from sites in Poplar Creek, Clinch River, Tennessee River, and Norris Lake

Site[a]	GSI[b]	Atretic[c] Oocytes (oocytes/g)	Ovary Parasites (cysts/g)	Vitellogenic Oocytes (oocytes/g)	Batch[d] Fecundity (oocytes/g)	Plasma Estradiol (pg/ml)	Plasma Testosterone (pg/ml)
CRM 125	6.36±0.77 (13)	0.36±0.12 (13)	0.06±0.05 (13)	168±17(13)	143±14 (12)	4633±987 (11)	3449±1379 (11)
CRM 0.5	7.21±0.95 (10)	3.51±1.09 (10)	0 (10)	162±15 (10)	129±8 (10)	2051±394 (10)	2221±553 (10)
PRM 30	7.48±0.50 (12)	0.52±0.35 (12)	0.12±0.09 (12)	153±10 (12)	127±10 (12)	2877±554 (12)	1958±328 (12)
TRM 570	7.94±0.81 (12)	2.33±0.97 (12)	0 (12)	172±13 (12)	126±8 (11)	3579±663 (11)	4850±1196 (11)
PCK 1.0	9.87±1.20 (12)	4.47±1.97 (12)	0.36±0.14 (12)	225±27 (12)	155±16 (12)	1682±362 (12)	1472±349 (12)
TRM 557	7.80±0.98 (12)	1.07±0.48 (12)	0.05±0.05 (12)	154±19 (12)	121±13 (12)	2958±775 (12)	918±175 (12)
CRM 20	7.64±0.89 (16)	2.71±1.41 (16)	0 (16)	163±13 (16)	135±8 (15)	3433±559 (16)	3274±684 (16)

[a] CRM = Clinch River Mile, PRM = Powell River (Norris Lake) Mile, PCM = Poplar Creek Mile, and TRM = Tennessee River Mile
[b] GSI = Gonadal-Somatic Index ([gonad wt./body wt.]*100)
[c] Atretic oocytes are dead and/or reabsorbing oocytes
[d] Batch fecundity is the enumeration of a clutch of simultaneously developing oocytes, mature eggs, and/or shed follicles

Appendix D

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) was passed by Congress and signed into law on December 11, 1980 (Public Law 96-510). This act was intended to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste disposal sites." The Superfund Amendments and Reauthorization Act (SARA), adopted on October 17, 1986 (Public Law 99-499), did not substantially alter the original structure of CERCLA but provided extensive amendments to it.

In particular, § 121(d) of CERCLA specifies that remedial actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate to the hazardous substances or particular circumstances at a site. Inherent in the interpretation of applicable or relevant and appropriate requirements (ARARs) is the assumption that protection of human health and the environment is ensured.

The purpose of this report is to supply a preliminary list of available federal and state chemical-, location-, and action-specific ARARs for the remediation of the CR/PC OU. Results of the site characterization and baseline risk assessment (see Chap. 5 of this RI/FS report) indicate that surface water in the CR/PC OU does not pose a risk to human health via any pathway. Risk to human health from dredged sediments is a factor for consideration. The ecological risk assessment suggests a risk to ecological receptors from both surface water (Sect. 6.2) and sediment (Sect. 6.3).

CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA § 121(e) and FFA § XXII]. CERCLA defines "on-site" to mean "the areal extent of contamination and all suitable areas in very close proximity" (40 CFR 300.5). To ensure that CERCLA response actions proceed as rapidly as possible, the EPA has reaffirmed this position in the final National Contingency Plan (NCP) (55 *FR* 8756, March 8, 1990). ***Substantive requirements*** pertain directly to the actions or conditions at a site; ***administrative requirements*** facilitate their implementation. EPA recognizes that certain of the administrative requirements, such as consultation with state agencies, reporting, etc., are accomplished through the state involvement and public participation requirements of the NCP. These administrative requirements should be observed if they are useful in determining cleanup standards at the site (55 *FR* 8757). It is assumed for development of ARARs for the CR/PC OU that all remedial activities are "on-site."

1. CHEMICAL-SPECIFIC ARARs

"Chemical-specific requirements set health- or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants" (53 *FR* 51437). These requirements generally set protective cleanup levels for the chemicals of concern in the designated media or indicate a safe level of discharge that may be incorporated when a specific remedial activity is being considered. The only medium under consideration in the FS is contaminated sediment. However, ARARs for cleanup of contaminated surface water are presented here for comparison with surface water sampling results to confirm this decision. Potential chemicals of concern for human health and ecological receptors are listed in Chapts. 5 and 6, respectively, of this RI report.

1.1 Surface Water

Under the Tennessee Water Quality Control Act, the Tennessee Water Quality Control Board has classified the Clinch River for domestic water supply, industrial water supply, fish and aquatic life, recreation, irrigation, livestock watering and wildlife uses, and navigation [Chap. 1200-4-4 of the Rules of the Tennessee Department of Environment and Conservation (TDEC)]. Poplar Creek from mile 0.0 to 0.5 is classified for all but domestic water supply and navigation. Poplar Creek from mile 0.5 to 5.5 and McCoy Branch are classified for fish and aquatic life, recreation, irrigation, livestock watering, and wildlife uses.

TDEC has revised its water quality standards and promulgated the current Safe Drinking Water Act maximum contaminant levels (MCLs) as water quality criteria (WQC) for domestic water supplies (effective date August 30, 1991). Table D.1 lists these WQC for Clinch River. The EPA has promulgated an MCL for polychlorinated biphenyls (PCBs), effective July 1992. TDEC has proposed this MCL as a WQC for domestic water supply (Proposed 1994 Revisions to Water Quality Standards, December 5, 1994). The EPA has also promulgated an MCL of 4 mrem/year for man-made radionuclides in community water systems (40 CFR 141.16); if two or more radionuclides are present, the sum of their total dose equivalent shall not exceed 4 mrem/year.

TDEC includes WQC for protection of recreational uses (applicable for Clinch River, McCoy Branch, and Poplar Creek). These human health criteria are derived to protect the consumer from consumption of contaminated fish; these criteria are the WQC for the protection of human health from consumption of fish alone. For carcinogens, the TDEC WQC are based on a risk of 10^{-5} rather than the 10^{-6} risk on which the federal WQC are based. Federal WQC derived for the protection of human health from the consumption of aquatic organisms are listed in Table D.1 for those chemicals lacking a TDEC WQC for recreation. Proposed TDEC WQC for these chemicals are listed in parentheses on the table, and may be "to be considered" (TBC) guidance until promulgated (promulgation expected April 1995). Table D.1 also lists TDEC WQC for the protection of freshwater aquatic life.

1.2 Sediment

There is no legislation available governing cleanup criteria for protection of either humans or ecological receptors from contaminated sediments. However, in the EPA guidance report for remedial actions at Superfund sites containing PCBs, preliminary remediation goals (PRGs) are set at 1 ppm for residential land use (a risk of 10^{-5}) and between 10 and 25 ppm for industrial and/or remote areas (a risk of 10^{-4}). Alternatives should reduce concentrations to these levels, or limit exposures; EPA estimates that for every 10 in. of cap, risk is reduced by an order of magnitude. EPA also presents an approach to deriving cleanup levels for PCBs in sediments (EPA 1990). This approach results in ``sediment quality criteria" as a function of organic carbon concentration and is meant to protect wildlife consumers of freshwater benthic species. The above values may be TBC guidance, not ARARs for estimation of PRGs for either protection of human health or ecological receptors.

2. RADIATION PROTECTION STANDARDS

Very few applicable standards are available for the cleanup of radioactive contamination at CERCLA sites. The Atomic Energy Act (AEA) of 1954 and its amendments delegated authority for control of nuclear energy to DOE, the U.S. Nuclear Regulatory Commission (NRC), and EPA.

DOE has proposed radiation protection requirements for the public and environment for all sources of exposure and from all DOE sources of radiation [10 CFR 834, Notice of Proposed Rulemaking (NPRM) 58 *FR* 16268, March 25, 1993; final rule expected May 1995]. The proposed rule, when final, would codify the requirements of DOE Order 5400.5. The radiation exposure limits as defined in proposed 10 CFR 834, ``Radiation Protection of the Public and the Environment," are an effective dose equivalent of 100 mrem/year from all exposure pathways and all sources of radiation from the activity and from all other sources (excluding dose from radon and its decay products, diagnostic or therapeutic medical radiation exposures, consumer products, and natural background). In addition, effluent releases to surface water must not result in exposures to aquatic organisms that exceed an absorbed dose of 1 rad/d. The overriding principle of the regulation is that all releases of radioactive material shall be "as low as reasonably achievable" (ALARA). Until this rule is promulgated, it or DOE Order 5400.5 may be considered TBC guidance.

Residual radioactive material is defined in DOE Order 5400.5 as that level of radioactive material that is acceptable for use of property without restrictions on use. Residual concentrations of radionuclides in soils or sediments shall be derived using the basic dose limit of 100 mrem/year, and the DOE RESRAD model with site-specific input parameters or any other pathways analysis model, with DOE approval.

3. LOCATION-SPECIFIC ARARs

Location-specific requirements ``set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations" (53 *FR* 51437). Preconstruction activities performed for alternative 3, such as building of access roads or removal of bank vegetation, as well as actual containment construction activities, may trigger certain location-specific ARARs. The following location-specific ARARs will not apply to either the no action or the institutional controls alternatives since no such activities will be performed.

3.1 Wetlands and floodplains

The Clinch River drainage basin includes a number of wetland areas that may require protection. If any preconstruction or construction activities would affect such wetlands, consideration should be given to Executive Order 11990 and 10 CFR 1022 for applicable requirements. In addition, regulations protecting floodplains are found in Executive Order 11988 and 10 CFR 1022. Table D.2 summarizes the substantive portions of these regulations.

3.2 Aquatic Resources

As mentioned previously, CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA § 121(e)]. However, the TVA, the U. S. Army Corps of Engineers (COE), and the TDEC Division of Water Pollution Control retain authority for approving activities impacting TVA lands, waters of the United States, or waters of the state, respectively.

3.2.1 TVA authority

The TVA Act § 26a regulates lands under TVA jurisdiction within the Tennessee River Valley. Sect. 26(a) requires that TVA approval be obtained prior to the "construction, operation, or maintenance of any dam, appurtenant works, or other obstruction affecting navigation, flood control, or public lands

or reservations along or in the Tennessee River or any of its tributaries." On-shore capping activities within the 100- or 500-year floodplain as well as other activities, such as road construction, may require a Section 26(a) authorization; use of TVA public use boat ramps for dredging operations might require land use permits.

3.2.2 COE authority

The substantive requirements of the COE authorization for activities occurring in navigable waters, under the authority of § 10 of the Rivers and Harbors Act (RHA), or waters of the United States, under the authority of § 404 of the Clean Water Act (CWA), may also be triggered (Table D.2). CERCLA activities must comply with the substantive requirements of any permitting process. COE Regulatory Guidance Letter 85-7 and its extension adopt this policy for on-site EPA or state response actions at the location of the release or threatened release pursued under the authority of CERCLA.

The COE has established the ordinary high water mark for impoundments to be the normal summer pool elevation; for Watts Bar Lake, this elevation is El. 741.0 msl. A regional survey by the COE identified "navigable waters" in the area (Public Notice ORNOR-F86-23, May 8, 1986); Poplar Creek from its mouth to River Mile 18.3 has been designated a navigable water. However, no tributaries to Poplar Creek have received such a designation.

The COE Nationwide Permit (NWP) program establishes COE authorization for activities that have minimal impact on "waters of the U.S." (33 CFR 330, Appendix A). NWP 38 authorizes activities required to effect the containment, stabilization, or removal of hazardous and toxic materials by a government agency with established legal or regulatory authority, provided the COE District Engineer is notified in accordance with the ``Notification" general condition [33 CFR 330, Appendix A(C)(13)]. Other NWPs that might apply are NWP 13 (*Bank Stabilization*) and NWP 18 (*Minor Discharges*).

If an activity does not meet all the requirements of an NWP, or involves alterations that cause more than minimal individual or cumulative adverse effects to waters of the United States, an individual permit application may be required, with further substantive requirements dictated by the COE. Note that as mentioned previously, administrative and procedural requirements are not ARARs for on-site CERCLA activities. However, adherence to the COE notification process is strongly recommended by EPA because of the effectiveness of the COE permitting process in identifying and protecting sensitive resources.

3.2.3 TDEC authority

The substantive requirements of the TDEC Aquatic Resource Alteration regulations found at Chapter 1200-4-7 may be applicable to preconstruction or construction activities. General permits exist for activities that would cause minimal individual or cumulative impacts to water quality, and included permits are available for such things as bank stabilization and debris removal. Individual permits are required for activities that cannot meet the conditions of the general permits, which include a prohibition of activities in waterways containing contaminated sediments. However, permits are not required for CERCLA activities [CERCLA § 121(e) and FFA § XXII]. If any remedial actions at the CR/PC OU cannot be accomplished under the substantive general permit conditions, consultation with TDEC is recommended to ensure that TDEC is aware of the portion of the river affected and the character and scope of the project with sufficient detail to determine probable water quality impacts.

3.3 Endangered and Threatened Species

DOE had designated areas on the ORR as DOE-National Environmental Research Park (NERP) Natural Areas (NAs), which have been established to protect rare plant and animal species. One such area, NA-8, the McCoy Embayment "barren" has also been registered as a state NA as it contains a state-listed endangered species of plant, the tall larkspur (*Delphinium exaltatum*). Construction activities that would affect this area must be avoided (TCA 11-14-101 *et seq.*).

The possibility exists that there may be other protected species of plants in the area of this OU. Should any remedial activity in the CR/PC OU affect any federal-listed endangered or threatened plant species, the provisions found in the Endangered Species Act of 1973 (16 USC 1531 et seq.)and 50 CFR 402 may be applicable.

3.4 Archaeological and Historical Resources

There have been no known cultural resource surveys of the entire area found in the CR/PC OU; however, surveys that encompassed portions of the Clinch River indicate the presence of archaeological and historical resources. Therefore, before the start of any ground-breaking activities, consultation should be initiated with the Tennessee State Historic Preservation Officer and Advisory Council on Historic Preservation, pursuant to §106 of the National Historic Preservation Act (16 USC 470f) and its implementing regulations (36 CFR 800). Although such consultation is an administrative requirement, and not required for on-site activities, such consultation will ensure compliance with the substantive requirements of any other applicable cultural resource laws [Archaeological Resources Recovery Act (16 USC 470aa-ll), 43 CFR 7, Archaeological and Historic Preservation Act (16 USC 469a-c)].

Several cemeteries can be found along Poplar Creek. Building of any access roads or general construction activities must avoid damaging any gravesites pursuant to TCA 39-17-311.

4. ACTION-SPECIFIC ARARS

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to the management of hazardous waste (53 *FR* 51437). Selection of a particular remedial action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. Remediation alternatives include (1) no action, (2) institutional controls and advisories, and (3) containment combined with institutional controls. Section 10 of the FS report presents a detailed analysis of these alternatives.

4.1 No Action Response

As confirmed by EPA Guidance (OSWER Directive 9234.2-01/FS-A, June 1991, "ARARs Q's and A's"), there are no ARARs for the no action alternative.

4.2 Use of Institutional Controls and Advisories

Institutional controls could be implemented to limit access and exposure. There are no regulatory requirements specifying institutional controls for CERCLA units. However, the NCP at 40 CFR 300.430(e)(3)(ii) suggests consideration of one or more alternatives that involve little or no treatment,

but provide protection of human health and the environment through the use of institutional controls. The preamble to the NCP provides examples of institutional controls that include land and water use restrictions, deed restrictions, well-drilling prohibitions, building permits, and well use advisories and deed notices (55 *FR* 3706). In addition, DOE Order 5400.5, Chapter IV, requires administrative (institutional) controls for long-term management in areas containing residual radioactivity. Active controls specified in the Order, which may be considered TBC guidance include land restrictions, fences, and warning signs.

Although not an ARAR for the CR/PC OU, institutional controls in the form of statutory authority of either TDEC or the TVA and the COE are already in place. An Interagency Agreement (IAG) for WBR Permit Coordination has been signed by TDEC, COE, TVA, and DOE. Under this agreement, a screening list identifies three categories of actions disturbing sediments: no significant sediment disturbance (NSSD); marginal sediment disturbance (MSD); and potential major sediment disturbance (PMSD). The screening list of action categories was amended to include in the NSSD category all proposed projects (other than between CRM 4.3 and White Oak Creek) if the project does not have any sediment disturbance below Elev. 735 msl, and provided the work is accomplished when pool elevation is below the project site (Amendment 1, IAG Watt's Bar Reservoir Permit Coordination, January 28, 1992). For permit applications for activities that fall within the MSD or PMSD categories, DOE must supply existing sediment data and acquire additional sediment data if needed [IAG, Sect. IV(C)].

Under the Tennessee Water Quality Control Act, § 69-3-107(15), authority is granted the Commission to "inspect waters of the state where good cause is shown that the public health is threatened by pollutants therein, and, upon verification by the commissioner, post or cause to be posted such signs as required to give notice to the public of the potential or actual dangers of specific uses of such waters or restrictions of uses thereof." To that end, posting of advisories is not an ARAR or TBC for remediation of the CR/PC OU; however, it implements the institutional controls suggested for alternatives 2 and 3 (i.e., posting of warning signs).

Currently, the TDEC Division of Water Pollution Control develops fish advisories based on the Food and Drug Administration (FDA) action levels for poisonous or deleterious substances in human food. "Do not consume" advisories are issued when warranted for the protection of typical consumers and a "precautionary advisory" is issued when warranted for protection of atypical consumers. Atypical consumers are those especially sensitive due to physiological factors or previous exposures.

The TDEC Division of Water Pollution Control has issued proposed revisions to Chapt. 1200-4-3 and 1200-4-4 of the TDEC Water Quality Standards. This proposal includes the modification and promulgation of procedures for issuing fish advisories. The revision would create a new subparagraph regarding fish consumption advisories [TDEC 1200-4-3-.03(j)]. Such advisories would be warranted if the calculated risk of additional cancer risk exceeds 10^{-4} for typical consumers and 10^{-5} for atypical consumers. The proposed change includes a methodology for calculating risk. Notices are posted for "Do not consume advisories" and "Precautionary advisories," as described above. This rule was submitted to the Attorney General's Office in December 1994; promulgation of the final rule is expected in April 1995).

4.3 Containment

This alternative is proposed only for Poplar Creek and upper and lower McCoy Branch. Source containment options include capping near-shore or on-shore contaminated sediments. Containment activities will be combined with turbid water technologies to decrease the release of sediments into the

streams. Activities in wetlands and floodplains should be designed to minimize impacts and restore and preserve natural and beneficial uses (see Sect. 3 of this Appendix for location-specific ARARs).

4.3.1 Fugitive dust control

Preconstruction activities such as building of access roads or equipment movement may result in airborne pollutants. The primary concern is elevation of particulate concentrations. The TDEC Division of Air Pollution Control (APC) has promulgated regulations governing fugitive dust emissions (TDEC 1200-3-8-.01). These are listed in Table D.2, and are applicable to remedial activities at the OU.

4.3.2 Turbidity controls

Storm water discharges from activities at industrial sites involving construction operations that result in the disturbance of 5 acres or more total land have been included in the final rule for National Pollutant Discharge Elimination System (NPDES) permits for storm water discharges (40 CFR 122) and incorporated into the TDEC permitting regulations. Consultation with TDEC is required to ensure compliance with the substantive requirements of the NPDES permitting process for storm water discharges during construction activities (TDEC 1200-4-10-.05). These requirements are listed in Table D.2 and would be applicable to remedial activities impacting 5 acres or more, and relevant and appropriate for those affecting less than 5 acres.

The Tennessee Antidegradation Statement (TDEC 1200-4-3-.06) requires that all cost effective and reasonable best management practices for nonpoint-source control shall be implemented; this would be applicable for turbidity control of sediments released during construction of containment areas. In addition, the TDEC narrative WQC for protection of aquatic life prohibits the presence of turbidity in such amounts or of such character that will materially affect fish and aquatic life [TDEC 1200-4-3-.03(d)].

REFERENCES

EPA (U.S. Environmental Protection Agency). 1990. *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*, EPA/540/G-90/007, EPA Office of Emergency and Remedial Response, Washington, DC, August.

Suter, G.W. II, M.A. Futrell, and G.A. Kerchner, 1992. *Toxicological Benchmarks for Screening of Potential Contaminants of Concern for Effects on Aquatic Biota on the Oak Ridge Reservation, Oak Ridge, Tennessee*. ORNL/ER-139, Environmental Restoration Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Table D.1. Tennessee water quality criteria for designated water uses (μg/L)[a]

Chemical	Domestic water supply	Recreation[b]	Fish and aquatic life	
			CMC[c]	CCC[d]
COCs[e] for human health				
Arsenic[b]	50	1.4[f]		
Antimony	NA	NA		
Manganese	50[g]	NA		
Silver	NA	NA[h]		
Phthlates				
Bis(2-ethylhexyl)phthalate[b]	6	59		
di-n-Octyl phthalate				
Polychlorinated biphenyls (total)[b]	0.5	0.00045[f]		
All man-made radionuclides	4 mrem/year[i]	NA		
COCs for Ecological receptors				
Cadmium[j]			4	1
Carbon disulfide			NA	NA
Copper[j]			18	12
Iron				1000
Mercury			2.4	0.012
Nickel			1400	160
Bis(2-ethylhexyl)phthalate			NA	NA
Polychlorinated biphenyl 1254			NA	0.001
Silver[j]			4	NA
Zinc[j]			117	106
All man-made radionuclides			NA	1 rad/day[k]

[a]Rules of the TDEC, Chapter 1200-4-3.
[b]Ingestion of aquatic organisms only. Based on a 10^{-5} risk level for carcinogens.
[c]CMC = criterion maximum concentration.
[d]CCC = criterion continuous concentration.
[e]COC = contaminant of concern
[f]TDEC has proposed WQC for these chemicals; they currently may be considered TBC guidance. However, when promulgated they will be applicable (Proposed 1994 Revisions to Water Quality Standards expected to be promulgated April 1995).
[g]
[h]WQC withdrawn in the National Toxics Rule [57 FR 60848 (December 22,1992)]. TDEC has proposed to remove these WQC from their standards (Final rule expected April 1995).
[i]Annual dose equivalent to total body or any internal organ (40 CFR 141.16).
[j]Calculated for a water hardness of 100 mg/L, the approximate average hardness of the Clinch River; values presented are for the dissolved form of this metal (Suter et al. 1992).
[k]DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (Proposed as 10 CFR 834, 58 *FR* 16268, March 25, 1993) (TBC guidance).

Table D2. ARARs[a] and TBC[b] guidance for alternatives 1–3 for the Clinch River/Poplar Creek OU

Actions	Requirements	Prerequisites	Citation
Alternative 1 - no action	None	No remedial actions are implemented - **TBC**	OSWER[d] Directive 9234.2-01/FS-A
Alternative 2 - institutional controls			
Chemical- or radionuclide-specific	Residual concentrations of radionuclides in soils shall be derived using the basic dose limit of 100 mrem/year, and the DOE[e] RESRAD[f] model with site-specific input paramenters	Residual radioactive materials left in place without restrictions - **TBC**	DOE Order 5400.5(IV)
	The general public must not receive an effective dose equivalent greater than 100 mrem/year	Dose received by the general public from all sources of radiation exposure and routine activities, including remedial action, at a DOE facility - **TBC**	DOE Order 5400.5
	All releases of radioactive material must be "as low as reasonably achievable" (ALARA)	Releases of radioactive material from DOE activities — **TBC**	DOE Order 5400.5
Location-specific	None		
Action-specific			
Institutional controls	Controls include periodic monitoring, as appropriate; appropriate shielding; physical barriers to prevent access, fences, warning signs, and restrictions on land use	Interim management of residual radioactive material above acceptable dose limits - **TBC**	DOE Order 5400.5(IV)(6)(c)
	Controls recommended for long-term management of contamination left in place include restrictions on land use, deed restrictions, well-drilling prohibitions, etc.	Long-term management of contamination left in place - **TBC**	40 CFR[g] 300.430(e)(3)
Alternative 3 - containment			
Chemical- or radionuclide-specific	The general public must not receive an effective dose equivalent greater than 100 mrem/year	Dose received by the general public from all sources of radiation exposure and routine activities, including remedial action, at a DOE facility - **TBC**	DOE Order 5400.5
	All releases of radioactive material must be "as low as reasonably achievable" (ALARA)	Releases of radioactive material from DOE activities — **TBC**	DOE Order 5400.5

Table D2 (continued)

Actions	Requirements	Prerequisites	Citation
	Residual concentrations of radionuclides in soils shall be derived using the basic dose limit of 100 mrem/year, and the DOE RESRAD model with site-specific input paramenters	On-shore placement of residual radioactive materials without restrictions - **TBC**	DOE Order 5400.5(IV)
Location-specific			
Presence of wetlands as defined in Executive Order 11990 §7(c)	Whenever possible, actions involving federal activities and programs affecting land use must avoid or minimize adverse impacts on wetlands and act to preserve and enhance their natural and beneficial values. New construction in wetlands areas should be particularly avoided unless there are no practicable alternatives. Wetlands protection considerations shall be incorporated into planning, regulating, and decision-making processes	Actions taken in wetlands areas - **applicable**	Executive Order 11990; 10 CFR 1022
Presence of wetlands as defined in 40 *CFR* 230.3(t) and 33 *CFR* 328.3(b)	Action to avoid degradation or destruction of wetlands must be taken to the extent possible. Discharges for which there is a practicable alternative with less adverse impacts or those which would cause or contribute to significant degradation are prohibited	Actions taken in wetlands areas - **applicable**	Clean Water Act §404 40 *CFR* 230 33 *CFR* 323
Activities in "waters of the U.S." as defined in 40 *CFR* 230.3	Compliance with the general and specific terms and conditions of NWP[h] 13 (*Bank Stabilization*), NWP 18 (*Minor Discharges*), NWP 38 (*Cleanup of Hazardous and Toxic Waste*), or others if authorized by COE[i] for minor adverse environmental effects *	Actions taken in "waters of the U.S." - **applicable**	33 CFR 330, Appendix A
	Notification to COE to ensure compliance with the substantive requirements of the individual permitting process for alterations to "waters of the U.S." which cause more than minimal individual or cumulative adverse environmental effects *	Actions taken in "waters of the U.S." - **applicable**	33 CFR 325.1

Table D2 (continued)

Actions	Requirements	Prerequisites	Citation
Within area encompassing or affecting waters of the state of Tennessee as defined in TCA 69-3-103(32)	Discharge of "substances" into the waters of the state which "will result or will likely result in harm, potential harm or detriment to the health of animals, birds, fish, or aquatic life" is prohibited	Actions taken in "waters of the state" - **applicable**	TCA 69-3-101 *et seq.*; TDEC[k] 1200-4-4
	Compliance with the substantive requirements of general or individual aquatic resource alteration permit process for bank stabilization, channel relocation, wetlands disturbance[a]	Actions taken in "waters of the state" - **applicable**	TDEC 1200-4-7
Within "lowland and relatively flat areas adjoining inland and coastal waters and other floodprone areas....." [Executive Order 11988 §6(c)	Action shall be taken to reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values of floodplains during federal activities involving acquisition, management, and disposition of lands and facilities or conducting any federal activities and programs affecting land use. The potential effects of actions in floodplains shall be evaluated and consideration of flood hazards and floodplain management ensured. If action is taken in floodplains, alternatives that avoid adverse effects and incompatible development and minimize potential harms shall be considered	Actions taken in floodplains - **applicable**	Executive Order 11988; 10 CFR 1022
Presence of endangered or threatened species or critical habitat of such species as designated in 50 CFR 17, 50 CFR 226, or 50 CFR 227	Actions that jeopardize species/habitats must be avoided or appropriate mitigation measures taken. Consultation with Department of Interior and/or state agencies is required for CERCLA off-site activities and recommended for CERCLA on-site activities	Action that is likely to jeopardize or adversely modify critical habitat - applicable to off-site activities	Endangered Species Act (16 USC 1531 *et seq.*); 50 CFR 402; Tennessee Rare Plant Protection and Conservation Act (TCA 11-26-201 *et seq.*)
Location encompassing a state-designated natural area	The scientific, scenic, recreational, and educational values of these areas must be preserved and steps taken to prevent impairment	Actions which are likely to impact or adversely modify designated natural areas - **applicable**	TCA 11-14-101 *et seq.*
Presence of archaeological and historical resources on public land	Consultation with Tennessee State Historic Preservation Officer and Advisory Council on Historic Preservation before the initiation of any ground-breaking activities for off-site CERCLA actions. Steps must be taken to mitigate adverse effects on such resources.	Action that would affect archaeological or historical resources - applicable to off-site activities	National Historic Preservation Act (16 USC 470; 36 CFR 800 *et seq.*)

Table D2 (continued)

Actions	Requirements	Prerequisites	Citation
Presence of cemetery	It is unlawful to intentionally desecrate a place of burial	Actions which would impact a cemetery - applicable	TCA 39-17-311
Action-specific			
Construction/containment activities	Use sediment and erosion controls and best management practices to control run-off from construction activities at an industrial site that result in disturbances of 5 acres or greater total land	Construction activities at industrial sites - relevant and appropriate	40 CFR 122 TDEC 1200-4-10-.05
Turbidity controls	Prohibits the presence of turbidity in such amounts or of such character that will materially affect fish and aquatic life	Containment activities in "waters of the state" - applicable	TDEC 1200-4-3-.03(d)
	Requires that all cost effective and reasonable best management practices for nonpoint source control shall be implemented	Containment activities in "waters of the state" - applicable	TDEC 1200-4-3-.06
Fugitive dust controls during preconstruction activities (road building, bank stabilization)	Take reasonable precautions to prevent particulate matter from becoming airborne; no visible emissions are permitted beyond property boundary lines for more than 5 min/hr or 20 min/day.		TDEC 1200-3-8-.010

[a]ARARs = applicable or relevant and appropriate requirements.
[b]TBC = to be considered; all entries on table are potential ARARs unless noted as TBC.
[c]TDEC = Tennessee Department of Environment and Conservation.
[d]OSWER = EPA Office of Solid Waste and Emergency Response.
[e]DOE = U.S. Department of Energy.
[f]RESRAD = residual radioactive materials guidelines.
[g]CFR = Code of Federal Regulations.
[h]NWP = Nationwide Permit.
[i]COE = U.S. Army Corps of Engineers
[j]TCA - Tennessee Code Annotated.
* = Although administrative and procedural requirements are not ARARs for on-site CERCLA activities, adherence to these steps is strongly recommended by EPA because of the effectiveness of these procedures in identifying and protecting sensitive resources.

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Remedial Investigation/Feasibility Study of the Clinch River/Poplar Creek Operable Unit

Volume 3. Appendixes E and F—Risk Assessment Information

Other than inclusion of an updated executive summary, no substantive changes have been requested or made to this volume from the D2 issue of this document.

This document has been approved by the ORNL Technical Information Office for release to the public. Date: 6/18/96

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Energy Systems Environmental Restoration Program

Remedial Investigation/Feasibility Study of the Clinch River/Poplar Creek Operable Unit

Volume 3. Appendixes E and F—Risk Assessment Information

Date Issued—June 1996

Prepared by
Environmental Sciences Division
Oak Ridge National Laboratory

Prepared for the
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Office of Environmental Management
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Environmental Management Activities at the
OAK RIDGE Y-12 PLANT
Oak Ridge, Tennessee 37831-8169
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
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under contract DE-AC05-84OR21400

PREFACE

This Remedial Investigation/Feasibility Study Report of the Clinch River/Poplar Creek Operable Unit on the Oak Ridge Reservation (DOE/OR/01-1393/V1–V5&D3) was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act for reporting results of a site characterization for public review. This work was performed under Work Breakdown Structure 1.4.12.3.1.02.41 (Activity Data Sheet 9302, "Clinch River/Poplar Creek Operable Unit"). This document provides the Environmental Restoration Program with information about the Phase 1 and Phase 2 investigations (1988–1995) performed at the operable unit. It includes information on risk assessments that have evaluated impacts to human health and the environment, and it contains information about the development of the feasibility study. Information provided in the document forms the basis for the Record of Decision in the Clinch River/Poplar Creek Operable Unit.

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ABBREVIATIONS

AET	apparent effect threshold
ALT	alanine aminotransferase
ANC	American Nuclear Corporation
ANOVA	analysis of variance
ARARs	applicable or relevant and appropriate requirements
AWQC	ambient water quality criteria
BEDS	Biological Effects Database for Sediments
BEIAS	Biomedical and Environmental Information Analysis
BMAP	Biological Monitoring and Abatement Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CCC	chronic continuous criterion
CLP PQL	Contract Laboratory Program Practical Quantification Limit
CNF	Central Neutralization Facility
COC	chemical of concern
COPC	contaminant of potential concern
COPEC	contaminants of potential ecological concern
CR-ERP	Clinch River Environmental Restoration Program
CRM	Clinch River mile
CR/PC	Clinch River/Poplar Creek
CRRI	Clinch River Remedial Investigation
CV	chronic value
DNA	deoxyribonucleic acid
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQO	data quality objective
ECR	excess cancer risk
EFPC	East Fork Poplar Creek
EMP	Environmental Monitoring Program
EPA	U.S. Environmental Protection Agency
EQ_Part	equalibrium partitioning benchmark
EPRI	Electric Power Research Institute
EPT	ephemeroptera, plecotera, tricoptera
ER.	Environmental Restoration
ER-L	effects range—low
ER-M	effects range—medium
EROD	7-ethoxyresorufin O-deethylase
FDA	Food and Drug Administration
FFA	Federal Facility Agreement
FY	fiscal year
GI	gastrointestinal
GSI	gonadal-somatic index
HAI	Health Assessment Index
HEAST	Health Effects Assessment Summary Tables
HI	hazard index

HQ	hazard quotient
IAEA	International Atomic Energy Agency
i.p.	Intraperitoneal
IRIS	Integrated Risk Information System
LCL_{95}	95% lower confidence limit
LCV	lowest chronic value
LEL	lowest effect level
LET	linear energy transfer
LHS	Latin Hypercube Sampling
LOAEL	lowest-observed-adverse-effect level
LOEC	lowest-observed effective level
LSI	liver-somatic index
LLW	low-level waste
LTV	lowest test value
M&M	monitoring and maintenance
MCL	maximum contaminant level
MOE	Ministry of Environment (Ontario)
msl	mean sea level
NAWQC	national ambient water quality criteria
NCP	National Contingency Plan
NCRP	National Council on Radiation Protection
NOAEL	no-observed-adverse-effect level
NOEC	no-observed-effect concentration
NOEL	no-observed-effect level
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORREMP	Oak Ridge Reservation Enviornmental Monitoring Program
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OU	operable unit
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl (marketed as Aroclor mixtures)
PCM	Poplar Creek mile
PLE	product limit estimate
PNL	Pacific Northwest Laboratory
PORTS	Portsmouth Gaseous Diffusion Plant
q_1^*	carcinogenicity slope factor
QA	quality assurance
RA	remedial action
RAO	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RfC	reference concentration
RfD	reference dose
RGO	remedial goal option
RI/FS	remedial investigation/feasibility study

ROD	Record of Decision
RME	reasonable maximum exposure
SAV	secondary acute value
s.c.	subcutaneous
SCV	secondary chronic value
SF	slope factor
SI	sensitivity index
SQAG	Sediment Quality Assessment Guideline
SQC	sediment quality criteria
SSNAEL	site-specific no apparent effects level
SWSA	solid waste storage area
T&E	threatened and endangered
TBC	to be considered
TCLP	Toxicity Characteristics Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TIE	toxicity evaluation and identification
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TRE	trivalent rare earths
TRM	Tennessee River mile
TSCA	Toxic Substances Control Act
TU	toxic unit
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
UCB	upper confidence bound
UCL_{95}	95% upper confidence limit
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
VSI	visceral-somatic index
WAC	waste acceptance criteria
WBR	Watts Bar Reservoir
WOC	White Oak Creek
%GI	percent gastrointestinal absorption efficiency
ΣTU	sum of toxic units

EXECUTIVE SUMMARY

This report presents the findings of an investigation into contamination of the Clinch River and Poplar Creek near the U.S. Department of Energy's (DOE's) Oak Ridge Reservation (ORR) in eastern Tennessee. For more than 50 years, various hazardous and radioactive substances have been released to the environment as a result of operations and waste management activities at the ORR. In 1989, the ORR was placed on the National Priorities List (NPL), established and maintained under the federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Under CERCLA, NPL sites must be investigated to determine the nature and extent of contamination at the site, assess the risk to human health and the environment posed by the site, and, if necessary, identify feasible remedial alternatives that could be used to clean the site and reduce risk. To facilitate the overall environmental restoration effort at the ORR, CERCLA activities are being implemented individually as distinct operable units (OUs). This document is the combined Remedial Investigation and Feasibility Study Report for the Clinch River/Poplar Creek OU.

This report is organized into five volumes, the first of which presents the main text. Chapter 1 describes the regulatory setting, and Chapter 2 broadly portrays the environmental setting. Chapter 3 depicts the operational and release history of the site and characterizes in detail the nature and extent of contamination. Chapter 4 briefly identifies other regulatory requirements that are applicable or appropriate to the site. Chapters 5 and 6 assess the risk to human health and the environment, respectively. Chapter 7 explains the purpose and organization of the feasibility study. Chapter 8 defines remedial action objectives for the site; identifies pathways and contaminants of concern; and screens general response actions, potential remedial technologies, and process options. Chapter 9 develops remedial alternatives based on the remedial action objectives, the screened technologies, and representative process options. Chapter 10 analyzes, evaluates, and compares the remedial alternatives. Chapter 11 lists the references cited in the main text.

Volumes 2–5 consist of appendices that contain supporting data and information. Volume 2 characterizes the biota on the ORR (Appendix A) and summarizes data related to contaminant concentrations in water (Appendix B), in sediment (Appendix C), and in biota (Appendix D). Volume 3 presents information related to the human health risk assessment (Appendix E) and the ecological risk assessments (Appendix F). Volume 4 focuses on the feasibility study, detailing the selection of remedial process options (Appendix G) and providing the basis for the cost estimates for each remedial alternative (Appendix H). Volume 4 (Appendix I) additionally presents the applicable or relevant and appropriate requirements (ARARs), which help define the extent of the remedial response. Volume 5 is a compilation of data from individual studies that were conducted as part of the overall remedial investigation. As such, the volume addresses the quality assurance objectives for measuring the data (Appendix J) and presents selected historical data (Appendix K), data from several discrete water characterization studies (Appendix L), data supporting the sediment characterization (Appendix M), and data related to several biota characterization studies (Appendix N).

BACKGROUND

The ORR is a 34,600-acre tract of land in Anderson and Roane counties, Tennessee. It is administered by DOE, and it houses three main facilities: the Oak Ridge Y-12 Plant, the K-25 Site (formerly known as the Oak Ridge Gaseous Diffusion Plant), and Oak Ridge National Laboratory (ORNL). Each facility was created in the early 1940s as part of the U.S. government's war effort. The K-25 Site was used for the large-scale production of enriched uranium until its shutdown in 1985. The Y-12 Plant had several missions, but it primarily manufactured nuclear weapons components; production there ended in 1992. ORNL was initially a pilot-scale plant for the production of plutonium, but its post-war mission has centered on nuclear reactor research and the production of radionuclides for use in medicine and science. In addition to these operations, each plant has housed large support operations, including maintenance shops; waste treatment, storage, and disposal areas; steam plants; storm and sewer drains; and infrastructure.

The Clinch River/Poplar Creek OU is located adjacent to the ORR and consists of the Clinch River and several tributary embayments in Melton Hill and Watts Bar reservoirs. Both reservoirs are large multipurpose impoundments created and maintained by the Tennessee Valley Authority. The OU extends from the upstream boundary of the ORR at Clinch River mile (CRM) 49 in Melton Hill Reservoir, downstream to the mouth of the Clinch River in Watts Bar Reservoir at Kingston. It also includes several embayments that extend up tributary streams, including the McCoy Branch embayment of Melton Hill Reservoir and the Poplar Creek embayment [up to Poplar Creek mile (PCM) 5.5] of Watts Bar Reservoir. Originally, the OU included all of Watts Bar Reservoir downstream of the confluence of the Clinch and Tennessee rivers, but this area was segregated into a new OU (the lower Watts Bar Reservoir OU) in 1994, and a CERCLA Record of Decision was reached in 1995. No action-based remedial alternatives were implemented in lower Watts Bar Reservoir. The OU is currently being monitored to ensure that exposure to contaminants remains low.

REMEDIAL INVESTIGATION

The remedial investigation had two primary objectives: (1) to characterize the nature and extent of contamination, and (2) to assess the baseline risk to human health and the environment. Under CERCLA, if site risks are too high, remedial action is generally warranted. This investigation was implemented in a phased approach. First, existing environmental data were used to develop a preliminary site model, which considered the known or suspected contaminant sources, the physical characteristics of the site, and the environmental fate of various contaminants. An initial round (Phase 1) of limited sampling of water, sediment, and fish was then conducted (in 1989) to confirm these historical data and to refine the site model. A much more extensive sampling effort (Phase 2) was conducted in 1994 to more definitively meet the objectives.

Nature and Extent of Contamination

Several contaminant sources were included in the site model. The waters of Poplar Creek were known to receive effluent from the Y-12 Plant (and the City of Oak Ridge) via East Fork Poplar Creek (EFPC), which enters the Poplar Creek at PCM 5.5. Large quantities of elemental mercury were released from the Y-12 Plant in the late 1950s, and small quantities currently continue to escape from contaminated buildings, equipment, and soils. Increased levels of mercury, therefore, were predicted in water, sediment, and biota of Poplar Creek downstream of EFPC. (Contamination at the Y-12 Plant and contamination in the EFPC floodplain have been addressed separately in efforts at

other ORR OUs). Other contaminants known to have been released from the Y-12 Plant include uranium, polychlorinated biphenyls (PCBs), and several metals. Poplar Creek also has historically received a variety of effluents from the K-25 Site, through which the creek flows. Numerous metals, uranium, PCBs, laboratory chemicals, and organic solvents are thought to have been released from the site. In addition, the downstream reaches of Poplar Creek formerly received coal ash from the K-770 steam plant at the K-25 Site, and sediment at this location was expected to contain elevated levels of several metals, particularly arsenic.

The contaminants of potential concern in the Clinch River below Melton Hill Dam are primarily man-made radionuclides, by-products of nuclear fission. Contaminants were released to the Clinch River via White Oak Creek, which enters at CRM 20.8. Studies in the 1960s demonstrated that water-soluble radionuclides were rapidly and greatly diluted upon entering the Clinch River and were quickly transported downstream, with little loss of contaminant mass (i.e., they remained in solution). However, those contaminants that adsorbed to particulate matter became bound to particles of suspended sediment and accumulated in areas of sediment deposition. Earlier studies indicated that the principal radionuclide of potential concern in Clinch River sediment at the beginning of this investigation was ^{137}Cs, which is strongly particle-associated and has a relatively long (30-year) half-life. Because peak releases of ^{137}Cs from ORNL occurred at the same time as peak releases of mercury from the Y-12 Plant, peak concentrations of each were known to co-occur in the lower Clinch River, buried under several inches of cleaner sediment. Although one would have expected sediment in the Clinch River below White Oak Creek to contain the highest levels of ^{137}Cs and other radionuclides, there was actually very little sediment in this portion of the river, most having been scoured and transported downstream by the periodic high-volume releases of water from Melton Hill Dam, located approximately 2 miles upstream.

Current contaminant releases from ORNL are much lower than those of the 1950s and 1960s and are largely due to leaching or runoff from waste disposal areas. Most of these areas are no longer in use and are themselves the focus of environmental restoration efforts at ORNL.

Fly ash from the Y-12 steam plant was formerly disposed of in a settling pond located near the headwaters of McCoy Branch on Chestnut Ridge. As a result, several contaminants associated with coal ash, particularly arsenic, were known to be present at elevated levels in surface water and sediment in the McCoy Branch embayment of Melton Hill Reservoir. Because the embayment is bisected by a road built on fill material, conditions were expected to be worse in the upper embayment, whose water had limited mixing (via a culvert) with waters of the lower embayment and the main reservoir.

In addition to these ORR-specific concerns, it was known that fish collected on and near the reservation contained more PCBs than fish found at most upstream reference areas. PCBs had been used at each of the three facilities. The ORR as a whole has likely been a source of PCBs to the environment. However, PCBs have been widely used in transformers and in industrial operations, and numerous potential sources exist throughout eastern Tennessee. The identification of sources is difficult because PCBs bioaccumulate in fish and other organisms to much greater levels than in water or sediment, where they are largely undetected. The extent to which the ORR had contributed to the problem was unclear.

The knowledge of these site conditions was used to guide the remedial investigation. Much of the sampling focused on Poplar Creek, where the combination of multiple sources and site conditions (e.g., areas of significant sedimentation, less water volume than in the Clinch River) were expected

to result in some of the highest levels of contamination. Sampling in the Clinch River focused on fish and sediment, media in which contaminants tend to accumulate. Sediment sampling was limited in the Clinch River between Melton Hill Dam and Poplar Creek because sediment was scarce there.

The results of the site characterization phase of the remedial investigation were consistent with the site model. The nature and extent of contamination were evaluated by identifying those study reaches in which levels of any contaminant in water, sediment, or biota were elevated in comparison with levels in upstream reference reaches. The nature and extent of contamination are described as follows.

- **Arsenic in surface water and sediment of upper McCoy Branch Embayment.** Average concentrations of arsenic (4.1 μg/L) in surface water exceeded the state of Tennessee's recreation-based Ambient Water Quality Criterion. This criterion is designed to protect persons who regularly consume fish taken from a particular body of water. In sediment, elevated levels of arsenic, vanadium, and boron were found throughout McCoy Branch Embayment, but concentrations were highest in the upper embayment.

- **Radionuclide levels in water, sediment, and biota of the Clinch River downstream of White Oak Creek.** Average gross alpha and gross beta levels and mean activities of ^{90}Sr and ^{3}H in surface water were a factor of ten higher than reference values. These data were extremely variable, probably as a result of the extreme variability in flow below Melton Hill Dam. A conservative evaluation of the radionuclide concentrations indicated that, even immediately below White Oak Creek, the state's Ambient Water Quality Criterion for protection of domestic supplies was not exceeded.

  Levels of ^{137}Cs were elevated in Clinch River sediment below the mouth of White Oak Creek. This radionuclide has a strong affinity for particles, particularly the clay minerals that make up a significant portion of Clinch River sediment. However, the discharge of water from Melton Hill Dam resulted in the scouring of most of the sediment from this portion of the river, creating larger inventories of ^{137}Cs in the lower Clinch River, where sedimentation is greater.

  Bluegill sunfish and largemouth bass collected in 1989 from the Clinch River near the mouth of White Oak Creek contained ^{137}Cs at levels 100 times that of fish from upstream reference areas. Catfish were found to have levels approximately ten times that of reference areas. Although elevated, these levels were not thought to pose a significant risk to persons or wildlife consuming these fish, and thus radionuclide analysis was discontinued after the initial round of sampling. However, the species-specific baseline human health risk assessment has identified ^{137}Cs as a contaminant of concern in largemouth bass. Additional bass and sunfish will be collected to determine whether concentrations have dropped since the Phase 1 data were collected.

- **Mercury in surface water, sediment, and biota of Poplar Creek downstream of East Fork Poplar Creek.** Average mercury concentrations in surface water, sediment, and biota were significantly elevated in Poplar Creek downstream of EFPC in comparison with average values upstream of EFPC. Elevated concentrations (up to 0.19 μg/L) measured in Poplar Creek surface water below EFPC and in the Clinch River downstream of Poplar Creek exceed the state's Criterion Continuous Concentration (CCC) (0.012 μg/L). This criterion is designed to protect aquatic life from chronic exposure to mercury. Although also elevated above reference values, mean mercury levels in fish did not exceed the Federal Drug Administration's action level (1.0 mg/kg) in any species sampled. Several individual largemouth bass, however, had mercury

levels that exceeded this value. Increased body burdens of mercury were also found in benthic organisms living in Poplar Creek, in heron eggs and chicks from a rookery near Poplar Creek, and in laboratory mink fed a diet high in fish from Poplar Creek. A decreasing gradient of biological effects, as measured by a suite of physiological and physical indices, was found to extend from upper Poplar Creek downstream through the Clinch River. This gradient in effects can be roughly correlated with a decreasing gradient in fish body burdens of mercury and PCBs in the downstream direction.

- **Metals and radionuclides in the sediment of Poplar Creek.** In addition to mercury, contaminants in Poplar Creek sediment that were elevated above reference levels were silver, arsenic, boron, cadmium, copper, chromium, nickel, vanadium, ^{238}U, ^{235}U, ^{234}U, ^{99}Tc, ^{137}Cs, and ^{60}Co. PCBs (Aroclor 1254), rarely detected in sediment anywhere in the system, were detected in Poplar Creek. As with mercury, concentrations of copper, cadmium, and chromium increased immediately below EFPC and likely represented releases from the Y-12 Plant. Concentrations of silver, nickel, ^{99}Tc, and the uranium isotopes were elevated below K-25 discharge points, and copper and chromium concentrations in this area were substantially increased above the already elevated levels found below EFPC. Increased levels of arsenic, vanadium, and boron were found in lower Poplar Creek and were associated with an area where the disposal of coal ash from the K-770 steam plant historically took place. The increased levels of ^{137}Cs and ^{60}Co were restricted to the last mile of Poplar Creek and are thought to be caused by backflow from the Clinch River, which regularly takes place as a result of reservoir operations.

- **PCBs in fish of Poplar Creek and the Clinch River.** Mean PCB levels in largemouth bass were highest in Poplar Creek. Although no bass were available from the reference reach of Poplar Creek, concentrations were still greater than at most other study and reference sites.

  Mean concentrations of PCBs in catfish were highest in Phase 1 samples collected from the White Oak Creek Embayment (now part of a separate OU) and in fish from the Clinch River immediately downstream. Levels were significantly increased over those in Melton Hill and Norris Reservoir catfish. Mean concentrations in catfish from Poplar Creek below the confluence with EFPC were greater than those in catfish from above the confluence. Mean total PCB concentrations in largemouth bass did not exceed the FDA action level (2.0 mg/kg) at any location. The mean concentration in catfish did not exceed this action level at any location (except at the White Oak Creek Embayment). However, individual fish from the Clinch River and Poplar Creek had concentrations that exceeded this level.

  The PCBs detected in fish flesh were almost exclusively Aroclor 1254 and Aroclor 1260. An analysis of individual PCB congeners in catfish did not reveal any patterns that could explain additional sources of PCB contamination.

Risk Assessment

The data used to characterize the nature and extent of contamination were also used to meet the second objective of the remedial investigation, risk assessment. The baseline risk assessment contained in this report consists of a human health risk assessment and an ecological risk assessment.

Risk to human health was evaluated for seven exposure scenarios, each of which contained one or more pathways through which exposure actually occurs. The seven scenarios were (1) the use of

surface water as an untreated drinking water source, (2) the consumption of fish, (3) the use of the reservoir shoreline during winter drawdown, (4) swimming, (5) the hunting and consumption of waterfowl that frequent the ORR, (6) the dredging and subsequent land disposal of sediment, and (7) the use of surface water for irrigation. In each scenario, risk from carcinogens was assessed by assuming a 30-year exposure duration, and risk from noncarcinogens was assessed by assuming a 6-year exposure period. Under CERCLA, media whose pathways result in either a cumulative excess cancer risk of 1.0E−04 or a Hazard Quotient of 1.0 (a measure of noncarcinogenic exposure) generally warrant remedial action at the site.

The human health risk assessment evaluated the risk from each contaminant for which sufficient data existed to obtain a representative concentration. Therefore, the human health risk assessment identified certain analytes whose presence did not appear to be the result of the ORR operations. Because these contaminants might have contributed significantly to overall risk, they generally were included in the risk assessment.

Thirty-five potential contaminants of concern were identified in Clinch River and Poplar Creek water, sediment, and fish. The majority of contaminants were found in deep sediment, and the greatest risks were identified through the agricultural pathways. Of the contaminants identified, only 2 in water, 7 in fish, and 19 in sediment were clearly site-related.

Eight contaminants of concern, all noncarcinogens, were identified in surface water in the OU. Five were identified in the drinking water scenario; the non-site-related analyte manganese drove the risk in all reaches except in upper McCoy Branch, where arsenic contributed most of the risk. Seven contaminants of concern were identified in the irrigation scenario, and two were identified in the swimming scenario (Poplar Creek only). The two contaminants identified in the swimming scenario (Di-n-octylphthalate and Aroclor 1254, also identified in the irrigation scenario) were detected infrequently and therefore might not be contaminants of concern. In general, the number of contaminants of concern in each scenario was greatest in Poplar Creek and least in McCoy Branch.

Seven contaminants of concern were identified in the shoreline-use scenario, which was based on contaminant concentrations in near-shore sediment only. Melton Hill Reservoir is managed in such a way that no prolonged drawdown occurs; therefore, assessment of this scenario was not conducted for the area. Noncarcinogenic risk was common throughout near-shore areas along both the Clinch River and Poplar Creek, and it was driven almost exclusively by manganese via inhalation of resuspended sediment. A significant (<1.0E−04) excess cancer risk existed in one subreach of Poplar Creek, primarily because of chromium exposure via the inhalation pathway.

Eleven contaminants of concern were found in fish. Most of the contaminants were organic compounds (PCBs and pesticide residues) and were found in catfish and largemouth bass from both the Clinch River and Poplar Creek. The excess cancer risk from the consumption of catfish exceeded 1.0E−03 in all study reaches, primarily as a result of Aroclor 1260. The excess cancer risk from the ingestion of largemouth bass was generally equal to or less than one half of that from the ingestion of catfish. Arsenic and Aroclor 1260 were the primary contributors to carcinogenic risk from the ingestion of largemouth bass. Several radionuclides were also identified as carcinogenic contaminants of concern, but they generally contributed only a small portion of the total risk. The exception was ^{137}Cs, which contributed a significant portion of the risk associated with the ingestion of largemouth bass from the Clinch River immediately below the mouth of White Oak Creek. Contaminants of concern that were important noncarcinogens included mercury, Aroclor 1254, and chlordane in one or more species in Poplar Creek and the Clinch River.

In the dredging scenario, 31 contaminants of concern were identified in sediment. This scenario assessed the risk from contaminant exposure that would occur if dredge spoil were placed on land where it was accessible to humans. Several direct exposure pathways were evaluated, as were several agricultural scenarios in which contaminant concentrations in produce, milk, and beef were modeled from sediment contaminant concentrations.

Of the direct pathways, external exposure to gamma-emitting radionuclides in spoil from throughout most of the Clinch River (including Melton Hill Reservoir) and at the mouth of Poplar Creek would result in an excess cancer risk greater than 1.0E−04. At all locations downstream of White Oak Creek, the primary contributor to risk via external exposure was ^{137}Cs. In Melton Hill Reservoir, the risk was primarily due to ^{60}Co from a non-DOE source (now closed) on Braden Branch. In all reaches for which data were available, manganese in spoil posed the greatest risk to adults and children via the inhalation of resuspended sediment. Barium similarly posed ubiquitous risk but generally only to children. In addition to this noncarcinogenic risk, the inhalation of resuspended spoil from lower Poplar Creek would result in an excess cancer risk of 2.1E−04, primarily due to arsenic and chromium. Finally, the incidental ingestion of arsenic and mercury in spoil from lower Poplar Creek would be potentially harmful to children.

In the three agricultural pathways evaluated under the dredging scenario, the milk and meat ingestion pathways showed the most carcinogenic potential. Evaluation of the majority of the reaches for which data were available indicated that the ingestion of milk and beef produced with vegetation grown on dredge spoil would result in an excess cancer risk greater than 1.0E−04 and that many reaches had risk values an order of magnitude greater. The contaminants responsible for the majority of this risk were members of a class of ubiquitous contaminants known as polycyclic aromatic hydrocarbons. In particular, benzo(a)pyrene and dibenz(a,h)anthracene drove this risk. In addition, in those reaches where it was detected, Aroclor 1260 contributed significantly to the risk. By contrast, the excess cancer risk in vegetables was generally lower, exceeding the 1.0 E−04 threshold in only two locations; in these locations the risk was driven by different analytes than in the other two pathways. In Poplar Creek adjacent to the K-25 Site, ^{99}Tc was the primary contributor to risk, although nine other analytes at this location were also of concern. At one location in the Clinch River, the organic analyte N-nitroso-di-n-propylamine was identified as a contaminant of concern but was detected in only one of three samples from that reach.

Evaluation of every subreach for which there were data indicated that one or more of the agricultural pathways posed an unacceptable risk under the dredging scenario. Fourteen noncarcinogenic contaminants of concern were identified. Risk in the milk and meat pathways was frequently driven by mercury and Aroclor 1254. Risk in the vegetable ingestion pathway was frequently driven by manganese, except in the Poplar Creek subreaches, where mercury was the concern.

The ecological baseline risk assessment estimated the ecological risk due to contaminants in the Clinch River/Poplar Creek OU. Seven assessment endpoints were evaluated during the assessment: (1) reduced species richness or abundance or the increased frequency of gross pathologies in fish; (2) reduced species richness or abundance of benthic macroinvertebrate communities; (3) reduced abundance or production of piscivorous wildlife populations; (4) reduced abundance or production of flying insectivorous wildlife populations; (5) reduced production in terrestrial plant communities; (6) reduced abundance or production of terrestrial wildlife populations; and (7) reduced viability of any individuals of a threatened or endangered species. For each endpoint, the reduction in the parameter was required to be 20% or more and to be the result of toxicity.

Three lines of evidence were used in the ecological risk assessment. First, the site and media-specific contaminant data used in the site characterization were evaluated against a series of benchmark values (e.g., the no-observed-effects level) to determine whether concentrations were great enough to cause adverse effects. Second, site-specific toxicity data were used to determine whether these levels were actually causing a toxic effect at a particular site. Finally, site-specific biological survey data (species richness and abundance) were used to help assess whether any toxicity was actually having an impact at the population or community level. When all lines of evidence were not available for each of the endpoints, risk assessment was usually based on contaminant data alone. The assessment for the fish endpoint used data on fish pathologies and fecundity as a fourth line of evidence.

The fish community in Poplar Creek was found to be at significant risk from episodically high concentrations of several metals (copper, mercury, nickel, and silver). Toxicity to fish was assessed by using several test protocols and organisms. Poplar Creek water was toxic to Japanese medaka and redbreast sunfish embryos, but not to fathead minnows or *Ceriodaphnia*. The fish community of Poplar Creek exhibited decreased species richness and abundance in comparison with a reference site with similar habitat (Bull Run Creek embayment of Melton Hill Reservoir). The results of the ecological risk assessment for fish indicated that, while individual fish were probably suffering some physiological impacts immediately below WOC, the fish community was not being significantly impacted in the Clinch River. In McCoy Branch, adverse impacts could not be ruled out, but data were unavailable for some of the lines of evidence (data on fish community, pathology, and fecundity).

The benthic macroinvertebrate community of Poplar Creek was identified as being at significant risk from several metals (arsenic, mercury, nickel, and silver) and PCBs in surface sediment. The benthic community contained fewer species and had less abundance of organisms than the communities at other sites. The toxicity data did not reveal consistently toxic effects, but in at least one test from each site a toxic response was observed in test organisms of at least one species. The benthic communities of the Clinch River and the McCoy Branch embayment were found not to be significantly impacted by contaminants.

Risks to piscivorous wildlife were assessed by using two avian species (great blue heron and osprey) and two mammalian species (mink and river otter). Two lines of evidence, biomonitoring data and contaminant data in whole fish, were available for assessing risk to heron and osprey. Partly because of their wide foraging behavior, osprey were found to be not at risk from contaminants even though mercury levels in Poplar Creek fish exceeded benchmark values. Although the data indicated that individual heron feeding exclusively in certain portions of Poplar Creek might be at risk, the local populations of the avian species were not expected to be impacted. This conclusion was supported by surveys of the reproductive success of osprey and great blue heron in Poplar Creek: the surveys found high reproduction and no increase in deformities. Mink were not identified as being at risk from contaminants in either Poplar Creek or the Clinch River. However, individual river otter feeding in Poplar Creek near the mouth of EFPC would be expected to have a significant risk of impaired reproduction. Although river otter do not currently exist within the OU, they have recently been reintroduced into east Tennessee, and the natural expansion of their range is expected to lead to their re-establishment on the ORR. Because the otter is a state threatened species, impacts to individual otter would be considered significant.

The risk to insectivorous wildlife was assessed by using one avian species, the rough-winged swallow, and two mammalian species, the gray and little brown bats. In each case, only one line of

evidence (contaminant concentrations in benthic insects) was available for the assessment. These data indicate that a colony of rough-winged swallows feeding in Poplar Creek near the mouth of EFPC could suffer impaired reproductive potential as a result of mercury exposure, but the magnitude of the effects could not be evaluated. Populations of neither species of bat were found to be at risk. Although mercury concentrations in Poplar Creek were high enough to put individual bats at risk if they were to forage exclusively within this area, the foraging range of bats is great enough that this possibility is unlikely.

The ecological risk assessment for terrestrial wildlife was based on a dredging scenario much like that used in the human health risk assessment. The assessment examined risk both to the plant community that would develop on dredge spoil and to a herbivorous mammal (eastern cottontail) foraging there. A single line of evidence (contaminant concentrations in sediment) was available for use in the assessment. In the sediment of one or more study reaches, 12 metals were found at concentrations that exceeded benchmarks indicative of plant toxicity. The greatest number of metals were found in lower Poplar Creek, which contained arsenic, boron, cadmium, chromium, mercury, nickel, selenium, uranium, and vanadium. Benchmark numbers for plants were not available for a large number (i.e., 37) of the organic compounds; therefore, these analytes could not be evaluated. Populations of cottontails foraging on future spoil from lower Poplar Creek or from the Clinch River immediately downstream of Poplar Creek would be at significant risk of impaired reproduction due to levels of mercury and cadmium. A number of other analytes from these (and most other) reaches might pose a risk to individual cottontails foraging on future spoil; however, population-level effects from these contaminants would not be expected.

Ecological risk from radiation exposure was assessed separately. Risks to many of the same endpoint species were assessed, including a benthic organism (a mayfly), epibenthic (bottom-dwelling) fish, piscivorous wildlife (great blue heron), and a terrestrial herbivore (eastern cottontail). The assessment used the contaminant data for radionuclides to calculate the total radiation dose to these organisms. The DOE limit of 1.0 rad/day was used to assess acceptable exposures for most organisms; the International Atomic Energy Agency's recommended limit of 0.1 rad/day for terrestrial organisms was used to assess exposure for cottontail rabbits. None of the calculated doses approached the appropriate benchmarks above; thus, the radiological contaminants in the various environmental media of the OU did not pose a significant ecological risk.

Based on the findings of the site characterization and risk assessments, a number of pathway and media-specific remedial goal options (RGOs) were developed for individual analytes, which represent concentrations corresponding to an ARAR or to an acceptable human health or ecological risk level. RGOs were developed only for those reaches containing one or more environmental media that exceeded one of the criteria and thus indicated the potential need for remedial action in that reach. In almost every reach studied, RGOs were developed for one or more analytes for each of the three media evaluated.

FEASIBILITY STUDY

On the basis of the remedial investigation, a feasibility study was conducted to identify remedial alternatives that would be effective in reducing contaminant concentrations or reducing or eliminating exposure and that could be feasibly implemented. The overall approach taken in the feasibility study was to focus on remedies for site-related contaminants as identified in the site characterization. Therefore, remedies were not evaluated for those reaches in which risk was

primarily the result of non-site-related contaminants (e.g., manganese-driven risks in surface sediment or in water). In addition, no remedies were evaluated for surface water contaminants. Remediation of surface water is best effected at the source of the contamination, which in each case is primarily in upstream OUs. Moreover, remediation of the large volumes of flowing water is not practical. The use of institutional controls is the only remedy considered for limiting human exposure to fish. Therefore, active remedies evaluated in the feasibility study focus on site-related contaminants of concern in sediment.

Four alternatives are evaluated in the feasibility study. Alternative 1, the no-action alternative, is required by CERCLA to be evaluated. As the name implies, this alternative would be easily implemented at no cost. However, the risk assessments indicate that the no-action alternative would not be protective of human health or the environment.

Alternative 2 consists of the use of institutional controls and advisories to reduce exposure to contaminants in fish and sediment. Although not empowered under CERCLA, the state of Tennessee, the Tennessee Valley Authority, and the U.S. Army Corps of Engineers each have separate regulatory authority to regulate activities that could result in the disturbance of sediment in the Clinch River and Poplar Creek. Each of these agencies is party to an interagency agreement with DOE that requires the multiagency review, on a case-by-case basis, of all permit applications that propose activities with the potential to disturb sediment. The state of Tennessee currently issues fish consumption advisories warning the public to avoid or limit consumption of certain species of fish in which contaminant levels are unacceptably high. The present worth cost of implementing alternative 2 for 30 years, including future monitoring and administrative costs, is estimated to be $3.6M.

Alternative 3 incorporates the institutional controls described in alternative 2 and in addition proposes the combined containment and removal of contaminated sediment from Poplar Creek. The presence of several contaminants in the sediment of Poplar Creek posed a risk to human health or benthic organisms. Seven separate locations in Poplar Creek would be remediated, through the use of a combination of sediment containment technologies in the near-shore areas (bottom elevation >733 ft msl) and sediment removal technologies in deep water areas (bottom elevation <733 ft msl). A total area of 388,800 ft^2 is proposed for containment, and a total of 179,250 yd^3 for removal (the top 3 ft of sediment), at a total present worth cost of $109.6M. Removal of the deep sediment would also address the potential for future risks to human health and the environment in the dredging scenario.

Alternative 4 also incorporates the institutional controls of alternative 2, but in addition it proposes the removal of contaminated sediment from Poplar Creek. Removal of those sediments in Poplar Creek that pose a human health or ecological risk would require the removal and safe disposal of approximately 226,500 yd^3 of sediment, at a total present worth cost of approximately $123.5M. Because benthic habitat extends bank-to-bank, addressing the existing ecological risk by removing sediment would also address both the existing human health risk in the near-shore scenario and the potential for future human health risk and ecological risk in the dredging scenario.

Appendix E

HUMAN HEALTH RISK ASSESSMENT DATA

Table E1. Ingestion of contaminants in drinking water

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CW \times IR \times EF \times ED$$

Parameter Explanation

	Parameter	Value used	Explanation/source
CW =	Concentration in water	Chemical-specific (mg/L or pCi/L)	95% UCL on the mean
IR =	Ingestion rate	1.0 L/day 2.0 L/day	Child rate (EFH, EPA 1989) Adult rate (OSWER Directive, EPA 1991a)
EF =	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED =	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW =	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT =	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens (EPA 1989b; EPA 1991a)

Table E2. Inadvertent ingestion of sediment in near-shore pathway

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CS \times IR \times FI \times EF \times CF \times ET \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CS \times IR \times FI \times EF \times CF \times ET \times ED$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CS	=	Concentration in near-shore sediments	Chemical-specific (mg/kg, pCi/g, dry wt)	95% UCL on the mean
IR	=	Ingestion rate	0.0002 kg/day or 0.2 g/day	Child (OSWER Directive, EPA 1991a)
			0.0001 kg/day or 0.1 g/day	Adult (OSWER Directive, EPA 1991a)
FI	=	Fraction ingested	1 (unitless)	Maximum value; equivalent to 100%
EF	=	Exposure frequency	175 days/year	Based on the average time near-shore sediments are known to be available for exposure.
ET	=	Exposure time exposed to the near-shore sediments	8 hours/day	Estimated; hours per day an individual is
CF	=	Conversion factor	1 day/24 hours	Necessary to convert to appropriate units
ED	=	Exposure duration	6 years	Child exposure (RAGS, EPA 1989b)
			30 years	Adult exposure (RAGS, EPA 1989b)
BW	=	Body weight	15 kg	Child (OSWER Directive, EPA 1991a)
			70 kg	Adult (OSWER Directive, EPA 1991a)
AT	=	Averaging time	365 days/year × ED	Averaging time for non-carcinogens
			365 days/year × 70 years	Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E3. Dermal contact with sediment in the near-shore pathway

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CS \times AF \times ABS \times SA \times ET \times CF \times EF \times ED}{BW \times AT}$$

Parameter Explanation

	Parameter	Value used	Explanation/source
CS =	Concentration in near-shore sediment	Chemical-specific (mg/kg, dry wt)	Concentration listed in Appendix E
AF =	Adherence factor	0.01 kg/m^2	Unit-adjusted adherence factor for soil 1.0 mg/cm^2 (10^{-6} kg/mg x 10^4 cm^2/m^2) (EPA 1992b)
ABS =	Absorption factor	0.001 (unitless) 0.01 (unitless)	Equivalent to 0.1% for inorganics and 1.0% for organics (EPA 1992b)
SA =	Available surface area	0.2295 m^2/day 0.57 m^2/day	(0.918 m^2/day)(0.25), children (2.28 m^2/day)(0.25), adults 25% of the 95th percentile total body surface area (represents summer exposure) (DEA, EPA 1992a)
EF =	Exposure frequency	175 days/year	Equilvalent to 350 days/year · 0.5; six months exposure per year
ET =	Exposure time	8 hours/day	Estimated; hours per day an individual is exposed to near-shore sediment
CF =	Conversion factor	1 day/24 hours	Necessary to convert to appropriate units
ED =	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW =	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT =	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E4. Inhalation of resuspended sediment in the near-shore pathway

$$Intake_{\ nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

$$Intake_{\ radionuclides}(pCi) = CA \times IR \times ET \times EF \times ED$$

Where,

$$CA\left(\frac{mg}{m^3}, \frac{pCi}{m^3}\right) = CS \times r_e \times \rho$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CA	=	Concentration in air	Chemical-specific (mg/m^3, pCi/m^3)	Concentration calculated as above
CS	=	Concentration in sediment	Chemical specific (mg/kg, pCi/g, dry wt)	Measured values listed in Appendix E
r_e	=	Soil resuspension constant	2.0E-10 (unitless)	Till & Meyer, 1983
ρ	=	Soil density	1600 kg/m^3	Till & Meyer, 1983
IR	=	Air inhalation rate	2.0 m^3/hour 2.1 m^3/hour	Moderate child rate (EFH, EPA 1989a) Moderate adult rate (EFH, EPA 1989a)
ET	=	Exposure time	8 hours/day	Estimated; fraction of day an individual is exposed to near-shore sediment
EF	=	Exposure frequency	175 days/year	OSWER Directive, EPA 1991a
ED	=	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW	=	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT	=	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens

Table E5. External exposure to radionuclides in sediment in the near-shore pathway

$$Dose_{near-shore}\left(\frac{pCi \cdot yr}{g}\right) = CS \times \left(\frac{1 - e^{-\lambda_i ED}}{\lambda_i}\right) \times ET \times CF_1 \times EF \times CF_2$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CS	=	Concentration in near-shore sediment	Radionuclide-specific (pCi/g, dry wt)	95% UCL on the mean
λ_i	=	Radioactive decay constant	Calculated value (1/years)	$\lambda_i = 0.693/TR$ (NCRP 1989)
TR	=	Radioactive half-life	Radionuclide-specific (years)	BEIAS (IRIS/HEAST databases)
ED	=	Exposure duration	30 years	Adult exposure (RAGS, EPA 1989b)
ET	=	Exposure time	8 hours/day	Estimated; hours per day an individual is exposed to near-shore sediment
CF_1	=	Conversion factor	1 day/24 hours	Necessary to convert to appropriate units
EF	=	Exposure frequency	175 days/year	Estimated; based on the number of days per year near-shore sediments are exposed
CF_2	=	Conversion factor	1 year/365 days	Necessary to convert to appropriate units

Table E6. Permeability constants

Chemical	Permeability Constant (m/hour)
2-Butanone	5.0E-05
4,4'-DDD	2.8E-03
4,4'-DDE	2.4E-03
4,4'-DDT	4.3E-03
Acetone	5.7E-06
Aldrin	1.6E-05
Antimony	1.0E-05
Arsenic	1.0E-05
Barium	1.0E-05
Benzo(a)anthracene	8.1E-03
Benzo(a)pyrene	1.2E-02
Benzo(b)fluoranthene	1.2E-02
Benzo(ghi)perylene	4.3E-02
Benzo(k)fluoranthene	4.0E-02
Beryllium	1.0E-05
Bis(2-ethylhexyl)phthalate	1.7E-02
Boron	1.0E-05
Butylbenzylphthalate	7.3E-04
Cadmium	1.0E-05
Carbon disulfide	5.0E-03
Chlordane, total	5.2E-04
Chloroform	1.3E-03
Chromium	1.0E-05
Chrysene	8.1E-03
Copper	1.0E-05
Di-n-butylphthalate	3.3E-04
Di-n-octylphthlate	2.7E-01
Diethylphthlate	4.8E-05
Fluoranthene	3.6E-03

Table E6 (continued)

Chemical	Permeability Constant (m/hour)
Indeno(1,2,3-cd)pyrene	1.9E-02
Lead	1.0E-05
Manganese	1.0E-05
Mercury	1.0E-05
Molybdenum	1.0E-05
Naphthalene	6.9E-04
Nitrate	1.0E-05
Phenanthrene	2.7E-03
Pyrene	6.7E-03
Selenium	1.0E-05
Silver	1.0E-05
Toluene	1.0E-02
Trichloroethene	2.3E-03
Vanadium	1.0E-05
Zinc	1.0E-05

Table E7. Ingestion of contaminants in water while swimming

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CW \times IR \times ET \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CW \times IR \times ET \times EF \times ED$$

Parameter Explanation

	Parameter	Value used	Explanation/source
CW =	Concentration in water	Chemical-specific (mg/L or pCi/L)	95% UCL on the mean
IR =	Intake rate	0.05 L/h	Children and adult (RAGS, EPA 1989b)
ET =	Exposure time	2.6 h/day	National average for swimming (RAGS, EPA 1989b)
EF =	Exposure frequency	45 days/year	USEPA Region IV Guidance, (EPA 1991b)
ED =	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW =	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT =	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens (EPA 1989a; EPA 1991a)

Table E8. Dermal contact with water while swimming

$$Dermal\ \ Dose\ \ Rate_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Parameter Explanation

	Parameter	Value used	Explanation/source
CW =	Concentration in water	Chemical-specific (mg/L)	95% UCL on mean
SA =	Available surface area	0.918 m^2 2.28 m^2	95th percentile total body surface area of a child and adult, respectively (DEA, EPA 1992)
PC =	Permeability constant	Chemical-specific (m/h)	DEA, EPA 1992
ET =	Exposure time	2.6 h/day	National average for swimming (RAGS, EPA 1989b)
EF =	Exposure frequency	45 days/year	USEPA Region IV Guidance (EPA 1991b)
ED =	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
CF =	Conversion factor	10^3 L/m^3	Volumetric conversion: 1000 L = 1 m^3
BW =	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT =	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E9. Ingestion of fish

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CF \times IR \times FI \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CF \times IR \times FI \times EF \times ED$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CF	=	Concentration in fish fillets (by species)	Chemical-specific (mg/kg, pCi/g)	95% UCL or maximum value
IR	=	Fish ingestion rate	0.030 kg/day or 30 g/day 0.054 kg/day or 54 g/day	Child, ages 3-6 (Yang & Nelson 1986) Adult (OSWER Directive EPA 1991a)
FI	=	Fraction ingested from local source	1 (unitless)	Maximum value; equivalent to 100%
EF	=	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED	=	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW	=	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT	=	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E10. Ingestion of Canada Geese

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CG \times IR \times FI \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CG \times IR \times FI \times EF \times ED$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CG	=	Concentration in goose breast tissue	Chemical-specific (mg/kg, pCi/g)	95% UCL or maximum value
IR	=	Ingestion rate		
		Adult	0.130 kg/day or 130 g	Best professional judgement
		Child	0.065 kg/day or 65 g	Best professional judgement
FI	=	Fraction ingested from local source	1 (unitless)	Maximum value; equivalent to 100%
EF	=	Exposure frequency	14 days/year	Best professional judgement
ED	=	Exposure duration	6 years	Child exposure (RAGS, EPA 1989b)
			30 years	Adult exposure (RAGS, EPA 1989b)
BW	=	Body weight	15 kg	Child (OSWER Directive, EPA 1991a)
			70 kg	Adult (OSWER Directive, EPA 1991a)
AT	=	Averaging time	365 days/year × ED	Averaging time for non-carcinogens
			365 days/year × 70 years	Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E11. Contaminant concentration in vegetables

Concentration in irrigated soil [a]:

$$CS_{irrigated} = \frac{(CW)(I_r)(F)(1 - e^{-\lambda_B t_b})}{P\,\lambda_B}$$

Concentration in Vegetables [b]:

$$CV = (CW)(I_r)\left[\frac{f_R}{Y_v}\frac{(1 - e^{-\lambda_B t_v})}{\lambda_B}\right] + (CS)(B_{v_{veg}}) + (CS)(r_c)(\rho)(d)\left[\frac{f_R}{Y_v}\frac{(1 - e^{-\lambda_B t_v})}{\lambda_B}\right]$$

where

Parameter Explanation

	Parameter	Value used	Explanation/Source
CS =	Concentration in soil	Chemical-specific (pCi/g or mg/kg)	Measured value for dredging scenario Calculated value for irrigation (see above)
CW =	Concentration in water	Chemical-specific (pCi/L or mg/L)	Measured values listed in Appendix E.
I_r =	irrigation rate	1321.3 L/m^2-year or 3.62 L/m^2-day	Personal communication with the Roane County Agricultural Extension Agent
F =	fraction of the year crops are irrigated	0.25 (unitless)	Based on 3 months per year
λ_B =	Loss rate from decay and harvesting/leaching	Calculated (1/year)	$\lambda_B = \lambda_i + \lambda_{HL}$ (NCRP 1984)
λ_i =	radioactive decay	Calculated (1/year or 1/day)	$\lambda_i = 0.693/TR$ (NCRP 1984)
λ_{HL} =	Removal rate for harvesting/leaching	9.9E-03/year	(2.7E-05/day)(365 days/year) NCRP 1984
TR =	Radioactive half-life	Radionuclide-specific	BEIAS (IRIS/HEAST databases)
t_b =	time of long-term build up in the soil	30 years	NCRP 1984
P =	areal density for the effective root zone (15 cm depth)	240 kg/m^2	Till & Meyer 1983
CV =	Concentration in vegetables	pCi/kg or mg/kg	Calculated as above

Table E11 (continued)

Parameter Explanation

	Parameter	Value used	Explanation/Source
f_R	= Interception fraction	0.25 (unitless)	fraction of deposited contaminant intercepted and retained by edible portion of crop (RAPS 1987)
Y_v	= Standing crop biomass (edible portion of vegetation)	2 kg/m^2	RAPS 1987
λ_E	= Effective decay constant for removal of contaminant deposited on vegetation	Calculated (1/day)	$\lambda_E = \lambda_i + (0.693/t_w)$
t_w	= Weathering half-life	14 days	the time required for one-half of the originally deposited contaminant to be lost from vegetation (RAPS 1987)
t_v	= Time period vegetables are exposed to above-ground contamination	60 days	RAPS 1987
$B_{v\text{-}wet}$	= Plant to soil concentration ratio (wet weight)	Calculated	$B_{v\text{-}wet} = B_{v\text{-}organics} \times 0.25$ (conversion factor from dry wt to wet wt)
$B_{v\text{-}organics}$	= Plant to soil concentration ratio (dry weight) contaminants	Unitless	Table E.35, NCRP, 1989 (commentary 3)
r_c	= soil resuspension constant	2.0E-10	NCRP 1984
ρ	= soil density	1600 kg/m^3	NCRP 1984
d	= deposition velocity	1000 m/day	RAPS 1987

[a] Based on IAEA, *Generic Models and Parameters for Assessing the Environmental Transfer of Radionuclides from Routine Releases*, Safety Series No. 57, International Atomic Energy Agency, Vienna, 1982.
[b] Based on *Remedial Actions Priority Systems (RAPS) Mathematical Formulations*, August 1987, DOE/RL/87-06.

Table E12. Contaminant concentration in pasture forage

Concentration in irrigated soil [a]:

$$CS_{irrigated} = \frac{(CW)(I_r)(F)(1 - e^{-\lambda_B t_b})}{P\,\lambda_B}$$

Concentration in pasture forage [b]:

$$CP = (CW)(I_r)\left[\frac{f_R}{Y_P}\,\frac{(1 - e^{-\lambda_B t_P})}{\lambda_B}\right] + (CS)(B_{v_{dry}}) + (CS)(r_c)(\rho)(d)\left[\frac{f_R}{Y_P}\,\frac{(1 - e^{-\lambda_B t_P})}{\lambda_B}\right]$$

where

Parameter Explanation

	Parameter	Value used	Explanation/Source
CS =	Concentration in soil	Chemical-specific (pCi/g or mg/kg)	Measured value for dredging scenario Calculated value for irrigation (see above)
CW =	Concentration in water	Chemical-specific (pCi/L or mg/L)	Measured values listed in Table E.1 or E.2.
I_r =	irrigation rate	1321.3 L/m²-year or 3.62 L/m²-day	Personal communication with the Roane County Agricultural Extension Agent
F =	fraction of the year crops are irrigated	0.25 (unitless)	Based on 3 months per year
λ_B =	Loss rate from decay and harvesting/leaching	Calculated (1/year)	$\lambda_B = \lambda_i + \lambda_{HL}$ (NCRP 1984)
λ_i =	radioactive decay	Calculated (1/year or 1/day)	$\lambda_i = 0.693/TR$ (NCRP 1984)
λ_{HL} =	Removal rate for harvesting/leaching	9.9E-03/year	(2.7E-05/day)(365 days/year) NCRP 1984
TR =	Radioactive half-life	Radionuclide-specific	BEIAS (IRIS/HEAST databases)
t_b =	time of long-term build up in the soil	30 years	NCRP 1984
P =	areal density for the effective root zone (15 cm depth)	240 kg/m²	Till & Meyer 1983
CP =	Concentration in pasture forage	pCi/kg or mg/kg	Calculated as above

Table E12 (continued)

Parameter Explanation

	Parameter	Value used	Explanation/Source
f_R	= Interception fraction	0.25 (unitless)	fraction of deposited contaminant intercepted and retained by edible portion of crop (RAPS 1987)
Y_p	= Standing crop biomass (edible portion of vegetation)	0.47 kg/m^2	Till and Meyer 1983
λ_E	= Effective decay constant for removal of contaminant deposited on vegetation	Calculated (1/day)	$\lambda_E = \lambda_i + (0.693/t_w)$
t_w	= Weathering half-life	14 days	the time required for one-half of the originally deposited contaminant to be lost from vegetation (RAPS 1987)
t_p	= Time period pasture is exposed to above-ground contamination	30 days	NCRP Commentary No. 3 1989
$B_{v\text{-}dry}$	= Pasture forage to soil concentration ratio for radionuclides and inorganic contaminants (wet weight)	Unitless	See Table E.35.
$B_{v\text{-}organics}$	= Vegetable to soil concentration ratio for organic contaminants (dry weight)	Unitless	See Table E.35.
r_c	= soil resuspension constant	2.0E-10	NCRP 1984
ρ	= soil density	1600 kg/m^3	NCRP 1984
d	= deposition velocity	1000 m/day	RAPS 1987

[a] Based on IAEA, *Generic Models and Parameters for Assessing the Environmental Transfer of Radionuclides from Routine Releases*, Safety Series No. 57, International Atomic Energy Agency, Vienna, 1982.
[b] Based on *Remedial Actions Priority Systems (RAPS) Mathematical Formulations*, August 1987, DOE/RL/87-06.

Table E13. Contaminant concentration in beef

Concentration in beef[a]:

$$CB = F_b [(CP \times Q_p) + (CS_1 \times Q_s) + (CW \times Q_w)]$$

where

CB	=	concentration in beef	mg/kg, pCi/g	Calculated as above.
F_b	=	transfer coefficient of contaminant in vegetation to contaminant in beef	day/kg	$\log F_b = -7.6 + \log K_{ow}$ (for organics) Elemental F_b = NCRP 1989 (Table E.x)
CP	=	contaminant concentration in pasture forage	mg/kg, pCi/g	Calculated as in Table E.20.
Q_p	=	quantity of dry forage ingested per day by beef cattle	7.2 kg/day	IAEA, 1993
CS_1	=	contaminant concentration in dry soil	mg/kg, pCi/g	Measured
CS_2	=	contaminant concentration in dry soil as the result of irrigation	mg/kg, pCi/g	Calculated
Q_s	=	quantity of dry soil ingested per day by beef cattle	0.72 kg/day	IAEA, 1993
CW	=	contaminant concentration in water	mg/L, pCi/L	Measured; see Table E.1 or E.2.
Q_w	=	quantity of water ingested per day by beef cattle	20 L/day	IAEA, 1993

[a] Based on NCRP, *Screening Techniques for Determining Compliance with Environmental Standards*, National Council on Radiation Protection and Measurements, NCRP Commentary No. 3, Revision of January 1989.

Table E14. Contaminant concentration in milk

Concentration in milk [a]:

$$CM = F_m [(CP \times Q_p) + (CS_1 \times Q_s) + (CW \times Q_w)]$$

where

CM	=	concentration in milk	mg/L or pCi/L	Calculated as above.
F_m	=	transfer coefficient of contaminant in vegetation to contaminant in milk	day/L	$\log F_m = -8.1 + \log K_{ow}$, (for organics) Elemental = NCRP, 1989
CP	=	contaminant concentration in pasture forage	mg/kg or pCi/g	Calculated; see Table E.20.
Q_p	=	quantity of dry forage ingested per day by dairy cattle	16.1 kg/day	IAEA, 1993
CS_1	=	contaminant concentration in dry soil	mg/kg, pCi/g	Measured
CS_2	=	contaminant concentration in dry soil as the result of irrigation	mg/kg, pCi/g	Calculated
Q_s	=	quantity of dry soil ingested per day by dairy cattle	1.61 kg/day	IAEA, 1993
CW	=	contaminant concentration in water	mg/L, pCi/L	Measured
Q_w	=	quantity of water ingested per day by dairy cattle	50 L/day	IAEA, 1993

[a] Based on NCRP, *Screening Techniques for Determining Compliance with Environmental Standards*, National Council on Radiation Protection and Measurements, NCRP Commentary No. 3, Revision of January 1989.

Table E15. Inadvertent ingestion of sediment in the dredging pathway

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CS \times IR \times FI \times ET \times CF \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CS \times IR \times FI \times ET \times CF \times EF \times ED$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CS	=	Concentration in dredged sediments	Chemical-specific (mg/kg, pCi/g, dry wt)	95% UCL on the mean
IR	=	Ingestion rate	0.0002 kg/day or 0.2 g/day	Child (OSWER Directive, EPA 1991a)
			0.0001 kg/day or 0.1 g/day	Adult (OSWER Directive, EPA 1991a)
FI	=	Fraction ingested	1 (unitless)	Maximum value; equivalent to 100%
ET	=	Exposure time	8 hours/day	Estimated; hours per day an individual is exposed to dredged sediment
CF	=	Conversion factor	1 day/24 hours	Necessary to convert to appropriate units
EF	=	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED	=	Exposure duration	6 years	Child exposure (RAGS, EPA 1989b)
			30 years	Adult exposure (RAGS, EPA 1989b)
BW	=	Body weight	15 kg	Child (OSWER Directive, EPA 1991a)
			70 kg	Adult (OSWER Directive, EPA 1991a)
AT	=	Averaging time	365 days/year × ED	Averaging time for non-carcinogens
			365 days/year × 70 years	Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E16. Dermal contact with sediment in the dredging pathway

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CS \times AF \times ABS \times SA \times ET \times CF \times EF \times ED}{BW \times AT}$$

Parameter Explanation

	Parameter	Value used	Explanation/source
CS =	Concentration in dredged sediment	Chemical-specific (mg/kg, dry wt)	Concentration listed in Appendix E
AF =	Adherence factor	0.01 kg/m^2	Unit-adjusted adherence factor for soil 1.0 mg/cm^2 (10^{-6} kg/mg x 10^4 cm^2/m^2) (EPA 1992b)
ABS =	Absorption factor	0.001 (unitless) 0.01 (unitless)	Equivalent to 0.1% for inorganics and 1.0% for organics (EPA 1992b)
SA =	Available surface area		25% of the 95th percentile total body surface area (DEA, EPA 1992a)
	Children Adults	0.2295 m^2/day 0.57 m^2/day	(0.918 m^2/day)(0.25), children (2.28 m^2/day)(0.25), adults
ET =	Exposure time	8 hours/day	Estimated; hours per day an individual is exposed to dredged sediment
CF =	Conversion factor	1 day/24 hours	Necessary to convert to appropriate units
EF =	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED =	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW =	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT =	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E17. Inhalation of resuspended sediment in the dredging pathway

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CA \times IR \times ET \times EF \times ED$$

Where,

$$CA\left(\frac{mg}{m^3}, \frac{pCi}{m^3}\right) = CS \times r_e \times \rho$$

Parameter Explanation

	Parameter	Value used	Explanation/source
CA =	Concentration in air	Chemical-specific (mg/m^3, pCi/m^3)	Concentration calculated as above
CS =	Concentration in dredged sediment	Chemical specific (mg/kg, pCi/g, dry wt)	Measured values listed in Appendix E
r_e =	Soil resuspension constant	2.0E-10 (unitless)	Till & Meyer 1983
ρ =	Soil density	1600 (kg/m^3)	Till & Meyer 1983
IR =	Air inhalation rate	2.0 m^3/hour 2.1 m^3/hour	Moderate child rate (EFH, EPA 1989a) Moderate adult rate (EFH, EPA 1989a)
ET =	Exposure time	8 hours/day	Estimated; hours per day an individual is exposed to dredged sediment
EF =	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED =	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW =	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT =	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens

Table E18. External exposure to radionuclides in sediment in the dredging pathway

$$Dose_{dredging}\left(\frac{pCi \cdot yr}{g}\right) = CS \times \left(\frac{1 - e^{-\lambda_b ED}}{\lambda_b}\right) \times EF \times CF_1 \times ET \times CF_2$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CS	=	Concentration in dredged sediment	Radionuclide-specific (pCi/g, dry wt)	95% UCL on the mean
λ_b	=	Loss rate from decay and harvesting/leaching	Calculated value (1/years)	$\lambda_b = \lambda_i + \lambda_{HL}$ (NCRP 1989)
λ_i	=	Radioactive decay constant	Calculated value (1/years)	$\lambda_i = 0.693/TR$ (NCRP 1989)
λ_{HL}	=	Removal rate for harvesting/leaching	9.9E-03 (1/year)	(2.7E-05/day)(365 days/year) NCRP 1989
TR	=	Radioactive half-life	Radionuclide-specific (years)	BEIAS (IRIS/HEAST databases)
ED	=	Exposure duration	30 years	Adult exposure (RAGS, EPA 1989b)
ET	=	Exposure frequency	8 hours/day	Estimated; hours per day an individual is exposed to dredged sediment
CF_1	=	Conversion factor	1 day/24 hours	Necessary to convert to appropriate units
EF	=	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
CF_2	=	Conversion factor	1 year/365 days	Necessary to convert to appropriate units

Table E19. Modeled concentrations in milk, meat, and vegetables for the dredging pathways for the Clinch River and Poplar Creek

Reach	Chemical type	Chemical	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
1	Inorganic	Arsenic	1.1E-03	1.7E-02	1.3E-02
1	Inorganic	Beryllium	2.7E-06	4.8E-04	7.1E-04
1	Inorganic	Cadmium	1.6E-03	2.9E-04	7.4E-03
1	Inorganic	Chromium	3.6E-04	1.4E-01	6.4E-02
1	Inorganic	Mercury	3.8E-04	3.6E-03	9.4E-03
1	Inorganic	Nickel	9.2E-01	1.3E-01	3.1E-01
1	Inorganic	Selenium	2.3E-02	1.0E-01	1.8E-02
1	Inorganic	Zinc	9.9E+00	4.4E+01	1.2E+01
1	Organic	4,4'-DDD	3.7E-03	5.3E-03	2.0E-03
1	Organic	4,4'-DDT	1.2E-02	1.8E-02	1.1E-03
1	Organic	Benzo(a)anthracene	5.7E-03	8.1E-03	4.7E-03
1	Organic	Benzo(k)fluoranthene	7.5E-02	1.1E-01	1.5E-03
1	Radionuclide	Cesium-137	1.8E+01	4.9E-02	1.0E-02
1	Radionuclide	Cobalt-60	8.7E-01	5.5E-04	4.8E-02
7	Inorganic	Arsenic	2.7E-03	4.0E-02	3.0E-02
7	Inorganic	Barium	1.4E-01	3.0E-02	5.2E-01
7	Inorganic	Beryllium	4.0E-06	7.2E-04	1.1E-03
7	Inorganic	Chromium	6.7E-04	2.7E-01	1.2E-01
7	Inorganic	Manganese	3.8E-01	2.9E+00	1.6E+02
7	Inorganic	Mercury	4.3E-04	4.1E-03	1.1E-02
7	Inorganic	Nickel	1.2E+00	1.7E-01	3.9E-01
7	Inorganic	Selenium	1.2E-01	5.4E-01	9.5E-02
7	Inorganic	Vanadium	7.1E-02	7.3E-02	4.7E-02
7	Inorganic	Zinc	7.1E+00	3.2E+01	8.9E+00
7	Organic	Benzo(a)anthracene	1.6E-03	2.3E-03	1.3E-03
7	Organic	Benzo(a)pyrene	1.2E-02	1.6E-02	2.3E-03
7	Organic	Benzo(b)fluoranthene	9.6E-04	1.4E-03	1.8E-04
7	Organic	Indeno(1,2,3-cd)pyrene	2.1E-03	3.0E-03	9.3E-05
7	Radionuclide	Cesium-137	8.4E+00	2.3E-02	4.7E-03
7	Radionuclide	Strontium-90	3.9E+01	5.6E-02	1.6E-01

Table E19 (continued)

Reach	Chemical type	Chemical	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
2.04	Inorganic	Arsenic	9.8E-04	1.5E-02	1.1E-02
2.04	Inorganic	Barium	1.1E-01	2.5E-02	4.3E-01
2.04	Inorganic	Beryllium	2.6E-06	4.6E-04	6.9E-04
2.04	Inorganic	Chromium	2.9E-04	1.2E-01	5.2E-02
2.04	Inorganic	Manganese	1.1E+00	8.1E+00	4.5E+02
2.04	Inorganic	Mercury	6.9E-04	6.5E-03	1.7E-02
2.04	Inorganic	Nickel	6.1E-01	8.8E-02	2.0E-01
2.04	Inorganic	Selenium	7.9E-02	3.6E-01	6.3E-02
2.04	Inorganic	Vanadium	3.4E-02	3.4E-02	2.2E-02
2.04	Inorganic	Zinc	5.5E+00	2.4E+01	6.8E+00
2.04	Organic	Benzo(a)anthracene	3.6E-03	5.1E-03	3.0E-03
2.04	Organic	Benzo(a)pyrene	9.0E-03	1.3E-02	1.8E-03
2.04	Organic	Benzo(b)fluoranthene	3.1E-03	4.3E-03	5.6E-04
2.04	Organic	Benzo(k)fluoranthene	4.8E-02	6.7E-02	9.3E-04
2.04	Organic	Indeno(1,2,3-cd)pyrene	9.4E-03	1.3E-02	4.1E-04
2.04	Organic	Pentachlorophenol	2.7E-02	3.8E-02	1.2E-02
2.04	Radionuclide	Cesium-137	4.1E+02	1.1E+00	2.3E-01
2.04	Radionuclide	Cobalt-60	2.8E-02	1.8E-05	1.5E-03
2.04	Radionuclide	Strontium-90	6.1E+01	8.7E-02	2.5E-01
2.04	Radionuclide	Uranium-234	9.1E-01	3.5E-04	1.7E-03
2.04	Radionuclide	Uranium-238	8.5E-01	4.2E-04	1.7E-03
3.01	Inorganic	Arsenic	1.3E-04	2.0E-03	1.5E-03
3.01	Inorganic	Barium	5.2E-02	1.1E-02	1.9E-01
3.01	Inorganic	Beryllium	1.7E-06	3.1E-04	4.6E-04
3.01	Inorganic	Chromium	1.9E-04	7.5E-02	3.4E-02
3.01	Inorganic	Manganese	7.7E-02	5.8E-01	3.2E+01
3.01	Inorganic	Nickel	4.1E-01	5.9E-02	1.4E-01
3.01	Inorganic	Vanadium	1.8E-02	1.8E-02	1.2E-02
3.01	Inorganic	Zinc	2.3E+00	1.0E+01	2.8E+00
3.01	Organic	Benzo(b)fluoranthene	3.1E-03	4.4E-03	5.8E-04
3.02	Inorganic	Arsenic	5.1E-04	7.6E-03	5.8E-03

Table E19 (continued)

Reach	Chemical type	Chemical	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
3.02	Inorganic	Barium	9.7E-02	2.1E-02	3.6E-01
3.02	Inorganic	Beryllium	2.6E-06	4.6E-04	6.8E-04
3.02	Inorganic	Cadmium	2.1E-03	3.7E-04	9.3E-03
3.02	Inorganic	Chromium	4.4E-04	1.8E-01	7.9E-02
3.02	Inorganic	Manganese	2.6E-01	1.9E+00	1.1E+02
3.02	Inorganic	Mercury	1.2E-02	1.2E-01	3.1E-01
3.02	Inorganic	Nickel	2.1E+00	3.0E-01	7.0E-01
3.02	Inorganic	Selenium	1.1E-02	4.9E-02	8.6E-03
3.02	Inorganic	Vanadium	3.7E-02	3.8E-02	2.4E-02
3.02	Inorganic	Zinc	9.5E+00	4.2E+01	1.2E+01
3.02	Organic	Benzo(a)anthracene	6.7E-03	9.4E-03	5.5E-03
3.02	Organic	Benzo(a)pyrene	9.6E-03	1.4E-02	1.9E-03
3.02	Organic	Benzo(b)fluoranthene	1.7E-02	2.4E-02	3.1E-03
3.02	Organic	Benzo(k)fluoranthene	3.9E-02	5.5E-02	7.5E-04
3.02	Organic	Dibenz(a,h)anthracene	3.9E-02	5.5E-02	7.6E-04
3.02	Organic	Indeno(1,2,3-cd)pyrene	1.8E-02	2.6E-02	8.0E-04
3.02	Organic	PCB-1248	3.4E-03	4.9E-03	2.1E-03
3.02	Organic	PCB-1254	1.2E-02	1.6E-02	2.9E-03
3.02	Organic	PCB-1260	1.5E-01	2.1E-01	1.2E-03
3.02	Radionuclide	Cesium-137	4.8E+00	1.3E-02	2.7E-03
3.02	Radionuclide	Cobalt-60	2.2E-02	1.4E-05	1.2E-03
3.02	Radionuclide	Strontium-90	4.8E+01	6.9E-02	2.0E-01
3.02	Radionuclide	Technetium-99	6.0E+02	1.9E-01	6.5E+01
3.02	Radionuclide	Uranium-234	7.5E+00	2.9E-03	1.4E-02
3.02	Radionuclide	Uranium-235	3.6E-01	1.8E-04	7.3E-04
3.02	Radionuclide	Uranium-238	4.8E+00	2.4E-03	9.7E-03
3.03	Inorganic	Arsenic	5.3E-04	7.9E-03	6.0E-03
3.03	Inorganic	Barium	1.1E-01	2.3E-02	3.9E-01
3.03	Inorganic	Beryllium	3.1E-06	5.5E-04	8.2E-04
3.03	Inorganic	Cadmium	7.5E-03	1.3E-03	3.4E-02
3.03	Inorganic	Chromium	8.0E-04	3.2E-01	1.4E-01

Table E19 (continued)

Reach	Chemical type	Chemical	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
3.03	Inorganic	Manganese	1.7E-01	1.3E+00	7.0E+01
3.03	Inorganic	Mercury	2.0E-02	1.9E-01	5.0E-01
3.03	Inorganic	Nickel	2.5E+00	3.6E-01	8.3E-01
3.03	Inorganic	Silver	8.1E-04	2.2E-02	1.7E-01
3.03	Inorganic	Vanadium	3.6E-02	3.7E-02	2.3E-02
3.03	Inorganic	Zinc	1.3E+01	5.8E+01	1.6E+01
3.03	Organic	Benzo(a)anthracene	1.7E-03	2.4E-03	1.4E-03
3.03	Organic	Benzo(a)pyrene	2.9E-03	4.1E-03	5.8E-04
3.03	Organic	Benzo(b)fluoranthene	5.5E-03	7.8E-03	1.0E-03
3.03	Organic	Benzo(k)fluoranthene	6.4E-03	9.0E-03	1.2E-04
3.03	Organic	Dibenz(a,h)anthracene	3.4E-03	4.8E-03	6.6E-05
3.03	Organic	Indeno(1,2,3-cd)pyrene	8.6E-03	1.2E-02	3.7E-04
3.03	Radionuclide	Cesium-137	2.3E+01	6.2E-02	1.3E-02
3.03	Radionuclide	Uranium-234	2.4E+00	9.0E-04	4.4E-03
3.03	Radionuclide	Uranium-238	1.4E+00	6.9E-04	2.9E-03
3.04	Inorganic	Arsenic	9.4E-03	1.4E-01	1.1E-01
3.04	Inorganic	Barium	2.5E-01	5.4E-02	9.5E-01
3.04	Inorganic	Beryllium	5.6E-06	1.0E-03	1.5E-03
3.04	Inorganic	Boron	4.2E-01	5.6E-02	1.3E+00
3.04	Inorganic	Cadmium	1.3E-02	2.3E-03	5.7E-02
3.04	Inorganic	Chromium	7.1E-04	2.9E-01	1.3E-01
3.04	Inorganic	Manganese	1.8E-01	1.3E+00	7.4E+01
3.04	Inorganic	Mercury	7.8E-02	7.4E-01	1.9E+00
3.04	Inorganic	Nickel	2.0E+00	2.9E-01	6.7E-01
3.04	Inorganic	Selenium	5.1E-02	2.3E-01	4.1E-02
3.04	Inorganic	Vanadium	9.9E-02	1.0E-01	6.5E-02
3.04	Inorganic	Zinc	9.4E+00	4.2E+01	1.2E+01
3.04	Organic	4-Methylphenol	9.6E-06	1.4E-05	2.1E-01
3.04	Organic	Benzo(a)anthracene	1.2E-03	1.7E-03	9.9E-04
3.04	Organic	Benzo(a)pyrene	4.1E-03	5.7E-03	8.1E-04
3.04	Organic	Benzo(b)fluoranthene	4.6E-03	6.4E-03	8.4E-04

Table E19 (continued)

Reach	Chemical type	Chemical	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
3.04	Organic	Benzo(k)fluoranthene	2.4E-02	3.4E-02	4.7E-04
3.04	Organic	Dibenz(a,h)anthracene	2.4E-02	3.4E-02	4.7E-04
3.04	Organic	Indeno(1,2,3-cd)pyrene	1.3E-02	1.8E-02	5.7E-04
3.04	Organic	PCB-1248	5.8E-04	8.2E-04	3.4E-04
3.04	Organic	PCB-1254	2.8E-03	4.0E-03	7.1E-04
3.04	Organic	PCB-1260	2.4E-02	3.4E-02	1.9E-04
3.04	Radionuclide	Cesium-137	1.5E+02	4.2E-01	8.5E-02
3.04	Radionuclide	Cobalt-60	2.8E-02	1.8E-05	1.5E-03
3.04	Radionuclide	Technetium-99	4.3E+01	1.4E-02	4.7E+00
3.04	Radionuclide	Uranium-234	4.1E+00	1.6E-03	7.7E-03
3.04	Radionuclide	Uranium-235	2.5E-01	1.2E-04	5.1E-04
3.04	Radionuclide	Uranium-238	3.5E+00	1.7E-03	7.0E-03
4.01	Inorganic	Arsenic	1.0E-03	1.5E-02	1.1E-02
4.01	Inorganic	Barium	6.9E-02	1.5E-02	2.6E-01
4.01	Inorganic	Beryllium	2.6E-06	4.6E-04	6.8E-04
4.01	Inorganic	Cadmium	1.5E-03	2.6E-04	6.5E-03
4.01	Inorganic	Chromium	3.3E-04	1.3E-01	6.0E-02
4.01	Inorganic	Manganese	2.0E-01	1.5E+00	8.5E+01
4.01	Inorganic	Mercury	3.7E-02	3.5E-01	9.2E-01
4.01	Inorganic	Nickel	7.7E-01	1.1E-01	2.6E-01
4.01	Inorganic	Selenium	1.2E-02	5.6E-02	9.8E-03
4.01	Inorganic	Silver	4.4E-04	1.2E-02	9.1E-02
4.01	Inorganic	Vanadium	2.7E-02	2.7E-02	1.7E-02
4.01	Inorganic	Zinc	5.3E+00	2.4E+01	6.6E+00
4.01	Organic	Benzo(a)anthracene	3.6E-03	5.1E-03	3.0E-03
4.01	Organic	Benzo(a)pyrene	9.2E-03	1.3E-02	1.8E-03
4.01	Organic	Benzo(b)fluoranthene	9.7E-03	1.4E-02	1.8E-03
4.01	Organic	Benzo(k)fluoranthene	4.7E-02	6.7E-02	9.2E-04
4.01	Organic	Dibenz(a,h)anthracene	4.7E-02	6.7E-02	9.2E-04
4.01	Organic	Indeno(1,2,3-cd)pyrene	2.6E-02	3.7E-02	1.1E-03
4.01	Organic	N-Nitroso-di-n-propylamine	9.4E-06	1.3E-05	7.9E-01

Table E19 (continued)

Reach	Chemical type	Chemical	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
4.01	Organic	PCB-1254	6.3E-03	8.9E-03	1.6E-03
4.01	Organic	PCB-1260	3.9E-01	5.6E-01	3.1E-03
4.01	Organic	Pentachlorophenol	2.7E-02	3.8E-02	1.1E-02
4.01	Radionuclide	Cesium-137	4.4E+02	1.2E+00	2.5E-01
4.01	Radionuclide	Cobalt-60	1.9E-02	1.2E-05	1.0E-03
4.02	Inorganic	Arsenic	1.1E-03	1.7E-02	1.3E-02
4.02	Inorganic	Barium	9.3E-02	2.0E-02	3.5E-01
4.02	Inorganic	Beryllium	2.2E-06	4.0E-04	5.9E-04
4.02	Inorganic	Chromium	2.6E-04	1.0E-01	4.7E-02
4.02	Inorganic	Manganese	1.6E-01	1.2E+00	6.7E+01
4.02	Inorganic	Mercury	1.0E-03	9.9E-03	2.6E-02
4.02	Inorganic	Nickel	5.2E-01	7.6E-02	1.8E-01
4.02	Inorganic	Vanadium	2.0E-02	2.1E-02	1.3E-02
4.02	Inorganic	Zinc	3.8E+00	1.7E+01	4.7E+00
4.02	Radionuclide	Cesium-137	7.7E+00	2.1E-02	4.3E-03
4.03	Inorganic	Arsenic	7.9E-04	1.2E-02	9.0E-03
4.03	Inorganic	Barium	1.1E-01	2.4E-02	4.2E-01
4.03	Inorganic	Beryllium	3.6E-06	6.4E-04	9.6E-04
4.03	Inorganic	Cadmium	1.3E-03	2.4E-04	6.1E-03
4.03	Inorganic	Chromium	6.7E-04	2.7E-01	1.2E-01
4.03	Inorganic	Manganese	3.8E-01	2.8E+00	1.6E+02
4.03	Inorganic	Mercury	1.1E-02	1.0E-01	2.7E-01
4.03	Inorganic	Nickel	1.6E+00	2.3E-01	5.3E-01
4.03	Inorganic	Selenium	3.1E-02	1.4E-01	2.4E-02
4.03	Inorganic	Vanadium	4.5E-02	4.7E-02	3.0E-02
4.03	Inorganic	Zinc	9.3E+00	4.1E+01	1.2E+01
4.03	Organic	Benzo(a)anthracene	8.0E-04	1.1E-03	6.6E-04
4.03	Organic	Benzo(a)pyrene	8.9E-03	1.3E-02	1.8E-03
4.03	Organic	Benzo(b)fluoranthene	3.4E-03	4.8E-03	6.3E-04
4.03	Organic	Dibenz(a,h)anthracene	2.5E-02	3.6E-02	4.9E-04
4.03	Organic	Indeno(1,2,3-cd)pyrene	4.7E-03	6.7E-03	2.0E-04

Table E19 (continued)

Reach	Chemical type	Chemical	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
4.03	Organic	PCB-1254	1.0E-03	1.4E-03	2.5E-04
4.03	Organic	PCB-1260	6.5E-03	9.2E-03	5.1E-05
4.03	Radionuclide	Cesium-137	3.5E+02	9.5E-01	1.9E-01
4.03	Radionuclide	Cobalt-60	5.9E-02	3.8E-05	3.3E-03
4.04	Inorganic	Arsenic	1.0E-03	1.5E-02	1.2E-02
4.04	Inorganic	Barium	1.2E-01	2.6E-02	4.5E-01
4.04	Inorganic	Beryllium	4.1E-06	7.3E-04	1.1E-03
4.04	Inorganic	Cadmium	1.6E-03	2.9E-04	7.4E-03
4.04	Inorganic	Chromium	4.7E-04	1.9E-01	8.5E-02
4.04	Inorganic	Manganese	4.0E-01	3.0E+00	1.7E+02
4.04	Inorganic	Mercury	9.3E-03	8.9E-02	2.3E-01
4.04	Inorganic	Nickel	1.4E+00	2.0E-01	4.7E-01
4.04	Inorganic	Selenium	2.7E-02	1.2E-01	2.2E-02
4.04	Inorganic	Vanadium	4.8E-02	4.9E-02	3.1E-02
4.04	Inorganic	Zinc	1.1E+01	5.1E+01	1.4E+01
4.04	Organic	Benzo(a)anthracene	2.2E-03	3.1E-03	1.8E-03
4.04	Organic	Benzo(a)pyrene	1.9E-02	2.7E-02	3.7E-03
4.04	Organic	Benzo(b)fluoranthene	3.0E-03	4.3E-03	5.5E-04
4.04	Organic	Dibenz(a,h)anthracene	3.3E-01	4.7E-01	6.5E-03
4.04	Organic	Indeno(1,2,3-cd)pyrene	5.1E-02	7.2E-02	2.2E-03
4.04	Organic	PCB-1254	1.5E-02	2.2E-02	3.8E-03
4.04	Radionuclide	Cesium-137	2.4E+02	6.5E-01	1.3E-01
4.04	Radionuclide	Cobalt-60	3.4E-02	2.2E-05	1.9E-03
4.04	Radionuclide	Strontium-90	1.6E+01	2.2E-02	6.5E-02
4.04	Radionuclide	Uranium-234	1.5E+00	5.7E-04	2.8E-03
4.04	Radionuclide	Uranium-238	1.3E+00	6.4E-04	2.6E-03

Table E20. Ingestion of produce, meat, and milk in the dredging pathway

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CP \times IR \times FI \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CP \times IR \times FI \times EF \times ED$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CP	=	Concentration in produce (vegetables and meat) (milk)	Calculated value (mg/kg, pCi/g, wet wt) (mg/L, pCi/L)	Modeled values based on equation outlined in Table E.19.
IR	=	Produce ingestion rate	0.2 kg/day	Vegetables, children and adults (Exposure Factors Handbook, EPA 1989)
			0.1 kg/day	Meat, children and adults (Exposure Factors Handbook, EPA 1989)
			1.0 L/day	Milk, children (based on water ingestion, OSWER Directive, EPA 1991a)
			0.5 L/day	Milk, adults (ICRP 23, 1975)
FI	=	Fraction ingested	0.4 (unitless)	Vegetables, reasonable worst case
			0.75 (unitless)	Beef and Milk, reasonable worst case (OSWER Directive, EPA 1991a)
EF	=	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED	=	Exposure duration	6 years	Child exposure (RAGS, EPA 1989b)
			30 years	Adult exposure (RAGS, EPA 1989b)
BW	=	Body weight	15 kg	Child (OSWER Directive, EPA 1991a)
			70 kg	Adult (OSWER Directive, EPA 1991a)
AT	=	Averaging time	365 days/year × ED	Averaging time for non-carcinogens
			365 days/year × 70 years	Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E21. Inadvertent ingestion of irrigated soil

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CS \times IR \times FI \times ET \times CF \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CS \times IR \times FI \times ET \times CF \times EF \times ED$$

Where,

$$CS_{irrigated}\left(\frac{mg}{kg}, \frac{pCi}{g}\right) = \frac{(CW)(I_r)(F)(1 - e^{-\lambda_B t_b})}{P\,\lambda_B}$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CS	=	Concentration in irrigated soil	Calculated value (mg/kg, pCi/g, dry wt)	Modeled value, as above
CW	=	Concentration in water	Contaminant-specific (mg/L, pCi/L)	95% UCL on the mean
I_r	=	Rate of irrigation	1321.3 L/m^2-year	(3.62 L/m^2/day) (365 days/year) Roane County Extension Agent
F	=	Fraction of the year irrigation occurs	0.25 (unitless)	Based on 3 months/year
λ_B	=	Loss rate from decay and harvesting/leaching	Calculated value (1/years)	$\lambda_B = \lambda_i + \lambda_{HL}$ (NCRP 1989)
λ_i	=	Radioactive decay constant	Calculated value (1/years)	$\lambda_i = 0.693/TR$ (NCRP 1989)
TR	=	Radioactive half-life	Radionuclide-specific (years)	BEIAS (IRIS/HEAST databases)
λ_{HL}	=	Removal rate for harvesting/leaching	9.9E-03 (1/year)	(2.7E-05/day)(365 days/year) NCRP 1989
t_b	=	Time of long-term build up in irrigated soil	30 years	NCRP 1989
P	=	Areal density for effective root zone (15-cm depth)	240 kg/m^2	Till & Meyer 1983

Table E21 (continued)

Parameter Explanation (continued)

	Parameter	Value used	Explanation/source
IR =	Soil ingestion rate	0.0002 kg/day, or 0.2 g/day 0.0001 kg/day, or 0.1 g/day	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
FI =	Fraction ingested	1 (unitless)	Maximum value; equivalent to 100%
ET =	Exposure time	8 hours/day	Estimated; hours per day an individual is exposed to irrigated soil
CF =	Conversion factor	1 day/24 hours	Necessary to convert to appropriate units
EF =	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED =	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW =	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT =	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E22. Dermal contact with soil in the irrigation pathway

$$CS_{irrigated}\left(\frac{mg}{kg}\right) = \frac{(CW)(I_r)(F)(1 - e^{-\lambda_b t_b})}{P\,\lambda_b}$$

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CS \times AF \times ABS \times SA \times ET \times CF \times EF \times ED}{BW \times AT}$$

Parameter Explanation

	Parameter	Value used	Explanation/source
CS =	Concentration in irrigated soil	Contaminant-specific (mg/kg, dry wt)	Calculated as specified above
CW =	Concentration in surface water	Contaminant-specific (mg/L)	95% UCL on the mean
I_r =	Rate of irrigation	1321.3 L/m²-year	(3.62 L/m²-day)(365 days/year) Roane County Extension Agent
F =	Fraction of the year irrigation occurs	0.25 (unitless)	Based on 3 months/year
λ_b =	Loss rate from decay and harvesting/leaching	Calculated value (1/years)	$\lambda_b = \lambda_i + \lambda_{HL}$ (NCRP 1989)
λ_i =	Radioactive decay constant	Calculated value (1/years)	$\lambda_i = 0.693/TR$ (NCRP 1989)
λ_{HL} =	Removal rate for harvesting/leaching	9.9E-03 (1/year)	(2.7E-05/day)(365 days/year) NCRP 1989
TR =	Radioactive half-life	Radionuclide-specific (years)	BEIAS (IRIS/HEAST databases)
t_b =	time of long-term build up in irrigated soil	30 years	NCRP 1989
P =	areal density for effective root zone (15 cm depth)	240 kg/m²	Till & Meyer, 1983
AF =	Adherence factor	0.01 kg/m²	Unit-adjusted adherence factor for soil 1.0 mg/cm² (10^{-6} kg/mg x 10^4 cm²/m²) (EPA 1992b)

Table E22 (continued)

Parameter Explanation

	Parameter	Value used	Explanation/source
ABS =	Absorption factor	0.001 (unitless) 0.01 (unitless)	Equivalent to 0.1% for inorganics and 1.0% for organics (EPA 1992b)
SA =	Available surface area	0.2295 m^2/day 0.57 m^2/day	(0.918 m^2/day)(0.25), children (2.28 m^2/day)(0.25), adults 25% of the 95th percentile total body surface area (DEA, EPA 1992a)
ET =	Exposure time	8 hours/day	Estimated; fraction of a day an individual is exposed to irrigated soil
CF =	Conversion factor	1 day/24 hours	Necessary to convert to appropriate units
EF =	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED =	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW =	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT =	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E23. Inhalation of resuspended soil in the irrigation pathway

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CA \times IR \times ET \times EF \times ED$$

$$Where, \quad CA\left(\frac{mg}{m^3}, \frac{pCi}{m^3}\right) = CS \times r_e \times \rho$$

$$Where, \quad CS_{irrigated} = \frac{(CW)(I_r)(F)(1 - e^{-\lambda_b t_b})}{P\,\lambda_b}$$

Parameter Explanation

		Parameter	Value used	Explanation/source
CA	=	Concentration in air	Chemical-specific (mg/m^3, pCi/m^3)	Concentration calculated as above
CS	=	Concentration in irrigated soil	Chemical specific (mg/kg, pCi/g, dry wt)	Measured values listed in Appendix E
r_e	=	Soil resuspension	2.0E-10 (unitless)	Till & Meyer 1983
ρ	=	Soil density	1600 (kg/m^3)	Till & Meyer 1983
CW	=	Concentration in surface water	Contaminant-specific (mg/L, pCi/L)	95% UCL on the mean
I_r	=	Rate of irrigation	1321.3 L/m^2-year	(3.62 L/m^2-day)(365 days/year) Roane County Extension Agent
F	=	Fraction of the year irrigation occurs	0.25 (unitless)	Based on 3 months/year
λ_b	=	Loss rate from decay and harvesting/leaching	Calculated value (1/years)	$\lambda_b = \lambda_i + \lambda_{HL}$ (NCRP 1989)
λ_i	=	Radioactive decay constant	Calculated value (1/years)	$\lambda_i = 0.693/TR$ (NCRP 1989)
λ_{HL}	=	Removal rate for harvesting/leaching	9.9E-03 (1/year)	(2.7E-05/day)(365 days/year) NCRP 1989

Table E23 (continued)

Parameter Explanation

		Parameter	Value used	Explanation/source
TR	=	Radioactive half-life	Radionuclide-specific (years)	BEIAS (IRIS/HEAST databases)
t_b	=	time of long-term build in the soil	30 years	NCRP 1989
P	=	areal density for effective root zone (15 cm depth)	240 kg/m^2 or 240,000 g/m^2	Till & Meyer 1983
IR	=	Air inhalation rate	2.0 m^3/hour 2.1 m^3/hour	Moderate child rate (EFH, EPA 1989a) Moderate adult rate (EFH, EPA 1989a)
ET	=	Exposure time	8 hours/day	Estimated; hours per day an individual is exposed to irrigated soil
EF	=	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED	=	Exposure duration	6 years 30 years	Child exposure (RAGS, EPA 1989b) Adult exposure (RAGS, EPA 1989b)
BW	=	Body weight	15 kg 70 kg	Child (OSWER Directive, EPA 1991a) Adult (OSWER Directive, EPA 1991a)
AT	=	Averaging time	365 days/year × ED 365 days/year × 70 years	Averaging time for non-carcinogens Averaging time for carcinogens

Table E24. External exposure to radionuclides in soil in the irrigation pathway

$$CS_{irrigated} = \frac{(CW)(I_r)(F)(1 - e^{-\lambda_b t_b})}{P\,\lambda_b}$$

$$Dose_{irrigated}\left(\frac{pCi \cdot yr}{g}\right) = CS \times ET \times CF_1 \times EF \times CF_2 \times ED$$

Parameter Explanation

Parameter			Value used	Explanation/source
CS	=	Concentration in irrigated soil	Radionuclide-specific (pCi/g, dry wt)	Calculated as specified above
CW	=	Concentration in surface water	Contaminant-specific (pCi/L)	95% UCL on the mean
I_r	=	Rate of irrigation	1321.3 L/m²-year	(3.62 L/m²-day)(365 days/year) Roane County Extension Agent
F	=	Fraction of the year irrigation occurs	0.25 (unitless)	Based on 3 months/year
λ_b	=	Loss rate from decay and harvesting/leaching	Calculated value (1/years)	$\lambda_b = \lambda_i + \lambda_{HL}$ (NCRP 1989)
λ_i	=	Radioactive decay constant	Calculated value (1/years)	$\lambda_i = 0.693/TR$ (NCRP 1989)
λ_{HL}	=	Removal rate for harvesting/leaching	9.9E-03 (1/year)	(2.7E-05/day)(365 days/year) NCRP 1989
TR	=	Radioactive half-life	Radionuclide-specific (years)	BEIAS (IRIS/HEAST databases)
t_b	=	time of long-term build up in irrigated soil	30 years	NCRP 1989
P	=	areal density for effective root zone (15 cm)	240 kg/m² or	Till & Meyer 1983
ED	=	Exposure duration	30 years	Adult exposure (RAGS, EPA 1989b)
ET	=	Exposure time	8 hours/day	Estimated; hours per day an individual is exposed to irrigated soil
CF_1	=	Conversion factor	1 day/24 hours	Necessary to convert to appropriate units
EF	=	Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
CF_2	=	Conversion factor	1 year/365 days	Necessary to convert to appropriate units

Table E25. Modeled concentrations in soil, milk, meat, and vegetables for the irrigation pathways for surface water collected in the Clinch River

Reach	Chemical type	Chemical	Concentration in Soil (pCi/g, mg/kg)	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
1	Inorganic	Arsenic	4.3E-02	4.3E-05	6.3E-04	1.0E-02
1	Inorganic	Nitrate	1.8E+02	6.1E+02	8.2E+02	3.8E+02
1	Radionuclide	Cobalt-60	3.7E+01	1.5E-01	9.5E-05	3.4E-02
1	Radionuclide	Strontium-90	2.8E+01	2.1E+00	3.0E-03	1.2E-02
2	Inorganic	Nickel	1.5E-01	4.2E-02	6.0E-03	3.8E-02
2	Inorganic	Nitrate	1.2E+02	4.1E+02	5.5E+02	2.5E+02
2	Organic	Acetone	5.0E-01	2.0E-06	2.8E-06	6.8E+00
2	Radionuclide	Cesium-137	3.2E+01	6.0E+00	1.6E-02	1.1E-02
2	Radionuclide	Strontium-90	2.2E+02	1.7E+01	2.4E-02	9.2E-02
2	Radionuclide	Tritium	1.5E+05	4.3E+03	4.3E+00	4.3E+00
4	Inorganic	Antimony	5.9E-02	2.5E-05	1.7E-05	1.4E-02
4	Inorganic	Arsenic	4.4E-02	4.4E-05	6.5E-04	1.1E-02
4	Inorganic	Nitrate	1.6E+02	5.4E+02	7.2E+02	3.3E+02
4	Radionuclide	Cesium-137	4.7E+01	8.9E+00	2.4E-02	1.6E-02
4	Radionuclide	Cobalt-60	4.8E+01	2.0E-01	1.2E-04	4.4E-02
4	Radionuclide	Strontium-90	5.0E+01	3.8E+00	5.4E-03	2.1E-02
4	Radionuclide	Uranium - radioactive	7.6E+01	5.2E-01	2.5E-04	1.8E-02
7	Inorganic	Arsenic	8.4E-02	8.3E-05	1.2E-03	2.0E-02
7	Inorganic	Nickel	1.4E-01	3.9E-02	5.6E-03	3.6E-02
7	Radionuclide	Strontium-90	5.5E+01	4.2E+00	6.0E-03	2.3E-02

Table E26. Modeled concentrations in soil, milk, meat, and vegetables for the irrigation pathways for surface water collected in Poplar Creek

Reach	Chemical type	Chemical	Concentration in Soil (pCi/g, mg/kg)	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
3.01	Inorganic	Antimony	5.1E-02	2.1E-05	1.5E-05	1.2E-02
3.01	Inorganic	Manganese	3.2E+00	2.2E-03	1.7E-02	1.1E+00
3.01	Inorganic	Nickel	1.7E-01	4.7E-02	6.7E-03	4.3E-02
3.01	Organic	PCB-1254	1.0E-02	1.5E-03	2.1E-03	2.6E-03
3.01	Radionuclide	Strontium-90	5.7E+01	4.4E+00	6.2E-03	2.3E-02
3.02	Inorganic	Antimony	6.8E-02	2.8E-05	2.0E-05	1.7E-02
3.02	Inorganic	Arsenic	1.1E-01	1.1E-04	1.6E-03	2.6E-02
3.02	Inorganic	Boron	2.4E+00	1.2E-01	1.6E-02	6.6E-01
3.02	Inorganic	Manganese	3.2E+00	2.2E-03	1.6E-02	1.1E+00
3.02	Inorganic	Nickel	1.5E-01	4.2E-02	6.0E-03	3.8E-02
3.02	Organic	Di-n-octylphthlate	3.6E-01	7.5E+01	1.0E+02	8.7E-02
3.02	Radionuclide	Strontium-90	3.9E+01	3.0E+00	4.2E-03	1.6E-02
3.03	Inorganic	Arsenic	5.2E-02	5.2E-05	7.7E-04	1.3E-02
3.03	Inorganic	Manganese	3.2E+00	2.2E-03	1.6E-02	1.1E+00
3.03	Inorganic	Nickel	1.5E-01	4.2E-02	6.0E-03	3.9E-02
3.03	Inorganic	Nitrate	1.8E+02	6.2E+02	8.3E+02	3.8E+02
3.03	Organic	Acetone	4.6E-01	1.9E-06	2.6E-06	6.3E+00
3.03	Radionuclide	Cesium-137	3.9E+01	7.4E+00	2.0E-02	1.3E-02
3.03	Radionuclide	Strontium-90	6.3E+01	4.9E+00	6.9E-03	2.6E-02
3.04	Inorganic	Antimony	6.2E-02	2.6E-05	1.9E-05	1.5E-02

Table E26 (continued)

Reach	Chemical type	Chemical	Concentration in Soil (pCi/g, mg/kg)	Concentration in Milk (pCi/L, mg/L)	Concentration in Meat (pCi/g, mg/kg)	Concentration in Vegetables (pCi/g, mg/kg)
3.04	Inorganic	Arsenic	4.3E-02	4.3E-05	6.3E-04	1.0E-02
3.04	Inorganic	Manganese	3.2E+00	2.2E-03	1.6E-02	1.1E+00
3.04	Inorganic	Molybdenum	1.8E-01	5.5E-03	1.4E-03	4.8E-02
3.04	Inorganic	Nickel	1.5E-01	4.2E-02	6.1E-03	3.9E-02
3.04	Organic	PCB-1254	7.5E-03	1.1E-03	1.5E-03	1.9E-03
3.04	Radionuclide	Strontium-90	4.3E+02	3.3E+01	4.7E-02	1.8E-01

Table E27. Ingestion of produce, meat, and milk in the irrigation pathway

$$Intake_{nonradionuclides}\left(\frac{mg}{kg \cdot day}\right) = \frac{CP \times IR \times FI \times EF \times ED}{BW \times AT}$$

$$Intake_{radionuclides}(pCi) = CP \times IR \times FI \times EF \times ED$$

Parameter Explanation

	Parameter	Value used	Explanation/source
CP	= Concentration in produce (vegetables and meat) (milk)	Calculated value (mg/kg, pCi/kg, wet wt) (mg/L, pCi/L)	Modeled values based on the equations outlined in Tables E.19. to E.22.
IR	= Produce ingestion rate	0.2 kg/day	Vegetables, children and adults (Exposure Factors Handbook, EPA 1989)
		0.1 kg/day	Meat, children and adults (Exposure Factors Handbook, EPA 1989)
		1.0 L/day	Milk, children (based on water ingestion, OSWER Directive, EPA 1991a)
		0.5 L/day	Milk, adults (ICRP 23, 1975)
FI	= Fraction ingested	0.4 (unitless)	Vegetables, reasonable worst case
		0.75 (unitless)	Beef and Milk, reasonable worst case (OSWER Directive, EPA 1991a)
EF	= Exposure frequency	350 days/year	OSWER Directive, EPA 1991a
ED	= Exposure duration	6 years	Child exposure (RAGS, EPA 1989b)
		30 years	Adult exposure (RAGS, EPA 1989b)
BW	= Body weight	15 kg	Child (OSWER Directive, EPA 1991a)
		70 kg	Adult (OSWER Directive, EPA 1991a)
AT	= Averaging time	365 days/year × ED	Averaging time for non-carcinogens
		365 days/year × 70 years	Averaging time for carcinogens (RAGS, EPA 1989b; EPA 1991a)

Table E28. Log K_{ow} and transfer coefficients used in food chain models

Chemical	Log Kow	Meat Transfer Coefficient	Milk Transfer Coefficient	Pasture Transfer Coefficient	Vegetable Transfer Coefficient
Acenaphthene	4.33E+00	2.51E-04	7.94E-05	1.89E-01	4.72E-02
Acenaphthylene					
Acetone	-2.40E-01	1.46E-08	4.61E-09	5.31E+01	1.33E+01
Aldrin	3.01E+00	8.51E-02	2.40E-02	3.34E-02	8.36E-03
Aluminum					
Am-241		4.00E-05	1.50E-06	4.00E-03	1.00E-03
Anthracene	4.45E+00	7.08E-04	2.24E-04	1.04E-01	2.59E-02
Antimony (metallic)		4.00E-05	2.50E-05	5.00E-02	1.00E-02
Aroclor 1254	6.03E+00	5.25E-02	1.12E-02	1.25E-02	3.12E-03
Aroclor-1248	5.76E+00	1.44E-02	4.57E-03	1.82E-02	4.54E-03
Aroclor-1260	7.15E+00	3.54E-01	1.12E-01	2.86E-03	7.14E-04
Arsenic, Inorganic		2.00E-03	6.00E-05	6.00E-03	1.50E-03
Barium		2.30E-04	4.80E-04	1.00E-01	1.00E-02
Be-7		1.00E-03	9.00E-07	1.50E-03	3.75E-04
Benz[a]anthracene	5.66E+00	1.00E-02	3.16E-03	2.25E-02	5.61E-03
Benzo[a]pyrene	6.10E+00	2.89E-02	9.13E-03	1.22E-02	3.04E-03
Benzo[b]fluoranthene	6.12E+00	2.89E-02	9.13E-03	1.22E-02	3.04E-03
Benzo[g,h,i]perylene	6.58E+00				
Benzo[k]fluoranthene	6.84E+00	2.89E-02	9.13E-03	1.22E-02	3.04E-03
Benzoic Acid	1.87E+00	1.86E-06	5.89E-07	3.22E+00	8.04E-01
Beryllium		8.00E-04	2.00E-06	1.88E-03	4.70E-04
Bis(2-ethylhexyl)phthalate	4.89E+00	1.03E-07	3.26E-08	1.71E+01	4.28E+00
Boron And Borates Only		8.00E-04	2.70E-03	4.80E-01	1.20E-01
Butyl Benzyl Phthlate	4.91E+00				
Cadmium (Diet)		4.00E-04	1.00E-03	1.50E-01	3.75E-02
Carbazole	3.76E+00	1.45E-04	4.57E-05	2.60E-01	6.50E-02
Carbon Disulfide	2.24E+00	2.51E-06	7.94E-07	2.70E+00	6.76E-01
Chlordane, Total	5.54E+00	7.41E-03	3.72E-04	6.68E-02	1.67E-02
Chloroform	1.97E+00	2.34E-06	7.41E-07	2.81E+00	7.04E-01
Chromium		9.00E-03	1.00E-05	4.00E-02	1.00E-02
Chrysene	5.66E+00	1.02E-02	3.23E-03	2.22E-02	5.54E-03

Table E28 (continued)

Chemical	Log Kow	Meat Transfer Coefficient	Milk Transfer Coefficient	Pasture Transfer Coefficient	Vegetable Transfer Coefficient
Cm-248		4.00E-05	1.50E-06	4.00E-03	1.00E-03
Co-60		1.00E-04	7.00E-05	4.00E-01	3.00E-02
Cobalt					
Copper		9.00E-03	1.50E-03	2.50E-01	6.25E-02
Cresol, p-	1.94E+00	2.14E-06	6.76E-07	2.97E+00	7.42E-01
Cs-137+D		5.12E-02	8.38E-03	2.00E-01	4.00E-02
Curium 243/244		4.00E-05	1.50E-06	4.00E-03	1.00E-03
Curium 245/246		4.00E-05	1.50E-06	4.00E-03	1.00E-03
DDD	5.80E+00	1.26E-02	3.02E-03	1.01E-02	2.53E-03
DDE	5.69E+00	4.90E-02	9.55E-03	3.48E-03	8.71E-04
DDT	6.36E+00	2.82E-02	1.07E-02	1.02E-02	2.56E-03
Dibenz[a,h]anthracene	6.84E+00	1.02E-02	3.23E-03	2.22E-02	5.54E-03
Dibutyl Phthalate	4.90E+00	1.00E-02	3.18E-03	2.24E-02	5.60E-03
Diethyl Phthalate	2.47E+00	7.23E-06	2.29E-06	1.47E+00	3.67E-01
Fluoranthene	4.95E+00	1.99E-03	6.31E-04	5.70E-02	1.43E-02
Fluorene	4.38E+00	3.97E-04	1.26E-04	1.45E-01	3.62E-02
H-3		0.00	1.50E-02	0.00	0.00
Heptachlor	4.27E+00	1.55E-02	3.24E-03	1.11E-01	2.77E-02
Indeno[1,2,3-cd]pyrene	6.58E+00	7.94E-02	2.51E-02	6.78E-03	1.70E-03
Iron					
K-40		1.80E-02	7.20E-03	3.00E+00	3.00E-01
Lead And Compounds		4.00E-04	2.50E-04	3.20E-03	8.00E-04
Magnesium					
Manganese (Diet)		5.00E-04	3.00E-05	3.00E+00	4.00E-01
Mercury, Inorganic		1.00E-02	4.70E-04	1.00E+00	3.00E-01
Methoxychlor	4.40E+00	5.02E-04	1.48E-04	1.26E-01	3.16E-02
Methyl Ethyl Ketone	2.75E-01	4.72E-08	1.49E-08	2.69E+01	6.72E+00
Methyl Mercury					
Molybdenum		1.00E-03	1.70E-03	4.00E-01	1.00E-01
Naphthalene	3.30E+00	4.27E-05	2.00E-04	5.26E-01	1.31E-01
Naphthalene, 2-Methyl					

Table E28 (continued)

Chemical	Log Kow	Meat Transfer Coefficient	Milk Transfer Coefficient	Pasture Transfer Coefficient	Vegetable Transfer Coefficient
Nickel Soluble Salts		5.20E-03	1.60E-02	2.00E-01	5.00E-02
Nitrate		7.50E-02	2.50E-02	3.00E+01	7.50E+00
Nitrophenol, 4-					
Octyl Phthalate, di-N-	9.20E+00	1.86E+02	5.89E+01	7.64E-05	1.91E-05
Pentachlorophenol	5.86E+00	2.51E-03	7.94E-04	4.99E-02	1.25E-02
Phenanthrene	4.57E+00	7.23E-04	2.29E-04	1.02E-01	2.56E-02
Phenol	1.46E+00	7.23E-07	2.29E-07	5.55E+00	1.39E+00
Plutonium-239/240		1.80E-05	1.10E-06	1.00E-03	5.00E-04
Pu-238		1.80E-05	1.10E-06	1.00E-03	5.00E-04
Pyrene	4.88E+00	5.25E-03	1.66E-03	3.26E-02	8.15E-03
Selenium		1.00E-01	1.00E-02	5.00E-01	1.00E-01
Silver		3.00E-03	5.00E-05	1.00E+00	2.00E-01
Sr-90+D		9.00E-03	2.82E-03	4.01E+00	3.02E-01
Sulfate					
Tc-99		1.00E-04	1.40E-04	4.00E-01	5.00E+00
Thallium					
Toluene	2.73E+00	1.35E-05	4.27E-06	1.02E+00	2.56E-01
Trichloroethylene	2.42E+00	6.03E-06	1.91E-06	1.63E+00	4.08E-01
U-234		3.40E-04	4.00E-04	1.00E-02	2.00E-03
U-235+D		4.40E-04	4.05E-04	1.10E-02	2.50E-03
Uranium					
Uranium-238		4.50E-04	4.10E-04	1.13E-02	2.56E-03
Vanadium, Metallic		2.30E-03	1.00E-03	5.20E-03	1.30E-03
Zinc (Metallic)		1.00E-01	1.00E-02	1.00E+00	4.00E-01

Table E29. Chemicals with an excess cancer risk (ECR) of >10^{-6} and pathway totals for the drinking water ingestion pathway for the Clinch River

Reach	Chemical Type	Chemical	Representative Concentration (pCi/g, mg/kg)	Ingestion ECR
1	Inorganic	Arsenic	1.2E-03	2.1E-05
1	Radionuclide	Cobalt-60	3.9E+00	1.5E-06
1	Radionuclide	Uranium - radioactive	1.2E+00	1.5E-06
1	Radionuclide	Strontium-90	1.1E+00	1.3E-06
1	Radionuclide	Tritium	6.7E+02	1.0E-06
1			Pathway Total	2.6E-05
2	Radionuclide	Tritium	8.5E+03	1.3E-05
2	Radionuclide	Strontium-90	8.6E+00	1.0E-05
2			Pathway Total	2.3E-05
4	Inorganic	Arsenic	1.2E-03	2.2E-05
4	Radionuclide	Uranium - radioactive	2.1E+00	2.8E-06
4	Radionuclide	Strontium-90	1.9E+00	2.3E-06
4	Radionuclide	Cobalt-60	5.0E+00	2.0E-06
4	Radionuclide	Cesium-137	1.8E+00	1.2E-06
4			Pathway Total	3.0E-05
7.01	Inorganic	Arsenic	5.2E-03	9.3E-05
7.01			Pathway Total	9.3E-05
7.02	Inorganic	Arsenic	1.3E-03	2.3E-05
7.02	Radionuclide	Strontium-90	2.4E+00	2.9E-06
7.02			Pathway Total	2.6E-05

Table E30. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the adult drinking water ingestion pathway for the Clinch River

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Adult Ingestion HQ
1	Inorganic	Manganese	6.3E-02	3.4E-01
1	Inorganic	Arsenic	1.2E-03	1.1E-01
1			Hazard Index	4.5E-01
2	Inorganic	Manganese	7.0E-02	3.8E-01
2			Hazard Index	3.8E-01
4	Inorganic	Manganese	5.9E-02	3.2E-01
4	Inorganic	Arsenic	1.2E-03	1.1E-01
4	Inorganic	Antimony	1.6E-03	1.1E-01
4			Hazard Index	5.5E-01
7.01	Inorganic	Manganese	5.7E-02	3.1E-01
7.01	Inorganic	Arsenic	5.2E-03	4.7E-01
7.01			Hazard Index	7.8E-01
7.02	Inorganic	Manganese	7.7E-02	4.2E-01
7.02	Inorganic	Arsenic	1.3E-03	1.2E-01
7.02			Hazard Index	5.4E-01

Table E31. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the child drinking water ingestion pathway for the Clinch River

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Child Ingestion HQ
1	Inorganic	Manganese	6.3E-02	8.0E-01
1	Inorganic	Arsenic	1.2E-03	2.6E-01
1	Inorganic	Nitrate	5.0E+00	2.0E-01
1			Hazard Index	1.3E+00
2	Inorganic	Manganese	7.0E-02	9.0E-01
2	Inorganic	Nitrate	3.4E+00	1.3E-01
2			Hazard Index	1.0E+00
4	Inorganic	Manganese	5.9E-02	7.5E-01
4	Inorganic	Arsenic	1.2E-03	2.6E-01
4	Inorganic	Antimony	1.6E-03	2.6E-01
4	Inorganic	Nitrate	4.4E+00	1.7E-01
4			Hazard Index	1.5E+00
7.01	Inorganic	Manganese	5.7E-02	7.2E-01
7.01	Inorganic	Arsenic	5.2E-03	1.1E+00
7.01			Hazard Index	1.8E+00
7.02	Inorganic	Manganese	7.7E-02	9.8E-01
7.02	Inorganic	Arsenic	1.3E-03	2.8E-01
7.02			Hazard Index	1.3E+00

Table E32. Chemicals with an excess cancer risk (ECR) of >10^{-6} and pathway totals for the drinking water ingestion pathway for Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration (pCi/g, mg/kg)	Ingestion ECR
3.01	Radionuclide	Tritium	1.9E+03	2.8E-06
3.01	Radionuclide	Strontium-90	2.2E+00	2.6E-06
3.01			Pathway Total	5.4E-06
3.02	Inorganic	Arsenic	3.0E-03	5.3E-05
3.02	Radionuclide	Strontium-90	1.5E+00	1.8E-06
3.02	Radionuclide	Tritium	8.2E+02	1.2E-06
3.02			Pathway Total	5.6E-05
3.03	Inorganic	Arsenic	1.5E-03	2.6E-05
3.03	Organic	Bis(2-ethylhexyl)phthalate	1.0E-02	1.6E-06
3.03	Radionuclide	Strontium-90	2.4E+00	2.9E-06
3.03	Radionuclide	Uranium - radioactive	1.7E+00	2.3E-06
3.03	Radionuclide	Uranium-234	1.9E+00	1.7E-06
3.03	Radionuclide	Tritium	8.8E+02	1.3E-06
3.03			Pathway Total	3.5E-05
3.04	Inorganic	Arsenic	1.2E-03	2.1E-05
3.04	Radionuclide	Strontium-90	1.7E+01	1.9E-05
3.04			Pathway Total	4.1E-05

Table E33. Chemicals with a hazard quotient (HQ) >0.1 and hazard indices for the adult drinking water ingestion pathway for Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration	Adult Ingestion HQ
3.01	Inorganic	Manganese	9.1E-02	5.0E-01
3.01	Organic	PCB-1254	2.9E-04	4.0E-01
3.01			Hazard Index	9.0E-01
3.02	Inorganic	Manganese	8.9E-02	4.9E-01
3.02	Inorganic	Arsenic	3.E-03	2.7E-01
3.02	Inorganic	Antimony	1.9E-03	1.3E-01
3.02			Hazard Index	8.9E-01
3.03	Inorganic	Manganese	8.9E-02	4.9E-01
3.03	Inorganic	Arsenic	1.5E-03	1.3E-01
3.03			Hazard Index	6.2E-01
3.04	Inorganic	Manganese	8.9E-02	4.9E-01
3.04	Inorganic	Antimony	1.7E-03	1.2E-01
3.04	Inorganic	Arsenic	1.2E-03	1.1E-01
3.04	Organic	PCB-1254	2.1E-04	2.9E-01
3.04			Hazard Index	1.0E+00

Table E34. Chemicals with a hazard quotient (HQ) >0.1 and hazard indices for the child drinking water ingestion pathway for Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration	Child Ingestion HQ
3.01	Inorganic	Manganese	9.1E-02	1.2E+00
3.01	Inorganic	Antimony	1.4E-03	2.3E-01
3.01	Organic	PCB-1254	2.9E-04	9.3E-01
3.01			Hazard Index	2.3E+00
3.02	Inorganic	Manganese	8.9E-02	1.1E+00
3.02	Inorganic	Arsenic	3.E-03	6.4E-01
3.02	Inorganic	Antimony	1.9E-03	3.0E-01
3.02			Hazard Index	2.1E+00
3.03	Inorganic	Manganese	8.9E-02	1.1E+00
3.03	Inorganic	Arsenic	1.5E-03	3.1E-01
3.03	Inorganic	Nitrate	5.1E+00	2.0E-01
3.03			Hazard Index	1.7E+00
3.04	Inorganic	Manganese	8.9E-02	1.1E+00
3.04	Inorganic	Antimony	1.7E-03	2.8E-01
3.04	Inorganic	Arsenic	1.2E-03	2.6E-01
3.04	Organic	PCB-1254	2.1E-04	6.7E-01
3.04			Hazard Index	2.3E+00

Table E35. Chemicals with an excess cancer risk (ECR) of >10^{-6} and pathway totals for the near-shore sediment pathways for selected subreaches of the Clinch River and Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration (pCi/g, mg/kg)	Ingestion ECR	Inhalation ECR	External Exposure ECR	Dermal Contact ECR	Total ECR Across Pathways
2.04	Inorganic	Chromium	2.1E+01		1.3E-05			1.3E-05
2.04	Inorganic	Arsenic	6.2E+00	9.1E-07	4.9E-06			5.8E-06
2.04	Inorganic	Beryllium	1.3E+00	5.4E-07	1.7E-07		3.1E-06	3.8E-06
2.04	Radionuclide	Potassium-40	1.4E+01	3.0E-08	2.9E-09	4.1E-05		4.1E-05
2.04	Radionuclide	Cesium-137	3.5E+00	1.9E-08	1.9E-09	2.5E-05		2.5E-05
2.04			Pathway Total	1.5E-06	1.8E-05	6.6E-05	3.1E-06	8.9E-05
3.01	Inorganic	Chromium	2.1E+01		1.3E-05			1.3E-05
3.01	Inorganic	Arsenic	4.1E+00	6.0E-07	3.2E-06			3.8E-06
3.01	Inorganic	Beryllium	7.0E-01	2.9E-07	9.3E-08		1.7E-06	2.1E-06
3.01			Pathway Total	9.0E-07	1.7E-05		1.7E-06	1.9E-05
3.02	Inorganic	Chromium	1.6E+02		1.0E-04			1.0E-04
3.02	Inorganic	Arsenic	1.3E+01	1.9E-06	1.0E-05			1.2E-05
3.02	Inorganic	Beryllium	9.2E-01	3.9E-07	1.2E-07		2.2E-06	2.7E-06
3.02	Radionuclide	Uranium-238	4.1E+01	4.4E-07	1.4E-05	1.0E-05		2.5E-05
3.02	Radionuclide	Uranium-234	5.9E+01	4.6E-07	2.3E-05	6.0E-09		2.4E-05
3.02	Radionuclide	Cesium-137	1.2E+00	6.7E-09	6.6E-10	8.8E-06		8.8E-06
3.02	Radionuclide	Uranium-235	3.1E+00	2.5E-08	1.1E-06	3.9E-06		5.0E-06

Table E35 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (pCi/g, mg/kg)	Ingestion ECR	Inhalation ECR	External Exposure ECR	Dermal Contact ECR	Total ECR Across Pathways
3.02	Radionuclide	Cobalt-60	1.6E-01	5.4E-10	3.2E-10	1.9E-06		1.9E-06
3.02			Pathway Total	3.2E-06	1.5E-04	2.5E-05	2.2E-06	1.8E-04
3.03	Inorganic	Chromium	6.7E+01		4.3E-05			4.3E-05
3.03	Inorganic	Arsenic	6.2E+00	9.2E-07	4.9E-06			5.8E-06
3.03	Inorganic	Beryllium	7.3E-01	3.1E-07	9.7E-08		1.7E-06	2.2E-06
3.03	Radionuclide	Cesium-137	1.7E+00	9.3E-09	9.1E-10	1.2E-05		1.2E-05
3.03	Radionuclide	Uranium-238	6.0E+00	6.5E-08	2.1E-06	1.5E-06		3.7E-06
3.03	Radionuclide	Uranium-234	7.9E+00	6.1E-08	3.1E-06	8.1E-10		3.2E-06
3.03			Pathway Total	1.4E-06	5.4E-05	1.4E-05	1.7E-06	7.0E-05
3.04	Inorganic	Arsenic	1.2E+01	1.8E-06	9.7E-06			1.1E-05
3.04	Inorganic	Chromium	5.6E+01		3.6E-05			3.6E-05
3.04	Inorganic	Beryllium	8.3E-01	3.4E-07	1.1E-07		2.0E-06	2.4E-06
3.04	Radionuclide	Cesium-137	5.1E+00	2.8E-08	2.7E-09	3.6E-05		3.6E-05
3.04	Radionuclide	Uranium-238	2.2E+00	2.4E-08	7.5E-07	5.5E-07		1.3E-06
3.04	Radionuclide	Uranium-234	2.9E+00	2.3E-08	1.1E-06	3.0E-10		1.2E-06
3.04	Radionuclide	Cobalt-60	1.9E-01	6.4E-10	3.8E-10	2.3E-06		2.3E-06
3.04			Pathway Total	2.2E-06	4.8E-05	3.9E-05	2.0E-06	9.1E-05

Table E35 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (pCi/g, mg/kg)	Ingestion ECR	Inhalation ECR	External Exposure ECR	Dermal Contact ECR	Total ECR Across Pathways
4.01	Inorganic	Chromium	1.9E+01		1.3E-05			1.3E-05
4.01	Inorganic	Arsenic	4.9E+00	7.1E-07	3.8E-06			4.5E-06
4.01	Inorganic	Beryllium	7.0E-01	2.9E-07	9.3E-08		1.7E-06	2.1E-06
4.01	Radionuclide	Cesium-137	5.9E+00	3.3E-08	3.2E-09	4.3E-05		4.3E-05
4.01	Radionuclide	Potassium-40	1.1E+01	2.4E-08	2.3E-09	3.2E-05		3.2E-05
4.01			Pathway Total	1.1E-06	1.6E-05	7.4E-05	1.7E-06	9.3E-05
4.02	Inorganic	Chromium	1.9E+01		1.2E-05			1.2E-05
4.02	Inorganic	Arsenic	4.9E+00	7.2E-07	3.8E-06			4.6E-06
4.02	Inorganic	Beryllium	7.0E-01	3.0E-07	9.3E-08		1.7E-06	2.1E-06
4.02	Radionuclide	Potassium-40	1.7E+01	3.6E-08	3.5E-09	4.9E-05		4.9E-05
4.02	Radionuclide	Cesium-137	5.0E+00	2.7E-08	2.7E-09	3.6E-05		3.6E-05
4.02	Radionuclide	Cobalt-60	1.4E-01	4.6E-10	2.7E-10	1.6E-06		1.6E-06
4.02			Pathway Total	1.1E-06	1.6E-05	8.6E-05	1.7E-06	1.1E-04
4.03	Inorganic	Chromium	3.5E+01		2.3E-05			2.3E-05
4.03	Inorganic	Arsenic	1.1E+01	1.6E-06	8.8E-06			1.0E-05
4.03	Inorganic	Beryllium	7.1E-01	3.0E-07	9.4E-08		1.7E-06	2.1E-06
4.03	Radionuclide	Cesium-137	4.0E+00	2.2E-08	2.2E-09	2.9E-05		2.9E-05

Table E35 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (pCi/g, mg/kg)	Ingestion ECR	Inhalation ECR	External Exposure ECR	Dermal Contact ECR	Total ECR Across Pathways
4.03			Pathway Total	2.0E-06	3.2E-05	2.9E-05	1.7E-06	6.5E-05
4.04	Radionuclide	Cesium-137	2.7E+00	1.5E-08	1.4E-09	1.9E-05		1.9E-05
4.04			Pathway Total	1.5E-08	1.4E-09	1.9E-05		1.9E-05

Table E36. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the adult near-shore sediment pathways for selected subreaches of the Clinch River and Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Ingestion HQ	Inhalation HQ	Dermal Contact HQ	Total HQ Across Pathways
2.04	Inorganic	Manganese	1.9E+03	3.1E-03	5.0E+00	4.5E-03	5.0E+00
2.04			Hazard Index	3.1E-03	5.0E+00	4.5E-03	5.0E+00
3.01	Inorganic	Manganese	3.8E+02	6.3E-04	9.9E-01	8.9E-04	9.9E-01
3.01			Hazard Index	6.3E-04	9.9E-01	8.9E-04	9.9E-01
3.02	Inorganic	Manganese	7.2E+02	1.2E-03	1.9E+00	1.7E-03	1.9E+00
3.02			Hazard Index	1.2E-03	1.9E+00	1.7E-03	1.9E+00
3.03	Inorganic	Manganese	9.2E+02	1.5E-03	2.4E+00	2.1E-03	2.4E+00
3.03			Hazard Index	1.5E-03	2.4E+00	2.1E-03	2.4E+00
3.04	Inorganic	Manganese	6.6E+02	1.1E-03	1.7E+00	1.5E-03	1.7E+00
3.04			Hazard Index	1.1E-03	1.7E+00	1.5E-03	1.7E+00
4.01	Inorganic	Manganese	6.9E+02	1.1E-03	1.8E+00	1.6E-03	1.8E+00
4.01			Hazard Index	1.1E-03	1.8E+00	1.6E-03	1.8E+00
4.02	Inorganic	Manganese	9.2E+02	1.5E-03	2.4E+00	2.1E-03	2.4E+00
4.02			Hazard Index	1.5E-03	2.4E+00	2.1E-03	2.4E+00
4.03	Inorganic	Manganese	1.5E+03	2.4E-03	3.9E+00	3.5E-03	3.9E+00
4.03			Hazard Index	2.4E-03	3.9E+00	3.5E-03	3.9E+00

Table E37. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the child near-shore sediment pathways for selected subreaches of the Clinch River and Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Ingestion HQ	Inhalation HQ	Dermal Contact HQ	Total HQ Across Pathways
2.04	Inorganic	Manganese	1.9E+03	2.9E-02	2.2E+01	8.4E-03	2.2E+01
2.04	Inorganic	Barium	1.9E+02	5.8E-03	2.2E-01	9.6E-04	2.3E-01
2.04			Hazard Index	3.5E-02	2.2E+01	9.4E-03	2.2E+01
3.01	Inorganic	Manganese	3.8E+02	5.8E-03	4.4E+00	1.7E-03	4.4E+00
3.01	Inorganic	Barium	8.6E+01	2.6E-03	9.9E-02	4.3E-04	1.0E-01
3.01			Hazard Index	8.5E-03	4.5E+00	2.1E-03	4.5E+00
3.02	Inorganic	Manganese	7.2E+02	1.1E-02	8.3E+00	3.2E-03	8.3E+00
3.02	Inorganic	Mercury	3.2E+01	2.3E-01	6.2E-02	3.8E-07	2.9E-01
3.02	Inorganic	Barium	1.6E+02	4.8E-03	1.8E-01	7.8E-04	1.8E-01
3.02	Inorganic	Chromium	1.6E+02	6.9E-02		4.0E-02	1.1E-01
3.02			Hazard Index	3.1E-01	8.5E+00	4.3E-02	8.9E+00
3.03	Inorganic	Manganese	9.2E+02	1.4E-02	1.1E+01	4.0E-03	1.1E+01
3.03	Inorganic	Barium	9.7E+01	3.0E-03	1.1E-01	4.9E-04	1.1E-01
3.03			Hazard Index	1.7E-02	1.1E+01	4.5E-03	1.1E+01
3.04	Inorganic	Manganese	6.6E+02	1.0E-02	7.5E+00	2.9E-03	7.5E+00
3.04	Inorganic	Mercury	5.3E+01	3.8E-01	1.0E-01	6.1E-07	4.8E-01
3.04	Inorganic	Barium	1.1E+02	3.4E-03	1.3E-01	5.6E-04	1.3E-01

Table E37 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Ingestion HQ	Inhalation HQ	Dermal Contact HQ	Total HQ Across Pathways
3.04			Hazard Index	3.9E-01	7.7E+00	3.5E-03	8.1E+00
4.01	Inorganic	Manganese	6.9E+02	1.1E-02	7.9E+00	3.0E-03	7.9E+00
4.01			Hazard Index	1.1E-02	7.9E+00	3.0E-03	7.9E+00
4.02	Inorganic	Manganese	9.2E+02	1.4E-02	1.1E+01	4.0E-03	1.1E+01
4.02			Hazard Index	1.4E-02	1.1E+01	4.0E-03	1.1E+01
4.03	Inorganic	Manganese	1.5E+03	2.3E-02	1.7E+01	6.6E-03	1.7E+01
4.03	Inorganic	Barium	8.7E+01	2.6E-03	9.9E-02	4.3E-04	1.0E-01
4.03			Hazard Index	2.6E-02	1.7E+01	7.0E-03	1.7E+01

Table E38. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the adult swimming pathways for Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration (mg/L)	Incidental Ingestion HQ	Dermal Contact HQ	Total HQ Across Pathways
3.01	Organic	PCB-1254	2.9E-04	3.3E-03	6.1E-01	
3.01			Pathway Total	3.3E-03	6.1E-01	6.1E-01
3.02	Organic	Di-n-octylphthlate	1.0E-02	1.1E-04	1.6E+00	
3.02			Pathway Total	1.1E-04	1.6E+00	1.6E+00
3.04	Organic	PCB-1254	2.1E-04	2.4E-03	4.4E-01	
3.04			Pathway Total	2.4E-03	4.4E-01	4.5E-01

Table E39. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the child swimming pathways for Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration (mg/L)	Incidental Ingestion HQ	Dermal Contact HQ	Total HQ Across Pathways
3.01	Inorganic	Manganese	9.1E-02	1.9E-02	8.9E-02	
3.01	Organic	PCB-1254	2.9E-04	1.5E-02	1.1E+00	
3.01			Hazard Index	3.5E-02	1.2E+00	1.3E+00
3.02	Inorganic	Manganese	8.9E-02	1.9E-02	8.7E-02	
3.02	Organic	Di-n-octylphthlate	1.0E-02	5.3E-04	2.9E+00	
3.02			Hazard Index	1.9E-02	3.0E+00	3.0E+00
3.03	Inorganic	Manganese	8.9E-02	1.9E-02	8.8E-02	
3.03			Hazard Index	1.9E-02	8.8E-02	1.1E-01
3.04	Inorganic	Manganese	8.9E-02	1.9E-02	8.7E-02	
3.04	Organic	PCB-1254	2.1E-04	1.1E-02	8.3E-01	
3.04			Hazard Index	3.0E-02	9.2E-01	9.5E-01

Table E40. Chemicals with an excess cancer risk (ECR) of >10^{-6} and pathway totals for the fish ingestion pathway for the Clinch River and Poplar Creek

Reach	Species	Chemical Type	Chemical	Representative concentration (mg/kg, pCi/g)	Ingestion ECR
1	Bluegill	Inorganic	Arsenic	7.2E-02	3.4E-05
1	Bluegill	Inorganic	Beryllium	6.0E-03	8.2E-06
1	Bluegill			Pathway Total	4.2E-05
1	Catfish	Organic	PCB-1260	3.7E-01	9.0E-04
1	Catfish	Organic	Chlordane, total	3.4E-01	1.4E-04
1	Catfish	Organic	4,4'-DDE	8.5E-02	9.1E-06
1	Catfish	Radionuclide	Cesium-137	8.1E-02	1.5E-06
1	Catfish			Pathway Total	1.0E-03
1	LargeMouth Bass	Inorganic	Arsenic	1.8E-01	8.6E-05
1	LargeMouth Bass			Pathway Total	8.6E-05
2	Bluegill	Inorganic	Arsenic	3.0E-02	1.4E-05
2	Bluegill	Inorganic	Beryllium	2.3E-03	3.2E-06
2	Bluegill	Radionuclide	Cesium-137	2.9E+00	5.3E-05
2	Bluegill			Pathway Total	7.0E-05
2	Catfish	Organic	PCB-1260	1.1E+00	2.8E-03
2	Catfish	Organic	Chlordane, total	2.1E-01	8.6E-05
2	Catfish	Organic	4,4'-DDE	1.3E-02	1.4E-06
2	Catfish	Radionuclide	Cesium-137	1.1E+00	1.9E-05
2	Catfish	Radionuclide	Strontium-90	5.4E-01	1.7E-05
2	Catfish			Pathway Total	2.9E-03
2	LargeMouth Bass	Inorganic	Arsenic	2.9E-01	1.4E-04
2	LargeMouth Bass	Inorganic	Beryllium	2.2E-03	3.0E-06
2	LargeMouth Bass	Organic	PCB-1260	1.9E-01	4.7E-04
2	LargeMouth Bass	Organic	Chlordane, total	7.2E-02	3.0E-05
2	LargeMouth Bass	Radionuclide	Cesium-137	8.2E+00	1.5E-04
2	LargeMouth Bass			Pathway Total	7.8E-04
2	Striped/hybrid Bass	Organic	PCB-1260	4.3E-01	1.1E-03

Table E40 (continued)

Reach	Species	Chemical Type	Chemical	Representative concentration (mg/kg, pCi/g)	Ingestion ECR
2	Striped/hybrid Bass	Organic	Chlordane, total	1.5E-01	6.0E-05
2	Striped/hybrid Bass			Pathway Total	1.1E-03
3	Bluegill	Inorganic	Arsenic	7.4E-02	3.5E-05
3	Bluegill	Inorganic	Beryllium	4.3E-03	5.9E-06
3	Bluegill	Radionuclide	Cesium-137	7.6E-02	1.4E-06
3	Bluegill			Pathway Total	4.2E-05
3	Catfish	Organic	PCB-1260	7.9E-01	1.9E-03
3	Catfish	Organic	Chlordane, total	9.4E-02	3.9E-05
3	Catfish	Radionuclide	Strontium-90	3.2E-01	1.0E-05
3	Catfish	Radionuclide	Cesium-137	6.8E-02	1.2E-06
3	Catfish			Pathway Total	2.0E-03
3	LargeMouth Bass	Inorganic	Arsenic	2.0E-01	9.6E-05
3	LargeMouth Bass	Inorganic	Beryllium	3.6E-03	4.9E-06
3	LargeMouth Bass	Organic	PCB-1260	3.8E-01	9.2E-04
3	LargeMouth Bass	Organic	Chlordane, total	7.9E-02	3.2E-05
3	LargeMouth Bass	Radionuclide	Cesium-137	1.0E-01	1.9E-06
3	LargeMouth Bass			Pathway Total	1.1E-03
4	Bluegill	Inorganic	Arsenic	5.5E-02	2.6E-05
4	Bluegill	Inorganic	Beryllium	2.4E-03	3.2E-06
4	Bluegill	Organic	PCB-1260	2.2E-01	5.4E-04
4	Bluegill	Organic	Chlordane, total	5.7E-02	2.3E-05
4	Bluegill	Radionuclide	Cesium-137	1.6E-01	2.8E-06
4	Bluegill			Pathway Total	1.0E-03
4	Catfish	Inorganic	Arsenic	3.7E-02	1.8E-05
4	Catfish	Inorganic	Beryllium	2.7E-03	3.7E-06
4	Catfish	Organic	PCB-1260	8.7E-01	2.1E-03
4	Catfish	Organic	Chlordane, total	1.3E-01	5.4E-05
4	Catfish	Organic	4,4'-DDT	2.0E-01	2.2E-05

Table E40 (continued)

Reach	Species	Chemical Type	Chemical	Representative concentration (mg/kg, pCi/g)	Ingestion ECR
4	Catfish	Organic	Aldrin	1.3E-03	6.9E-06
4	Catfish	Organic	4,4'-DDE	2.6E-02	2.8E-06
4	Catfish	Radionuclide	Strontium-90	3.0E-01	9.4E-06
4	Catfish	Radionuclide	Cesium-137	6.8E-02	1.2E-06
4	Catfish			Pathway Total	2.3E-03
4	LargeMouth Bass	Inorganic	Arsenic	2.4E-01	1.1E-04
4	LargeMouth Bass	Organic	PCB-1260	2.4E-01	5.9E-04
4	LargeMouth Bass	Organic	Chlordane, total	7.3E-02	3.0E-05
4	LargeMouth Bass	Radionuclide	Cesium-137	1.2E-01	2.1E-06
4	LargeMouth Bass			Pathway Total	7.3E-04
4	Striped/hybrid Bass	Organic	PCB-1260	7.6E-01	1.9E-03
4	Striped/hybrid Bass	Organic	Chlordane, total	1.1E-01	4.5E-05
4	Striped/hybrid Bass			Pathway Total	1.9E-03

Table E41. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the adult fish ingestion pathway for the Clinch River and Poplar Creek

Reach	Species	Chemical Type	Chemical	Representative Concentration (mg/kg)	Adult Ingestion HQ
1	Bluegill	Inorganic	Arsenic	7.2E-02	1.8E-01
1	Bluegill	Inorganic	Selenium	9.2E-01	1.4E-01
1	Bluegill	Inorganic	Mercury	4.4E-02	1.1E-01
1	Bluegill			Hazard Index	4.2E-01
1	Catfish	Organic	Chlordane, total	3.4E-01	4.2E+00
1	Catfish	Organic	PCB-1254	1.1E-01	4.2E+00
1	Catfish			Hazard Index	8.4E+00
1	LargeMouth Bass	Inorganic	Arsenic	1.8E-01	4.4E-01
1	LargeMouth Bass	Inorganic	Mercury	7.4E-02	1.8E-01
1	LargeMouth Bass	Inorganic	Selenium	1.1E+00	1.6E-01
1	LargeMouth Bass			Hazard Index	7.9E-01
2	Bluegill	Inorganic	Mercury	8.9E-02	2.2E-01
2	Bluegill			Hazard Index	2.2E-01
2	Catfish	Organic	PCB-1254	6.4E-01	2.4E+01
2	Catfish	Organic	Chlordane, total	2.1E-01	2.6E+00
2	Catfish			Hazard Index	2.6E+01
2	LargeMouth Bass	Inorganic	Arsenic	2.9E-01	7.2E-01
2	LargeMouth Bass	Inorganic	Mercury	2.9E-01	7.1E-01
2	LargeMouth Bass	Organic	PCB-1254	1.8E-01	6.8E+00
2	LargeMouth Bass	Organic	Chlordane, total	7.2E-02	8.8E-01
2	LargeMouth Bass			Hazard Index	9.1E+00
2	Striped/hybrid Bass	Organic	PCB-1254	6.1E-01	2.3E+01
2	Striped/hybrid Bass	Organic	Chlordane, total	1.5E-01	1.8E+00
2	Striped/hybrid Bass			Hazard Index	2.4E+01
3	Bluegill	Inorganic	Mercury	4.4E-01	1.1E+00
3	Bluegill	Inorganic	Arsenic	7.4E-02	1.8E-01
3	Bluegill			Hazard Index	1.3E+00

Table E41 (continued)

Reach	Species	Chemical Type	Chemical	Representative Concentration (mg/kg)	Adult Ingestion HQ
3	Catfish	Organic	PCB-1254	3.7E-01	1.4E+01
3	Catfish	Organic	Chlordane, total	9.4E-02	1.2E+00
3	Catfish			Hazard Index	1.5E+01
3	LargeMouth Bass	Inorganic	Mercury	7.3E-01	1.8E+00
3	LargeMouth Bass	Inorganic	Arsenic	2.0E-01	5.0E-01
3	LargeMouth Bass	Organic	PCB-1254	3.7E-01	1.4E+01
3	LargeMouth Bass	Organic	Chlordane, total	7.9E-02	9.7E-01
3	LargeMouth Bass			Hazard Index	1.7E+01
4	Bluegill	Inorganic	Mercury	1.9E-01	4.7E-01
4	Bluegill	Inorganic	Arsenic	5.5E-02	1.4E-01
4	Bluegill	Organic	PCB-1254	2.0E-01	7.4E+00
4	Bluegill	Organic	Chlordane, total	5.7E-02	7.0E-01
4	Bluegill			Hazard Index	8.7E+00
4	Catfish	Inorganic	Mercury	2.9E-01	7.3E-01
4	Catfish	Organic	PCB-1254	5.4E-01	2.0E+01
4	Catfish	Organic	Chlordane, total	1.3E-01	1.6E+00
4	Catfish	Organic	4,4'-DDT	2.0E-01	3.0E-01
4	Catfish			Hazard Index	2.3E+01
4	LargeMouth Bass	Inorganic	Mercury	3.3E-01	8.1E-01
4	LargeMouth Bass	Inorganic	Arsenic	2.4E-01	5.9E-01
4	LargeMouth Bass	Organic	PCB-1254	2.2E-01	8.1E+00
4	LargeMouth Bass	Organic	Chlordane, total	7.3E-02	9.0E-01
4	LargeMouth Bass			Hazard Index	1.0E+01
4	Striped/hybrid Bass	Organic	PCB-1254	4.9E-01	1.8E+01
4	Striped/hybrid Bass	Organic	Chlordane, total	1.1E-01	1.3E+00
4	Striped/hybrid Bass			Hazard Index	2.0E+01

Table E42. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the child fish ingestion pathway for the Clinch River and Poplar Creek

Reach	Species	Chemical Type	Chemical	Representative Concentration (mg/kg)	Child Ingestion HQ
1	Bluegill	Inorganic	Arsenic	7.2E-02	4.6E-01
1	Bluegill	Inorganic	Selenium	9.2E-01	3.5E-01
1	Bluegill	Inorganic	Mercury	4.4E-02	2.8E-01
1	Bluegill			Hazard Index	1.1E+00
1	Catfish	Organic	Chlordane, total	3.4E-01	1.1E+01
1	Catfish	Organic	PCB-1254	1.1E-01	1.1E+01
1	Catfish			Hazard Index	2.2E+01
1	LargeMouth Bass	Inorganic	Arsenic	1.8E-01	1.2E+00
1	LargeMouth Bass	Inorganic	Mercury	7.4E-02	4.7E-01
1	LargeMouth Bass	Inorganic	Selenium	1.1E+00	4.2E-01
1	LargeMouth Bass			Hazard Index	2.0E+00
2	Bluegill	Inorganic	Mercury	8.9E-02	5.7E-01
2	Bluegill	Inorganic	Selenium	5.1E-01	2.0E-01
2	Bluegill	Inorganic	Arsenic	3.0E-02	1.9E-01
2	Bluegill			Hazard Index	9.6E-01
2	Catfish	Organic	PCB-1254	6.4E-01	6.1E+01
2	Catfish	Organic	Chlordane, total	2.1E-01	6.7E+00
2	Catfish			Hazard Index	6.8E+01
2	LargeMouth Bass	Inorganic	Arsenic	2.9E-01	1.9E+00
2	LargeMouth Bass	Inorganic	Mercury	2.9E-01	1.8E+00
2	LargeMouth Bass	Inorganic	Selenium	4.3E-01	1.7E-01
2	LargeMouth Bass	Organic	PCB-1254	1.8E-01	1.8E+01
2	LargeMouth Bass	Organic	Chlordane, total	7.2E-02	2.3E+00
2	LargeMouth Bass			Hazard Index	2.4E+01
2	Striped/hybrid Bass	Organic	PCB-1254	6.1E-01	5.9E+01
2	Striped/hybrid Bass	Organic	Chlordane, total	1.5E-01	4.7E+00
2	Striped/hybrid Bass			Hazard Index	6.3E+01

Table E42 (continued)

Reach	Species	Chemical Type	Chemical	Representative Concentration (mg/kg)	Child Ingestion HQ
3	Bluegill	Inorganic	Mercury	4.4E-01	2.8E+00
3	Bluegill	Inorganic	Arsenic	7.4E-02	4.7E-01
3	Bluegill	Inorganic	Selenium	3.5E-01	1.3E-01
3	Bluegill			Hazard Index	3.4E+00
3	Catfish	Organic	PCB-1254	3.7E-01	3.5E+01
3	Catfish	Organic	Chlordane, total	9.4E-02	3.0E+00
3	Catfish			Hazard Index	3.8E+01
3	LargeMouth Bass	Inorganic	Mercury	7.3E-01	4.7E+00
3	LargeMouth Bass	Inorganic	Arsenic	2.0E-01	1.3E+00
3	LargeMouth Bass	Inorganic	Selenium	3.0E-01	1.2E-01
3	LargeMouth Bass	Organic	PCB-1254	3.7E-01	3.5E+01
3	LargeMouth Bass	Organic	Chlordane, total	7.9E-02	2.5E+00
3	LargeMouth Bass			Hazard Index	4.4E+01
4	Bluegill	Inorganic	Mercury	1.9E-01	1.2E+00
4	Bluegill	Inorganic	Arsenic	5.5E-02	3.5E-01
4	Bluegill	Inorganic	Selenium	5.1E-01	2.0E-01
4	Bluegill	Organic	PCB-1254	2.0E-01	1.9E+01
4	Bluegill	Organic	Chlordane, total	5.7E-02	1.8E+00
4	Bluegill			Hazard Index	2.3E+01
4	Catfish	Inorganic	Mercury	2.9E-01	1.9E+00
4	Catfish	Inorganic	Arsenic	3.7E-02	2.4E-01
4	Catfish	Organic	PCB-1254	5.4E-01	5.2E+01
4	Catfish	Organic	Chlordane, total	1.3E-01	4.2E+00
4	Catfish	Organic	4,4'-DDT	2.0E-01	7.7E-01
4	Catfish			Hazard Index	5.9E+01
4	LargeMouth Bass	Inorganic	Mercury	3.3E-01	2.1E+00
4	LargeMouth Bass	Inorganic	Arsenic	2.4E-01	1.5E+00
4	LargeMouth Bass	Inorganic	Selenium	4.2E-01	1.6E-01

Table E42 (continued)

Reach	Species	Chemical Type	Chemical	Representative Concentration (mg/kg)	Child Ingestion HQ
4	LargeMouth Bass	Organic	PCB-1254	2.2E-01	2.1E+01
4	LargeMouth Bass	Organic	Chlordane, total	7.3E-02	2.3E+00
4	LargeMouth Bass			Hazard Index	2.7E+01
4	Striped/hybrid Bass	Organic	PCB-1254	4.9E-01	4.7E+01
4	Striped/hybrid Bass	Organic	Chlordane, total	1.1E-01	3.5E+00
4	Striped/hybrid Bass			Hazard Index	5.1E+01

Table E43. Chemicals with an excess cancer risk (ECR) of >10^{-6} for the waterfowl ingestion pathway

Species	Chemical Type	Chemical	Representative Concentration (pCi/g)	Ingestion ECR
Canadian Goose	Radionuclide	Plutonium-238	1.5E-01	2.4E-06
Canadian Goose			Pathway Total	2.4E-06

Table E44. Chemicals with a hazard quotient (HQ) of >0.1 for the adult waterfowl ingestion pathway

Species	Chemical Type	Chemical	Representative Concentration (mg/kg)	Ingestion HQ
Canadian Goose	Inorganic	Selenium	1.7E+01	2.4E-01
Canadian Goose			Hazard Index	2.4E-01

Table E45. Chemicals with a hazard quotient (HQ) of >0.1 for the child waterfowl ingestion pathway

Species	Chemical Type	Chemical	Representative Concentration (mg/kg)	Ingestion HQ
Canadian Goose	Inorganic	Selenium	1.7E+01	5.7E-01
Canadian Goose			Hazard Index	5.7E-01

Table E46. Chemicals with an excess cancer risk (ECR) of >10^{-6} and pathway totals for the irrigation pathways for the Clinch River

Reach	Chemical Type	Chemical	Representative Concentration (pCi/g, mg/kg)	Soil Ingestion ECR	Inhalation of Resuspended Soil ECR	External Exposure ECR	Ingestion of Milk ECR	Ingestion of Meat ECR	Ingestion of Leafy Vegetables ECR	Total ECR Across Pathways
1	Inorganic	Arsenic	4.3E-02	1.3E-08	6.8E-08		1.4E-07	4.2E-07	7.4E-06	
1	Radionuclide	Cobalt-60	3.7E-02	2.5E-10	1.4E-10	3.5E-06	1.1E-08	1.4E-09	5.4E-07	
1	Radionuclide	Strontium-90	2.8E-02	5.5E-10	1.1E-10		4.7E-07	1.3E-07	5.4E-07	
1			Pathway Total	1.3E-08	6.8E-08	3.5E-06	6.3E-07	5.5E-07	8.4E-06	1.3E-05
2	Radionuclide	Strontium-90	2.2E-01	4.4E-09	8.7E-10		3.8E-06	1.1E-06	4.3E-06	
2	Radionuclide	Cesium-137	3.2E-02	3.5E-10	3.4E-11	6.4E-07	7.5E-07	4.1E-07	2.9E-07	
2	Radionuclide	Tritium	1.5E+02	3.8E-09	8.3E-10		1.2E-06	2.4E-07	2.6E-07	
2			Pathway Total	8.5E-09	1.7E-09	6.4E-07	5.7E-06	1.7E-06	4.9E-06	1.3E-05
4	Inorganic	Arsenic	4.4E-02	1.3E-08	7.0E-08		1.5E-07	4.3E-07	7.6E-06	
4	Radionuclide	Cobalt-60	4.8E-02	3.2E-10	1.9E-10	4.5E-06	1.5E-08	1.8E-09	7.0E-07	
4	Radionuclide	Cesium-137	4.7E-02	5.2E-10	5.1E-11	9.4E-07	1.1E-06	6.0E-07	4.2E-07	
4	Radionuclide	Strontium-90	5.0E-02	9.8E-10	2.0E-10		8.4E-07	2.4E-07	9.7E-07	
4	Radionuclide	Uranium - radioactive	7.6E-02	1.6E-09	5.3E-08	3.8E-08	1.3E-07	1.2E-08	9.6E-07	
4			Pathway Total	1.6E-08	1.2E-07	5.5E-06	2.2E-06	1.3E-06	1.1E-05	2.0E-05
7	Inorganic	Arsenic	8.4E-02	2.5E-08	1.3E-07		2.8E-07	8.1E-07	1.4E-05	
7	Radionuclide	Strontium-90	5.5E-02	1.1E-09	2.2E-10		9.3E-07	2.6E-07	1.1E-06	
7			Pathway Total	2.6E-08	1.3E-07		1.2E-06	1.1E-06	1.5E-05	1.8E-05

Table E47. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the adult irrigation pathways for the Clinch River

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Soil Ingestion HQ	Inhalation of Resuspended Soil HQ	Dermal Contact HQ	Ingestion of Milk HQ	Ingestion of Meat HQ	Ingestion of Leafy Vegetables HQ	Total HI Across Pathways
1	Inorganic	Nitrate	1.8E+02	5.1E-05		2.9E-06	2.0E+00	5.3E-01	2.6E-01	
1			Hazard Index	5.1E-05		2.9E-06	2.0E+00	5.3E-01	2.6E-01	2.8E+00
2	Inorganic	Nitrate	1.2E+02	3.4E-05		1.9E-06	1.3E+00	3.5E-01	1.7E-01	
2			Hazard Index	3.4E-05		1.9E-06	1.3E+00	3.5E-01	1.7E-01	1.8E+00
4	Inorganic	Nitrate	1.6E+02	4.5E-05		2.5E-06	1.7E+00	4.6E-01	2.3E-01	
4			Hazard Index	4.5E-05		2.5E-06	1.7E+00	4.6E-01	2.3E-01	2.4E+00

Table E48. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the child irrigation pathways for the Clinch River

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Soil Ingestion HQ	Inhalation of Resuspended Soil HQ	Dermal Contact HQ	Ingestion of Milk HQ	Ingestion of Meat HQ	Ingestion of Leafy Vegetables HQ	Total HI Across Pathways
1	Inorganic	Nitrate	1.8E+02	4.8E-04		5.5E-06	1.8E+01	2.5E+00	1.2E+00	
1	Inorganic	Arsenic	4.3E-02	6.1E-04		1.7E-05	6.8E-03	1.0E-02	1.8E-01	
1			Hazard Index	1.1E-03		2.3E-05	1.8E+01	2.5E+00	1.4E+00	2.2E+01
2	Inorganic	Nitrate	1.2E+02	3.2E-04		3.7E-06	1.2E+01	1.7E+00	8.1E-01	
2	Inorganic	Nickel	1.5E-01	3.2E-05		1.4E-06	1.0E-01	1.4E-03	9.8E-03	
2	Organic	Acetone	5.0E-01	2.1E-05		2.9E-06	9.6E-07	1.4E-07	3.5E-01	
2			Hazard Index	3.7E-04		8.0E-06	1.2E+01	1.7E+00	1.2E+00	1.5E+01
4	Inorganic	Nitrate	1.6E+02	4.2E-04		4.8E-06	1.6E+01	2.2E+00	1.1E+00	
4	Inorganic	Arsenic	4.4E-02	6.3E-04		1.8E-05	7.1E-03	1.0E-02	1.8E-01	
4	Inorganic	Antimony	5.9E-02	6.3E-04		3.6E-04	3.0E-03	2.1E-04	1.8E-01	
4			Hazard Index	1.7E-03		3.8E-04	1.6E+01	2.2E+00	1.4E+00	2.0E+01
7	Inorganic	Arsenic	8.4E-02	1.2E-03		3.3E-05	1.3E-02	2.0E-02	3.5E-01	
7	Inorganic	Nickel	1.4E-01	3.0E-05		1.3E-06	9.4E-02	1.3E-03	9.2E-03	
7			Hazard Index	1.2E-03		3.5E-05	1.1E-01	2.1E-02	3.6E-01	4.9E-01

Table E49. Chemicals with an excess cancer risk (ECR) of >10^{-6} and pathway totals for the irrigation pathways for Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration (pCi/g, mg/kg)	Soil Ingestion ECR	Inhalation of Resuspended Soil ECR	External Exposure ECR	Ingestion of Milk ECR	Ingestion of Meat ECR	Ingestion of Leafy Vegetables	Total ECR Across Pathways
3.01	Radionuclide	Strontium-90	5.7E-02	1.1E-09	2.2E-10		9.6E-07	2.7E-07	1.1E-06	
3.01			Pathway Total	1.1E-09	2.2E-10	0.00	9.6E-07	2.7E-07	1.1E-06	2.3E-06
3.02	Inorganic	Arsenic	1.1E-01	3.1E-08	1.7E-07		3.5E-07	1.0E-06	1.8E-05	
3.02	Radionuclide	Strontium-90	3.9E-02	7.6E-10	1.5E-10		6.5E-07	1.8E-07	7.5E-07	
3.02			Pathway Total	3.2E-08	1.7E-07	0.00	1.0E-06	1.2E-06	1.9E-05	2.2E-05
3.03	Inorganic	Arsenic	5.2E-02	1.5E-08	8.2E-08		1.7E-07	5.1E-07	8.9E-06	
3.03	Radionuclide	Strontium-90	6.3E-02	1.2E-09	2.5E-10		1.1E-06	3.0E-07	1.2E-06	
3.03	Radionuclide	Cesium-137	3.9E-02	4.3E-10	4.2E-11	7.8E-07	9.2E-07	5.0E-07	3.5E-07	
3.03			Pathway Total	1.7E-08	8.2E-08	7.8E-07	2.2E-06	1.3E-06	1.1E-05	1.5E-05
3.04	Inorganic	Arsenic	4.3E-02	1.3E-08	6.8E-08		1.4E-07	4.2E-07	7.4E-06	
3.04	Radionuclide	Strontium-90	4.3E-01	8.4E-09	1.7E-09		7.2E-06	2.0E-06	8.3E-06	
3.04			Pathway Total	2.1E-08	6.9E-08	0.00	7.4E-06	2.5E-06	1.6E-05	2.6E-05

Table E50. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the adult irrigation pathways for Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Soil Ingestion HQ	Inhalation of Resuspended Soil HQ	Dermal Contact HQ	Ingestion of Milk HQ	Ingestion of Meat HQ	Ingestion of Leafy Vegetables HQ	Total HI Across Pathways
3.01	Organic	PCB-1254	1.0E-02	2.4E-04		1.5E-04	3.8E-01	1.1E-01	1.4E-01	
3.01			Hazard Index	2.4E-04	0.00	1.5E-04	3.8E-01	1.1E-01	1.4E-01	6.3E-01
3.02	Inorganic	Arsenic	1.1E-01	1.6E-04		2.3E-05	1.8E-03	5.4E-03	9.5E-02	
3.02	Organic	Di-n-octylphthlate	3.6E-01	8.2E-06		5.2E-06	1.9E+01	5.4E+00	4.8E-03	
3.02			Hazard Index	1.7E-04	0.00	2.8E-05	1.9E+01	5.4E+00	1.0E-01	2.5E+01
3.03	Inorganic	Nitrate	1.8E+02	5.2E-05		3.0E-06	2.0E+00	5.4E-01	2.6E-01	
3.03			Hazard Index	5.2E-05	0.00	3.0E-06	2.0E+00	5.4E-01	2.6E-01	2.8E+00
3.04	Organic	PCB-1254	7.5E-03	1.7E-04		1.1E-04	2.8E-01	7.7E-02	1.0E-01	
3.04			Hazard Index	1.7E-04	0.00	1.1E-04	2.8E-01	7.7E-02	1.0E-01	4.5E-01

Table E51. Chemicals with a hazard quotient (HQ) of >0.1 and hazard indices for the child irrigation pathways for Poplar Creek

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Soil Ingestion HQ	Inhalation of Resuspended Soil HQ	Dermal Contact HQ	Ingestion of Milk HQ	Ingestion of Meat HQ	Ingestion of Leafy Vegetables HQ	Total HI Across Pathways
3.01	Inorganic	Antimony	5.1E-02	5.4E-04		3.1E-04	2.6E-03	1.8E-04	1.6E-01	
3.01	Inorganic	Nickel	1.7E-01	3.6E-05		1.5E-06	1.1E-01	1.6E-03	1.1E-02	
3.01	Inorganic	Manganese	3.2E+00	9.9E-05	7.4E-02	2.8E-05	7.7E-04	5.7E-04	4.1E-02	
3.01	Organic	PCB-1254	1.0E-02	2.2E-03		2.8E-04	3.6E+00	5.0E-01	6.5E-01	
3.01			Hazard Index	2.9E-03	7.4E-02	6.2E-04	3.7E+00	5.0E-01	8.6E-01	5.1E+00
3.02	Inorganic	Arsenic	1.1E-01	1.5E-03		4.3E-05	1.7E-02	2.5E-02	4.5E-01	
3.02	Inorganic	Antimony	6.8E-02	7.2E-04		4.2E-04	3.4E-03	2.4E-04	2.1E-01	
3.02	Inorganic	Manganese	3.2E+00	9.6E-05	7.3E-02	2.8E-05	7.5E-04	5.6E-04	4.0E-02	
3.02	Inorganic	Nickel	1.5E-01	3.2E-05		1.4E-06	1.0E-01	1.4E-03	9.8E-03	
3.02	Inorganic	Boron	2.4E+00	1.1E-04	1.4E-04	1.5E-06	6.5E-02	8.5E-04	3.8E-02	
3.02	Organic	Di-n-octylphthlate	3.6E-01	7.6E-05		9.7E-06	1.8E+02	2.5E+01	2.2E-02	
3.02			Hazard Index	2.6E-03	7.3E-02	5.0E-04	1.8E+02	2.5E+01	7.7E-01	2.1E+02
3.03	Inorganic	Nitrate	1.8E+02	4.8E-04		5.5E-06	1.9E+01	2.5E+00	1.2E+00	
3.03	Inorganic	Arsenic	5.2E-02	7.4E-04		2.1E-05	8.3E-03	1.2E-02	2.2E-01	
3.03	Inorganic	Manganese	3.2E+00	9.7E-05	7.3E-02	2.8E-05	7.6E-04	5.6E-04	4.0E-02	
3.03	Inorganic	Nickel	1.5E-01	3.2E-05		1.4E-06	1.0E-01	1.4E-03	9.8E-03	
3.03	Organic	Acetone	4.6E-01	2.0E-05		2.7E-06	8.9E-07	1.3E-07	3.2E-01	
3.03			Hazard Index	1.4E-03	7.3E-02	5.8E-05	1.9E+01	2.5E+00	1.8E+00	2.3E+01
3.04	Inorganic	Antimony	6.2E-02	6.7E-04		3.8E-04	3.1E-03	2.2E-04	2.0E-01	
3.04	Inorganic	Arsenic	4.3E-02	6.1E-04		1.7E-05	6.8E-03	1.0E-02	1.8E-01	
3.04	Inorganic	Manganese	3.2E+00	9.7E-05	7.3E-02	2.8E-05	7.5E-04	5.6E-04	4.0E-02	

Table E51 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg)	Soil Ingestion HQ	Inhalation of Resuspended Soil HQ	Dermal Contact HQ	Ingestion of Milk HQ	Ingestion of Meat HQ	Ingestion of Leafy Vegetables HQ	Total HI Across Pathways
3.04	Inorganic	Nickel	1.5E-01	3.2E-05		1.4E-06	1.0E-01	1.5E-03	9.9E-03	
3.04	Inorganic	Molybdenum	1.8E-01	1.5E-04		4.6E-06	5.3E-02	1.4E-03	4.9E-02	
3.04	Organic	PCB-1254	7.5E-03	1.6E-03		2.0E-04	2.6E+00	3.6E-01	4.7E-01	
3.04			Hazard Index	3.2E-03	7.3E-02	6.4E-04	2.7E+00	3.7E-01	9.5E-01	4.1E+00

Table E52. Chemicals with excess cancer risks (ECR) of >10^{-6} and pathway totals for the dredging pathways for reach 1 and 7 of the Clinch River

Reach	Chemical Type	Chemical	Representative concentration (mg/kg, pCi/g)	Ingestion ECR	Inhalation ECR	External Exposure ECR	Dermal ECR	Ingestion of Milk ECR	Ingestion of Meat ECR	Ingestion of Vegetables ECR	Total ECR Across Pathways
1	Inorganic	Arsenic	1.1E+01	3.2E-06	1.7E-05			3.7E-06	1.1E-05	8.9E-06	4.4E-05
1	Inorganic	Chromium	2.0E+01		2.5E-05						2.5E-05
1	Inorganic	Beryllium	8.1E-01	6.8E-07	2.1E-07		3.9E-06	2.5E-08	9.1E-07	1.4E-06	7.1E-06
1	Organic	Benzo(k)fluoranthene	7.9E-01	1.1E-08			2.1E-08	1.2E-05	3.4E-06	5.0E-08	1.6E-05
1	Organic	Benzo(a)anthracene	7.9E-01	1.1E-07			2.1E-07	9.1E-06	2.6E-06	1.6E-06	1.4E-05
1	Organic	4,4'-DDT	3.8E-01	2.6E-08	4.1E-09		2.1E-08	9.4E-06	2.6E-06	1.7E-07	1.2E-05
1	Organic	4,4'-DDD	3.8E-01	1.8E-08			1.5E-08	2.0E-06	5.6E-07	2.2E-07	2.8E-06
1	Radionuclide	Cobalt-60	5.8E+00	3.8E-08	2.2E-08	1.3E-04		6.4E-08	8.2E-09	7.6E-07	1.3E-04
1	Radionuclide	Cesium-137	9.3E-01	1.0E-08	1.0E-09	1.2E-05		2.2E-06	1.2E-06	2.7E-07	1.6E-05
1			Pathway Total	4.1E-06	4.3E-05	1.4E-04	4.1E-06	3.8E-05	2.2E-05	1.3E-05	2.6E-04
7	Inorganic	Arsenic	2.7E+01	7.8E-06	4.2E-05			8.8E-06	2.6E-05	2.1E-05	1.1E-04
7	Inorganic	Chromium	3.7E+01		4.8E-05						4.8E-05
7	Inorganic	Beryllium	1.2E+00	1.0E-06	3.2E-07		5.8E-06	3.8E-08	1.4E-06	2.2E-06	1.1E-05
7	Organic	Benzo(a)pyrene	6.3E-01	9.0E-07			1.6E-06	1.9E-04	5.2E-05	7.8E-06	2.5E-04
7	Organic	Indeno(1,2,3-cd)pyrene	4.1E-02	5.8E-09			1.1E-08	3.4E-06	9.8E-07	3.2E-08	4.5E-06
7	Organic	Benzo(a)anthracene	2.2E-01	3.2E-08			5.9E-08	2.6E-06	7.4E-07	4.6E-07	3.9E-06
7	Organic	Benzo(b)fluoranthene	4.9E-02	7.0E-09			1.3E-08	1.5E-06	4.3E-07	6.0E-08	2.0E-06

Table E52 (continued)

Reach	Chemical Type	Chemical	Representative concentration (mg/kg, pCi/g)	Ingestion ECR	Inhalation ECR	External Exposure ECR	Dermal ECR	Ingestion of Milk ECR	Ingestion of Meat ECR	Ingestion of Vegetables ECR	Total ECR Across Pathways
7	Radionuclide	Strontium-90	2.1E+00	4.2E-08	8.4E-09			8.6E-06	2.5E-06	7.6E-06	1.9E-05
7	Radionuclide	Cesium-137	4.4E-01	4.8E-09	4.7E-10	5.6E-06		1.0E-06	5.7E-07	1.3E-07	7.3E-06
7			Pathway Total	9.8E-06	9.0E-05	5.6E-06	7.5E-06	2.1E-04	8.5E-05	4.0E-05	4.5E-04

Table E53. Chemicals with a hazard quotient (HQ) >0.1 and hazard indices (HIs) for the adult dredging pathways for reach 1 and 7 of the Clinch River

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Adult Ingestion HQ	Adult Inhalation HQ	Adult Dermal HQ	Adult Ingestion of Milk HQ	Adult Ingestion of Meat HQ	Adult Ingestion of Vegetables HQ	Total HIs Across Pathways
1	Inorganic	Zinc	1.2E+02	1.9E-04		5.3E-05	1.7E-01	1.5E-01	4.5E-02	3.7E-01
1	Inorganic	Nickel	2.3E+01	5.3E-04		1.1E-04	2.4E-01	6.8E-03	1.7E-02	2.6E-01
1	Inorganic	Arsenic	1.1E+01	1.7E-02		2.3E-03	1.9E-02	5.7E-02	4.6E-02	1.4E-01
1	Organic	4,4'-DDT	3.8E-01	3.5E-04		2.9E-04	1.3E-01	3.6E-02	2.4E-03	1.7E-01
1			Hazard Index	1.8E-02		2.8E-03	5.5E-01	2.5E-01	1.1E-01	9.3E-01
7	Inorganic	Manganese	1.6E+03	5.1E-03	8.1E+00	7.3E-03	1.4E-02	2.1E-02	1.2E+00	9.4E+00
7	Inorganic	Arsenic	2.7E+01	4.0E-02		5.6E-03	4.6E-02	1.4E-01	1.1E-01	3.4E-01
7	Inorganic	Nickel	3.0E+01	6.8E-04		1.4E-04	3.0E-01	8.7E-03	2.2E-02	3.3E-01
7	Inorganic	Zinc	8.8E+01	1.3E-04		3.8E-05	1.2E-01	1.1E-01	3.2E-02	2.6E-01
7	Inorganic	Selenium	3.7E+00	3.4E-04		4.4E-05	1.2E-01	1.1E-01	2.1E-02	2.5E-01
7	Inorganic	Barium	1.6E+02	1.0E-03	8.2E-02	8.4E-04	1.0E-02	4.4E-04	8.1E-03	1.0E-01
7			Hazard Index	4.8E-02	8.2E+00	1.4E-02	6.2E-01	3.9E-01	1.4E+00	1.1E+01

Table E54. Chemicals with a hazard quotient (HQ) >0.1 and hazard indices (HIs) for the child dredging pathways for reach 1 and 7 of the Clinch River

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Child Ingestion HQ	Child Inhalation HQ	Child Dermal HQ	Child Ingestion of Milk HQ	Child Ingestion of Meat HQ	Child Ingestion of Vegetables HQ	Total HIs Across Pathways
1	Inorganic	Zinc	1.2E+02	1.7E-03		1.0E-04	1.6E+00	7.1E-01	2.1E-01	2.5E+00
1	Inorganic	Nickel	2.3E+01	5.0E-03		2.1E-04	2.2E+00	3.2E-02	7.9E-02	2.3E+00
1	Inorganic	Arsenic	1.1E+01	1.6E-01		4.4E-03	1.8E-01	2.6E-01	2.1E-01	8.2E-01
1	Inorganic	Selenium	6.9E-01	5.9E-04		1.5E-05	2.2E-01	9.7E-02	1.8E-02	3.3E-01
1	Inorganic	Mercury	1.2E-01	1.8E-03	4.7E-04	2.9E-09	6.0E-02	5.7E-02	1.6E-01	2.8E-01
1	Inorganic	Chromium	2.0E+01	1.7E-02		9.6E-03	3.4E-03	1.4E-01	6.6E-02	2.3E-01
1	Inorganic	Cadmium	7.3E-01	3.1E-03		3.6E-03	7.9E-02	1.4E-03	3.8E-02	1.2E-01
1	Organic	4,4'-DDT	3.8E-01	3.3E-03		5.4E-04	1.2E+00	1.7E-01	1.1E-02	1.4E+00
1			Hazard Index	1.9E-01	4.7E-04	1.8E-02	5.5E+00	1.5E+00	8.0E-01	8.0E+00
7	Inorganic	Manganese	1.6E+03	4.8E-02	3.6E+01	1.4E-02	1.3E-01	9.8E-02	5.8E+00	4.2E+01
7	Inorganic	Nickel	3.0E+01	6.3E-03		2.7E-04	2.8E+00	4.1E-02	1.0E-01	3.0E+00
7	Inorganic	Arsenic	2.7E+01	3.8E-01		1.1E-02	4.3E-01	6.4E-01	5.2E-01	2.0E+00
7	Inorganic	Zinc	8.8E+01	1.3E-03		7.2E-05	1.1E+00	5.1E-01	1.5E-01	1.8E+00
7	Inorganic	Selenium	3.7E+00	3.1E-03		8.2E-05	1.2E+00	5.2E-01	9.7E-02	1.8E+00
7	Inorganic	Vanadium	4.3E+01	2.6E-02		3.0E-02	4.9E-01	5.0E-02	3.4E-02	6.3E-01
7	Inorganic	Barium	1.6E+02	9.7E-03	3.6E-01	1.6E-03	9.5E-02	2.0E-03	3.8E-02	5.1E-01
7	Inorganic	Chromium	3.7E+01	3.1E-02		1.8E-02	6.4E-03	2.6E-01	1.2E-01	4.4E-01
7	Inorganic	Mercury	1.4E-01	2.0E-03	5.4E-04	3.3E-09	6.9E-02	6.6E-02	1.8E-01	3.2E-01
7			Hazard Index	5.0E-01	3.7E+01	7.4E-02	6.3E+00	2.2E+00	7.1E+00	5.3E+01

Table E55. Chemicals with excess cancer risks (ECR) of >10^{-6} and pathway totals for the dredging pathways for selected Clinch River and Poplar Creek subreaches

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg, pCi/g)	Ingestion ECR	Inhalation ECR	External ECR	Dermal ECR	Ingestion of Milk ECR	Ingesion of Meat ECR	Ingestion of Vegetables ECR	Total ECR Across Pathways
2.04	Inorganic	Arsenic	9.7E+00	2.9E-06	1.5E-05			3.2E-06	9.6E-06	7.8E-06	3.9E-05
2.04	Inorganic	Chromium	1.6E+01		2.1E-05						2.1E-05
2.04	Inorganic	Beryllium	7.8E-01	6.6E-07	2.1E-07		3.7E-06	2.5E-08	8.8E-07	1.4E-06	6.9E-06
2.04	Organic	Benzo(a)pyrene	4.9E-01	7.0E-07			1.3E-06	1.4E-04	4.1E-05	6.1E-06	1.9E-04
2.04	Organic	Indeno(1,2,3-cd)pyrene	1.8E-01	2.5E-08			4.7E-08	1.5E-05	4.3E-06	1.4E-07	2.0E-05
2.04	Organic	Benzo(k)fluoranthene	5.0E-01	7.2E-09			1.3E-08	7.7E-06	2.2E-06	3.2E-08	9.9E-06
2.04	Organic	Pentachlorophenol	2.4E+00	5.7E-08			3.3E-08	7.1E-06	2.0E-06	6.5E-07	9.8E-06
2.04	Organic	Benzo(a)anthracene	5.0E-01	7.2E-08			1.3E-07	5.8E-06	1.6E-06	1.0E-06	8.7E-06
2.04	Organic	Benzo(b)fluoranthene	1.6E-01	2.3E-08			4.2E-08	4.9E-06	1.4E-06	1.9E-07	6.6E-06
2.04	Radionuclide	Cesium-137	2.1E+01	2.4E-07	2.3E-08	2.7E-04		5.1E-05	2.8E-05	6.1E-06	3.6E-04
2.04	Radionuclide	Strontium-90	3.3E+00	6.5E-08	1.3E-08			1.3E-05	3.8E-06	1.2E-05	2.9E-05
2.04	Radionuclide	Cobalt-60	1.8E-01	1.2E-09	7.2E-10	4.0E-06		2.1E-09	2.6E-10	2.4E-08	4.0E-06
2.04	Radionuclide	Uranium-238	1.2E+00	2.7E-08	8.6E-07	5.3E-07		2.1E-07	2.0E-08	9.0E-08	1.7E-06
2.04	Radionuclide	Uranium-234	1.4E+00	2.1E-08	1.1E-06	2.4E-10		1.6E-07	1.2E-08	6.4E-08	1.3E-06
2.04			Pathway Total	4.7E-06	3.8E-05	2.8E-04	5.3E-06	2.5E-04	9.5E-05	3.6E-05	7.1E-04
3.01	Inorganic	Chromium	1.0E+01		1.3E-05						1.3E-05
3.01	Inorganic	Arsenic	1.3E+00	3.8E-07	2.1E-06			4.4E-07	1.3E-06	1.1E-06	5.2E-06

Table E55 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg, pCi/g)	Ingestion ECR	Inhalation ECR	External ECR	Dermal ECR	Ingestion of Milk ECR	Ingesion of Meat ECR	Ingestion of Vegetables ECR	Total ECR Across Pathways
3.01	Inorganic	Beryllium	5.3E-01	4.4E-07	1.4E-07		2.5E-06	1.7E-08	5.9E-07	9.4E-07	4.6E-06
3.01	Organic	Benzo(b)fluoranthene	1.6E-01	2.3E-08			4.3E-08	5.0E-06	1.4E-06	2.0E-07	6.7E-06
3.01			Pathway Total	8.5E-07	1.5E-05	0.0E+00	2.6E-06	5.5E-06	3.3E-06	2.2E-06	3.0E-05
3.02	Inorganic	Chromium	2.4E+01		3.1E-05						3.1E-05
3.02	Inorganic	Arsenic	5.0E+00	1.5E-06	8.0E-06			1.7E-06	5.0E-06	4.1E-06	2.0E-05
3.02	Inorganic	Beryllium	7.7E-01	6.5E-07	2.1E-07		3.7E-06	2.4E-08	8.7E-07	1.4E-06	6.8E-06
3.02	Organic	PCB-1260	7.9E-01	1.2E-06			7.5E-07	2.5E-03	7.2E-04	4.2E-06	3.3E-03
3.02	Organic	Dibenz(a,h)anthracene	4.1E-01	5.9E-07			1.1E-06	6.3E-04	1.8E-04	2.6E-06	8.1E-04
3.02	Organic	Benzo(a)pyrene	5.2E-01	7.5E-07			1.4E-06	1.5E-04	4.4E-05	6.6E-06	2.1E-04
3.02	Organic	PCB-1248	3.9E-01	5.9E-07			3.7E-07	5.8E-05	1.7E-05	7.4E-06	8.3E-05
3.02	Organic	Indeno(1,2,3-cd)pyrene	3.5E-01	5.0E-08			9.2E-08	3.0E-05	8.4E-06	2.7E-07	3.8E-05
3.02	Organic	Benzo(b)fluoranthene	8.7E-01	1.2E-07			2.3E-07	2.7E-05	7.7E-06	1.1E-06	3.6E-05
3.02	Organic	Benzo(a)anthracene	9.2E-01	1.3E-07			2.4E-07	1.1E-05	3.0E-06	1.9E-06	1.6E-05
3.02	Organic	Benzo(k)fluoranthene	4.1E-01	5.8E-09			1.1E-08	6.2E-06	1.8E-06	2.6E-08	8.0E-06
3.02	Radionuclide	Technetium-99	5.2E+01	2.6E-08	8.5E-09	2.7E-10		3.3E-06	2.1E-07	7.7E-05	8.1E-05
3.02	Radionuclide	Strontium-90	2.6E+00	5.2E-08	1.0E-08			1.1E-05	3.0E-06	9.4E-06	2.3E-05
3.02	Radionuclide	Uranium-234	1.1E+01	1.7E-07	8.9E-06	2.0E-09		1.3E-06	1.0E-07	5.3E-07	1.1E-05

Table E55 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg, pCi/g)	Ingestion ECR	Inhalation ECR	External ECR	Dermal ECR	Ingestion of Milk ECR	Ingesion of Meat ECR	Ingestion of Vegetables ECR	Total ECR Across Pathways
3.02	Radionuclide	Uranium-238	6.9E+00	1.5E-07	4.8E-06	3.0E-06		1.2E-06	1.2E-07	5.1E-07	9.8E-06
3.02	Radionuclide	Cesium-137	2.5E-01	2.8E-09	2.7E-10	3.2E-06		6.0E-07	3.3E-07	7.1E-08	4.2E-06
3.02	Radionuclide	Cobalt-60	1.5E-01	9.9E-10	5.8E-10	3.2E-06		1.7E-09	2.1E-10	2.0E-08	3.3E-06
3.02	Radionuclide	Uranium-235	5.3E-01	8.7E-09	3.9E-07	1.2E-06		6.7E-08	6.5E-09	2.9E-08	1.7E-06
3.02			Pathway Total	6.0E-06	5.4E-05	1.1E-05	7.9E-06	3.5E-03	9.9E-04	1.2E-04	4.7E-03
3.03	Inorganic	Chromium	4.4E+01		5.7E-05						5.7E-05
3.03	Inorganic	Arsenic	5.3E+00	1.5E-06	8.3E-06			1.8E-06	5.2E-06	4.2E-06	2.1E-05
3.03	Inorganic	Beryllium	9.2E-01	7.8E-07	2.5E-07		4.4E-06	2.9E-08	1.0E-06	1.7E-06	8.2E-06
3.03	Organic	Dibenz(a,h)anthracene	3.6E-02	5.1E-08			9.4E-08	5.4E-05	1.5E-05	2.3E-07	7.0E-05
3.03	Organic	Benzo(a)pyrene	1.6E-01	2.3E-07			4.2E-07	4.7E-05	1.3E-05	2.0E-06	6.3E-05
3.03	Organic	Indeno(1,2,3-cd)pyrene	1.6E-01	2.3E-08			4.3E-08	1.4E-05	3.9E-06	1.3E-07	1.8E-05
3.03	Organic	Benzo(b)fluoranthene	2.8E-01	4.1E-08			7.5E-08	8.9E-06	2.5E-06	3.5E-07	1.2E-05
3.03	Organic	Benzo(a)anthracene	2.3E-01	3.3E-08			6.1E-08	2.7E-06	7.6E-07	4.7E-07	4.0E-06
3.03	Organic	Benzo(k)fluoranthene	6.7E-02	9.6E-10			1.8E-09	1.0E-06	2.9E-07	4.2E-09	1.3E-06
3.03	Radionuclide	Cesium-137	1.2E+00	1.3E-08	1.3E-09	1.5E-05		2.8E-06	1.5E-06	3.4E-07	2.0E-05
3.03	Radionuclide	Uranium-234	3.5E+00	5.4E-08	2.8E-06	6.2E-10		4.1E-07	3.1E-08	1.7E-07	3.4E-06
3.03	Radionuclide	Uranium-238	2.0E+00	4.4E-08	1.4E-06	8.9E-07		3.4E-07	3.4E-08	1.5E-07	2.9E-06

Table E55 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg, pCi/g)	Ingestion ECR	Inhalation ECR	External ECR	Dermal ECR	Ingestion of Milk ECR	Ingesion of Meat ECR	Ingestion of Vegetables ECR	Total ECR Across Pathways
3.03			Pathway Total	2.8E-06	7.0E-05	1.6E-05	5.1E-06	1.3E-04	4.4E-05	9.7E-06	2.8E-04
3.04	Inorganic	Arsenic	9.4E+01	2.8E-05	1.5E-04			3.1E-05	9.3E-05	7.5E-05	3.8E-04
3.04	Inorganic	Chromium	3.9E+01		5.1E-05						5.1E-05
3.04	Inorganic	Beryllium	1.7E+00	1.4E-06	4.5E-07		8.1E-06	5.3E-08	1.9E-06	3.0E-06	1.5E-05
3.04	Inorganic	Cadmium	5.6E+00		1.1E-06						1.1E-06
3.04	Organic	PCB-1260	1.3E-01	1.9E-07			1.2E-07	4.1E-04	1.1E-04	6.7E-07	5.2E-04
3.04	Organic	Dibenz(a,h)anthracene	2.5E-01	3.6E-07			6.6E-07	3.8E-04	1.1E-04	1.6E-06	5.0E-04
3.04	Organic	Benzo(a)pyrene	2.2E-01	3.2E-07			5.8E-07	6.5E-05	1.8E-05	2.8E-06	8.7E-05
3.04	Organic	Indeno(1,2,3-cd)pyrene	2.5E-01	3.5E-08			6.5E-08	2.1E-05	5.9E-06	1.9E-07	2.7E-05
3.04	Organic	PCB-1248	6.5E-02	9.8E-08			6.2E-08	9.8E-06	2.8E-06	1.2E-06	1.4E-05
3.04	Organic	Benzo(b)fluoranthene	2.3E-01	3.4E-08			6.2E-08	7.3E-06	2.1E-06	2.9E-07	9.8E-06
3.04	Organic	Benzo(k)fluoranthene	2.5E-01	3.6E-09			6.6E-09	3.8E-06	1.1E-06	1.6E-08	5.0E-06
3.04	Organic	Benzo(a)anthracene	1.7E-01	2.4E-08			4.4E-08	1.9E-06	5.5E-07	3.4E-07	2.9E-06
3.04	Radionuclide	Cesium-137	7.9E+00	8.8E-08	8.5E-09	1.0E-04		1.9E-05	1.0E-05	2.3E-06	1.3E-04
3.04	Radionuclide	Uranium-238	5.0E+00	1.1E-07	3.5E-06	2.2E-06		8.4E-07	8.3E-08	3.6E-07	7.0E-06
3.04	Radionuclide	Uranium-234	6.1E+00	9.5E-08	4.8E-06	1.1E-09		7.2E-07	5.4E-08	2.9E-07	6.0E-06
3.04	Radionuclide	Technetium-99	3.8E+00	1.8E-09	6.2E-10	1.9E-11		2.4E-07	1.5E-08	5.5E-06	5.8E-06

Table E55 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg, pCi/g)	Ingestion ECR	Inhalation ECR	External ECR	Dermal ECR	Ingestion of Milk ECR	Ingesion of Meat ECR	Ingestion of Vegetables ECR	Total ECR Across Pathways
3.04	Radionuclide	Cobalt-60	1.9E-01	1.2E-09	7.3E-10	4.1E-06		2.1E-09	2.7E-10	2.4E-08	4.1E-06
3.04	Radionuclide	Uranium-235	3.7E-01	6.0E-09	2.7E-07	8.0E-07		4.6E-08	4.5E-09	2.0E-08	1.1E-06
3.04			Pathway Total	3.0E-05	2.1E-04	1.1E-04	9.7E-06	9.5E-04	3.6E-04	9.4E-05	1.8E-03
4.01	Inorganic	Arsenic	1.0E+01	2.9E-06	1.6E-05			3.3E-06	9.9E-06	8.0E-06	4.0E-05
4.01	Inorganic	Chromium	1.8E+01		2.4E-05						2.4E-05
4.01	Inorganic	Beryllium	7.7E-01	6.5E-07	2.1E-07		3.7E-06	2.4E-08	8.7E-07	1.4E-06	6.9E-06
4.01	Organic	PCB-1260	2.1E+00	3.1E-06			2.0E-06	6.7E-03	1.9E-03	1.1E-05	8.6E-03
4.01	Organic	N-Nitroso-di-n-propylamine	5.0E-01	6.8E-07			1.6E-06	1.5E-07	4.1E-08	2.6E-03	2.6E-03
4.01	Organic	Dibenz(a,h)anthracene	5.0E-01	7.1E-07			1.3E-06	7.6E-04	2.1E-04	3.2E-06	9.8E-04
4.01	Organic	Benzo(a)pyrene	5.0E-01	7.1E-07			1.3E-06	1.5E-04	4.2E-05	6.2E-06	2.0E-04
4.01	Organic	Indeno(1,2,3-cd)pyrene	5.0E-01	7.1E-08			1.3E-07	4.2E-05	1.2E-05	3.9E-07	5.5E-05
4.01	Organic	Benzo(b)fluoranthene	5.0E-01	7.1E-08			1.3E-07	1.6E-05	4.4E-06	6.1E-07	2.1E-05
4.01	Organic	Benzo(k)fluoranthene	5.0E-01	7.1E-09			1.3E-08	7.6E-06	2.1E-06	3.2E-08	9.8E-06
4.01	Organic	Pentachlorophenol	2.4E+00	5.7E-08			3.2E-08	7.0E-06	2.0E-06	6.5E-07	9.7E-06
4.01	Organic	Benzo(a)anthracene	5.0E-01	7.1E-08			1.3E-07	5.8E-06	1.6E-06	1.0E-06	8.6E-06
4.01	Radionuclide	Cesium-137	2.3E+01	2.5E-07	2.5E-08	2.9E-04		5.5E-05	3.0E-05	6.5E-06	3.8E-04
4.01	Radionuclide	Cobalt-60	1.3E-01	8.4E-10	4.9E-10	2.8E-06		1.4E-09	1.8E-10	1.7E-08	2.8E-06

Table E55 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg, pCi/g)	Ingestion ECR	Inhalation ECR	External ECR	Dermal ECR	Ingestion of Milk ECR	Ingesion of Meat ECR	Ingestion of Vegetables ECR	Total ECR Across Pathways
4.01		Pathway Total		9.3E-06	4.0E-05	2.9E-04	1.0E-05	7.7E-03	2.2E-03	2.6E-03	1.3E-02
4.02	Inorganic	Arsenic	1.1E+01	3.3E-06	1.8E-05			3.7E-06	1.1E-05	9.0E-06	4.5E-05
4.02	Inorganic	Chromium	1.4E+01		1.9E-05						1.9E-05
4.02	Inorganic	Beryllium	6.7E-01	5.6E-07	1.8E-07		3.2E-06	2.1E-08	7.5E-07	1.2E-06	5.9E-06
4.02	Radionuclide	Cesium-137	4.0E-01	4.4E-09	4.3E-10	5.1E-06		9.6E-07	5.3E-07	1.1E-07	6.7E-06
4.02		Pathway Total		3.9E-06	3.6E-05	5.1E-06	3.2E-06	4.7E-06	1.2E-05	1.0E-05	7.6E-05
4.03	Inorganic	Chromium	3.7E+01		4.8E-05						4.8E-05
4.03	Inorganic	Arsenic	7.8E+00	2.3E-06	1.2E-05			2.6E-06	7.8E-06	6.3E-06	3.1E-05
4.03	Inorganic	Beryllium	1.1E+00	9.1E-07	2.9E-07		5.2E-06	3.4E-08	1.2E-06	1.9E-06	9.6E-06
4.03	Organic	Dibenz(a,h)anthracene	2.7E-01	3.8E-07			7.0E-07	4.1E-04	1.1E-04	1.7E-06	5.2E-04
4.03	Organic	Benzo(a)pyrene	4.8E-01	6.9E-07			1.3E-06	1.4E-04	4.0E-05	6.0E-06	1.9E-04
4.03	Organic	PCB-1260	3.4E-02	5.2E-08			3.3E-08	1.1E-04	3.1E-05	1.8E-07	1.4E-04
4.03	Organic	Indeno(1,2,3-cd)pyrene	8.9E-02	1.3E-08			2.3E-08	7.6E-06	2.1E-06	7.0E-08	9.9E-06
4.03	Organic	Benzo(b)fluoranthene	1.8E-01	2.5E-08			4.6E-08	5.5E-06	1.6E-06	2.2E-07	7.4E-06
4.03	Organic	Benzo(a)anthracene	1.1E-01	1.6E-08			2.9E-08	1.3E-06	3.6E-07	2.3E-07	1.9E-06
4.03	Radionuclide	Cesium-137	1.8E+01	2.0E-07	1.9E-08	2.3E-04		4.3E-05	2.4E-05	5.2E-06	3.0E-04
4.03	Radionuclide	Cobalt-60	3.9E-01	2.6E-09	1.5E-09	8.6E-06		4.4E-09	5.6E-10	5.2E-08	8.6E-06

Table E55 (continued)

Reach	Chemical Type	Chemical	Representative Concentration (mg/kg, pCi/g)	Ingestion ECR	Inhalation ECR	External ECR	Dermal ECR	Ingestion of Milk ECR	Ingesion of Meat ECR	Ingestion of Vegetables ECR	Total ECR Across Pathways
4.03			Pathway Total	4.6E-06	6.0E-05	2.4E-04	7.3E-06	7.2E-04	2.2E-04	2.2E-05	1.3E-03
4.04	Inorganic	Arsenic	1.0E+01	3.0E-06	1.6E-05			3.4E-06	1.0E-05	8.3E-06	4.1E-05
4.04	Inorganic	Chromium	2.6E+01		3.4E-05						3.4E-05
4.04	Inorganic	Beryllium	1.2E+00	1.0E-06	3.3E-07		5.9E-06	3.9E-08	1.4E-06	2.2E-06	1.1E-05
4.04	Organic	Dibenz(a,h)anthracene	3.5E+00	5.1E-06			9.3E-06	5.4E-03	1.5E-03	2.2E-05	6.9E-03
4.04	Organic	Benzo(a)pyrene	1.0E+00	1.5E-06			2.7E-06	3.0E-04	8.5E-05	1.3E-05	4.0E-04
4.04	Organic	Indeno(1,2,3-cd)pyrene	9.6E-01	1.4E-07			2.5E-07	8.1E-05	2.3E-05	7.5E-07	1.1E-04
4.04	Organic	Benzo(b)fluoranthene	1.6E-01	2.2E-08			4.1E-08	4.9E-06	1.4E-06	1.9E-07	6.5E-06
4.04	Organic	Benzo(a)anthracene	3.0E-01	4.3E-08			8.0E-08	3.5E-06	9.9E-07	6.2E-07	5.2E-06
4.04	Radionuclide	Cesium-137	1.2E+01	1.4E-07	1.3E-08	1.6E-04		2.9E-05	1.6E-05	3.5E-06	2.1E-04
4.04	Radionuclide	Strontium-90	8.6E-01	1.7E-08	3.4E-09	3.5E-06			9.9E-07	3.1E-07	.5E-06
4.04	Radionuclide	Cobalt-60	2.3E-01	1.5E-09	9.0E-10	5.0E-06		2.6E-09	3.3E-10	3.0E-08	5.1E-06
4.04	Radionuclide	Uranium-238	1.9E+00	4.1E-08	1.3E-06	8.2E-07		3.2E-07	3.1E-08	1.4E-07	2.7E-06
4.04	Radionuclide	Uranium-234	2.2E+00	3.5E-08	1.8E-06	3.9E-10		2.6E-07	2.0E-08	1.1E-07	2.2E-06
4.04			Pathway Total	1.1E-05	5.4E-05	1.6E-04	1.8E-05	5.8E-03	1.7E-03	5.4E-05	7.8E-03

Table E56. Chemicals with a hazard quotient (HQ) >0.1 and hazard indices for the adult dredging pathways for selected subreaches of the Clinch River and Poplar Creek

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Adult Ingestion HQ	Adult Inhalation HQ	Adult Dermal HQ	Adult Ingestion of Milk HQ	Adult Ingestion of Meat HQ	Adult Ingestion of Vegetables HQ	Total HIs Across Pathways
2.04	Inorganic	Manganese	4.5E+03	1.5E-02	2.3E+01	2.1E-02	4.0E-02	6.0E-02	3.5E+00	2.7E+01
2.04	Inorganic	Zinc	6.8E+01	1.0E-04		2.9E-05	9.4E-02	8.4E-02	2.5E-02	2.0E-01
2.04	Inorganic	Nickel	1.5E+01	3.5E-04		7.4E-05	1.6E-01	4.5E-03	1.1E-02	1.7E-01
2.04	Inorganic	Selenium	2.4E+00	2.2E-04		2.9E-05	8.2E-02	7.3E-02	1.4E-02	1.7E-01
2.04	Inorganic	Arsenic	9.7E+00	1.5E-02		2.1E-03	1.7E-02	5.0E-02	4.1E-02	1.2E-01
2.04			Hazard Index	3.0E-02	2.3E+01	2.3E-02	3.9E-01	2.7E-01	3.6E+00	2.7E+01
3.01	Inorganic	Manganese	3.2E+02	1.0E-03	1.6E+00	1.5E-03	2.8E-03	4.2E-03	2.5E-01	1.9E+00
3.01	Inorganic	Nickel	1.0E+01	2.4E-04		5.0E-05	1.0E-01	3.0E-03	7.5E-03	1.2E-01
3.01			Hazard Index	1.3E-03	1.6E+00	1.5E-03	1.1E-01	7.3E-03	2.6E-01	2.0E+00
3.02	Inorganic	Manganese	1.1E+03	3.4E-03	5.4E+00	4.9E-03	9.4E-03	1.4E-02	8.3E-01	6.3E+00
3.02	Inorganic	Mercury	4.1E+00	6.2E-03	3.5E-03	5.0E-08	2.1E-01	4.0E-01	1.1E+00	1.8E+00
3.02	Inorganic	Nickel	5.2E+01	1.2E-03		2.5E-04	5.3E-01	1.5E-02	3.8E-02	5.8E-01
3.02	Inorganic	Zinc	1.2E+02	1.8E-04		5.1E-05	1.6E-01	1.4E-01	4.3E-02	3.5E-01
3.02	Organic	PCB-1254	7.3E-01	1.7E-02		1.1E-02	3.0E+00	8.4E-01	1.6E-01	4.0E+00
3.02			Hazard Index	2.8E-02	5.4E+00	1.6E-02	3.9E+00	1.4E+00	2.2E+00	1.3E+01
3.03	Inorganic	Manganese	6.9E+02	2.3E-03	3.6E+00	3.2E-03	6.2E-03	9.2E-03	5.5E-01	4.1E+00
3.03	Inorganic	Mercury	6.7E+00	1.0E-02	5.7E-03	8.3E-08	3.5E-01	6.6E-01	1.8E+00	2.9E+00

Table E56 (continued)

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Adult Ingestion HQ	Adult Inhalation HQ	Adult Dermal HQ	Adult Ingestion of Milk HQ	Adult Ingestion of Meat HQ	Adult Ingestion of Vegetables HQ	Total HIs Across Pathways
3.03	Inorganic	Nickel	6.2E+01	1.4E-03		3.0E-04	6.3E-01	1.8E-02	4.5E-02	7.0E-01
3.03	Inorganic	Zinc	1.6E+02	2.4E-04		7.0E-05	2.2E-01	2.0E-01	5.9E-02	4.8E-01
3.03	Inorganic	Chromium	4.4E+01	4.1E-03		1.2E-02	8.3E-04	6.7E-02	3.2E-02	1.1E-01
3.03			Hazard Index	1.8E-02	3.6E+00	1.5E-02	1.2E+00	9.6E-01	2.5E+00	8.3E+00
3.04	Inorganic	Mercury	2.6E+01	3.9E-02	2.2E-02	3.2E-07	1.3E+00	2.6E+00	7.1E+00	1.1E+01
3.04	Inorganic	Manganese	7.4E+02	2.4E-03	3.8E+00	3.4E-03	6.6E-03	9.8E-03	5.8E-01	4.4E+00
3.04	Inorganic	Arsenic	9.4E+01	1.4E-01		2.0E-02	1.6E-01	4.8E-01	3.9E-01	1.2E+00
3.04	Inorganic	Nickel	5.1E+01	1.2E-03		2.4E-04	5.1E-01	1.5E-02	3.7E-02	5.6E-01
3.04	Inorganic	Zinc	1.2E+02	1.8E-04		5.0E-05	1.6E-01	1.4E-01	4.3E-02	3.5E-01
3.04	Inorganic	Barium	2.9E+02	1.9E-03	1.5E-01	1.5E-03	1.9E-02	7.9E-04	1.5E-02	1.9E-01
3.04	Inorganic	Cadmium	5.6E+00	2.6E-03		1.5E-02	6.5E-02	2.3E-03	6.2E-02	1.5E-01
3.04	Inorganic	Vanadium	5.9E+01	3.9E-03		2.2E-02	7.3E-02	1.5E-02	1.0E-02	1.2E-01
3.04	Inorganic	Selenium	1.6E+00	1.4E-04		1.9E-05	5.3E-02	4.7E-02	8.9E-03	1.1E-01
3.04	Inorganic	Chromium	3.9E+01	3.6E-03		1.0E-02	7.3E-04	5.9E-02	2.8E-02	1.0E-01
3.04	Organic	PCB-1254	1.8E-01	4.1E-03		2.6E-03	7.3E-01	2.1E-01	3.9E-02	9.8E-01
3.04			Hazard Index	2.0E-01	4.0E+00	7.4E-02	3.1E+00	3.5E+00	8.3E+00	1.9E+01
4.01	Inorganic	Mercury	1.2E+01	1.9E-02	1.0E-02	1.5E-07	6.3E-01	1.2E+00	3.4E+00	5.2E+00
4.01	Inorganic	Manganese	8.4E+02	2.7E-03	4.3E+00	3.9E-03	7.5E-03	1.1E-02	6.6E-01	5.0E+00

Table E56 (continued)

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Adult Ingestion HQ	Adult Inhalation HQ	Adult Dermal HQ	Adult Ingestion of Milk HQ	Adult Ingestion of Meat HQ	Adult Ingestion of Vegetables HQ	Total HIs Across Pathways
4.01	Inorganic	Nickel	2.0E+01	4.5E-04		9.4E-05	2.0E-01	5.7E-03	1.4E-02	2.2E-01
4.01	Inorganic	Zinc	6.5E+01	1.0E-04		2.8E-05	9.1E-02	8.1E-02	2.4E-02	2.0E-01
4.01	Inorganic	Arsenic	1.0E+01	1.5E-02		2.1E-03	1.7E-02	5.1E-02	4.2E-02	1.3E-01
4.01	Organic	PCB-1254	4.0E-01	9.1E-03		5.8E-03	1.6E+00	4.6E-01	8.6E-02	2.2E+00
4.01			Hazard Index	4.6E-02	4.3E+00	1.2E-02	2.6E+00	1.8E+00	4.2E+00	1.3E+01
4.02	Inorganic	Manganese	6.7E+02	2.2E-03	3.4E+00	3.1E-03	5.9E-03	8.8E-03	5.2E-01	4.0E+00
4.02	Inorganic	Nickel	1.3E+01	3.0E-04		6.4E-05	1.3E-01	3.9E-03	9.7E-03	1.5E-01
4.02	Inorganic	Mercury	3.4E-01	5.2E-04	2.9E-04	4.2E-09	1.8E-02	3.4E-02	9.4E-02	1.5E-01
4.02	Inorganic	Arsenic	1.1E+01	1.7E-02		2.4E-03	1.9E-02	5.8E-02	4.7E-02	1.4E-01
4.02	Inorganic	Zinc	4.7E+01	7.1E-05		2.0E-05	6.5E-02	5.8E-02	1.7E-02	1.4E-01
4.02			Hazard Index	2.0E-02	3.4E+00	5.5E-03	2.4E-01	1.6E-01	6.9E-01	4.6E+00
4.03	Inorganic	Manganese	1.6E+03	5.1E-03	8.1E+00	7.3E-03	1.4E-02	2.1E-02	1.2E+00	9.4E+00
4.03	Inorganic	Mercury	3.5E+00	5.4E-03	3.0E-03	4.4E-08	1.8E-01	3.5E-01	9.7E-01	1.5E+00
4.03	Inorganic	Nickel	4.0E+01	9.2E-04		1.9E-04	4.1E-01	1.2E-02	2.9E-02	4.5E-01
4.03	Inorganic	Zinc	1.1E+02	1.7E-04		5.0E-05	1.6E-01	1.4E-01	4.2E-02	3.4E-01
4.03	Inorganic	Arsenic	7.8E+00	1.2E-02		1.7E-03	1.4E-02	4.0E-02	3.3E-02	1.0E-01
4.03	Organic	PCB-1254	6.4E-02	1.5E-03		9.2E-04	2.6E-01	7.3E-02	1.4E-02	3.5E-01
4.03			Hazard Index	2.5E-02	8.1E+00	1.0E-02	1.0E+00	6.4E-01	2.3E+00	1.2E+01

Table E56 (continued)

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Adult Ingestion HQ	Adult Inhalation HQ	Adult Dermal HQ	Adult Ingestion of Milk HQ	Adult Ingestion of Meat HQ	Adult Ingestion of Vegetables HQ	Total HIs Across Pathways
4.04	Inorganic	Manganese	1.7E+03	5.4E-03	8.6E+00	7.7E-03	1.5E-02	2.2E-02	1.3E+00	9.9E+00
4.04	Inorganic	Mercury	3.1E+00	4.6E-03	2.6E-03	3.8E-08	1.6E-01	3.0E-01	8.5E-01	1.3E+00
4.04	Inorganic	Zinc	1.4E+02	2.2E-04		6.1E-05	2.0E-01	1.8E-01	5.2E-02	4.2E-01
4.04	Inorganic	Nickel	3.6E+01	8.1E-04		1.7E-04	3.6E-01	1.0E-02	2.6E-02	4.0E-01
4.04	Inorganic	Arsenic	1.0E+01	1.6E-02		2.2E-03	1.8E-02	5.3E-02	4.3E-02	1.3E-01
4.04	Organic	PCB-1254	9.8E-01	2.2E-02		1.4E-02	4.0E+00	1.1E+00	2.1E-01	5.3E+00
4.04			Hazard Index	4.9E-02	8.6E+00	2.4E-02	4.7E+00	1.7E+00	2.5E+00	1.8E+01

Table E57. Chemicals with a hazard quotient (HQ) >0.1 and hazard indices for the child dredging pathways for selected subreaches of the Clinch River and Poplar Creek

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Child Ingestion HQ	Child Inhalation HQ	Child Dermal HQ	Child Ingestion of Milk HQ	Child Ingestion of Meat HQ	Child Ingestion of Vegetables HQ	Total HIs Across Pathways
2.04	Inorganic	Manganese	4.5E+03	1.4E-01	1.0E+02	3.9E-02	3.7E-01	2.8E-01	1.7E+01	1.2E+02
2.04	Inorganic	Nickel	1.5E+01	3.3E-03		1.4E-04	1.5E+00	2.1E-02	5.2E-02	1.5E+00
2.04	Inorganic	Zinc	6.8E+01	9.6E-04		5.5E-05	8.7E-01	3.9E-01	1.2E-01	1.4E+00
2.04	Inorganic	Selenium	2.4E+00	2.1E-03		5.4E-05	7.6E-01	3.4E-01	6.4E-02	1.2E+00
2.04	Inorganic	Arsenic	9.7E+00	1.4E-01		3.9E-03	1.6E-01	2.3E-01	1.9E-01	7.2E-01
2.04	Inorganic	Mercury	2.3E-01	3.2E-03	8.6E-04	5.2E-09	1.1E-01	1.0E-01	2.9E-01	5.1E-01
2.04	Inorganic	Barium	1.3E+02	8.0E-03	3.0E-01	1.3E-03	7.9E-02	1.7E-03	3.2E-02	4.2E-01
2.04	Inorganic	Vanadium	2.0E+01	1.2E-02		1.4E-02	2.3E-01	2.4E-02	1.6E-02	3.0E-01
2.04	Inorganic	Chromium	1.6E+01	1.4E-02		7.8E-03	2.8E-03	1.1E-01	5.4E-02	1.9E-01
2.04			Hazard Index	3.2E-01	1.0E+02	6.6E-02	4.0E+00	1.5E+00	1.7E+01	1.3E+02
3.01	Inorganic	Manganese	3.2E+02	9.7E-03	7.3E+00	2.8E-03	2.7E-02	2.0E-02	1.2E+00	8.5E+00
3.01	Inorganic	Nickel	1.0E+01	2.2E-03		9.4E-05	9.7E-01	1.4E-02	3.5E-02	1.0E+00
3.01	Inorganic	Zinc	2.8E+01	4.0E-04		2.3E-05	3.6E-01	1.6E-01	4.8E-02	5.8E-01
3.01	Inorganic	Barium	6.0E+01	3.6E-03	1.4E-01	5.9E-04	3.6E-02	7.6E-04	1.4E-02	1.9E-01
3.01	Inorganic	Vanadium	1.1E+01	6.4E-03		7.4E-03	1.2E-01	1.2E-02	8.4E-03	1.6E-01
3.01	Inorganic	Chromium	1.0E+01	8.7E-03		5.0E-03	1.8E-03	7.2E-02	3.4E-02	1.2E-01
3.01			Hazard Index	3.1E-02	7.4E+00	1.6E-02	1.5E+00	2.8E-01	1.3E+00	1.1E+01

Table E57 (continued)

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Child Ingestion HQ	Child Inhalation HQ	Child Dermal HQ	Child Ingestion of Milk HQ	Child Ingestion of Meat HQ	Child Ingestion of Vegetables HQ	Total HIs Across Pathways
3.02	Inorganic	Manganese	1.1E+03	3.2E-02	2.4E+01	9.2E-03	8.8E-02	6.5E-02	3.9E+00	2.8E+01
3.02	Inorganic	Mercury	4.1E+00	5.8E-02	1.6E-02	9.5E-08	2.0E+00	1.9E+00	5.3E+00	9.2E+00
3.02	Inorganic	Nickel	5.2E+01	1.1E-02		4.7E-04	4.9E+00	7.2E-02	1.8E-01	5.2E+00
3.02	Inorganic	Zinc	1.2E+02	1.7E-03		9.5E-05	1.5E+00	6.8E-01	2.0E-01	2.4E+00
3.02	Inorganic	Arsenic	5.0E+00	7.2E-02		2.0E-03	8.1E-02	1.2E-01	9.8E-02	3.7E-01
3.02	Inorganic	Barium	1.1E+02	6.8E-03	2.6E-01	1.1E-03	6.7E-02	1.4E-03	2.7E-02	3.6E-01
3.02	Inorganic	Vanadium	2.2E+01	1.3E-02		1.5E-02	2.5E-01	2.6E-02	1.8E-02	3.3E-01
3.02	Inorganic	Chromium	2.4E+01	2.1E-02		1.2E-02	4.2E-03	1.7E-01	8.1E-02	2.9E-01
3.02	Inorganic	Selenium	3.3E-01	2.8E-04		7.4E-06	1.0E-01	4.7E-02	8.8E-03	1.6E-01
3.02	Inorganic	Cadmium	9.1E-01	3.9E-03		4.5E-03	9.9E-02	1.8E-03	4.7E-02	1.6E-01
3.02	Organic	PCB-1254	7.3E-01	1.6E-01		2.0E-02	2.8E+01	3.9E+00	7.3E-01	3.2E+01
3.02			Hazard Index	3.8E-01	2.4E+01	6.5E-02	3.7E+01	7.0E+00	1.1E+01	7.9E+01
3.03	Inorganic	Manganese	6.9E+02	2.1E-02	1.6E+01	6.0E-03	5.8E-02	4.3E-02	2.5E+00	1.9E+01
3.03	Inorganic	Mercury	6.7E+00	9.5E-02	2.5E-02	1.6E-07	3.2E+00	3.1E+00	8.6E+00	1.5E+01
3.03	Inorganic	Nickel	6.2E+01	1.3E-02		5.7E-04	5.9E+00	8.6E-02	2.1E-01	6.2E+00
3.03	Inorganic	Zinc	1.6E+02	2.3E-03		1.3E-04	2.1E+00	9.3E-01	2.8E-01	3.3E+00
3.03	Inorganic	Cadmium	3.3E+00	1.4E-02		1.6E-02	3.6E-01	6.4E-03	1.7E-01	5.7E-01
3.03	Inorganic	Chromium	4.4E+01	3.8E-02		2.2E-02	7.7E-03	3.1E-01	1.5E-01	5.3E-01

Table E57 (continued)

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Child Ingestion HQ	Child Inhalation HQ	Child Dermal HQ	Child Ingestion of Milk HQ	Child Ingestion of Meat HQ	Child Ingestion of Vegetables HQ	Total HIs Across Pathways
3.03	Inorganic	Arsenic	5.3E+00	7.5E-02		2.1E-03	8.5E-02	1.3E-01	1.0E-01	3.9E-01
3.03	Inorganic	Barium	1.2E+02	7.3E-03	2.8E-01	1.2E-03	7.2E-02	1.5E-03	2.9E-02	3.9E-01
3.03	Inorganic	Vanadium	2.2E+01	1.3E-02		1.5E-02	2.5E-01	2.5E-02	1.7E-02	3.2E-01
3.03	Inorganic	Silver	3.3E+00	2.8E-03		1.8E-04	7.8E-03	2.1E-02	1.7E-01	2.0E-01
3.03			Hazard Index	2.8E-01	1.6E+01	6.3E-02	1.2E+01	4.6E+00	1.2E+01	4.5E+01
3.04	Inorganic	Mercury	2.6E+01	3.6E-01	9.8E-02	6.0E-07	1.3E+01	1.2E+01	3.3E+01	5.8E+01
3.04	Inorganic	Manganese	7.4E+02	2.2E-02	1.7E+01	6.4E-03	6.1E-02	4.6E-02	2.7E+00	2.0E+01
3.04	Inorganic	Arsenic	9.4E+01	1.3E+00		3.7E-02	1.5E+00	2.2E+00	1.8E+00	7.0E+00
3.04	Inorganic	Nickel	5.1E+01	1.1E-02		4.6E-04	4.8E+00	6.9E-02	1.7E-01	5.0E+00
3.04	Inorganic	Zinc	1.2E+02	1.6E-03		9.4E-05	1.5E+00	6.7E-01	2.0E-01	2.4E+00
3.04	Inorganic	Cadmium	5.6E+00	2.4E-02		2.7E-02	6.1E-01	1.1E-02	2.9E-01	9.6E-01
3.04	Inorganic	Barium	2.9E+02	1.8E-02	6.7E-01	2.9E-03	1.7E-01	3.7E-03	6.9E-02	9.3E-01
3.04	Inorganic	Vanadium	5.9E+01	3.6E-02		4.1E-02	6.8E-01	7.0E-02	4.7E-02	8.7E-01
3.04	Inorganic	Selenium	1.6E+00	1.3E-03		3.5E-05	4.9E-01	2.2E-01	4.1E-02	7.5E-01
3.04	Inorganic	Chromium	3.9E+01	3.3E-02		1.9E-02	6.8E-03	2.7E-01	1.3E-01	4.6E-01
3.04	Inorganic	Boron	4.4E+01	2.1E-03	2.5E-03	2.6E-05	2.3E-01	3.0E-03	7.7E-02	3.1E-01
3.04	Organic	PCB-1254	1.8E-01	3.8E-02		4.9E-03	6.8E+00	9.6E-01	1.8E-01	8.0E+00
3.04	Organic	4-Methylphenol	2.8E-01	2.4E-04		4.3E-05	9.2E-05	1.3E-05	2.1E-01	2.1E-01

Table E57 (continued)

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Child Ingestion HQ	Child Inhalation HQ	Child Dermal HQ	Child Ingestion of Milk HQ	Child Ingestion of Meat HQ	Child Ingestion of Vegetables HQ	Total HIs Across Pathways
3.04			Hazard Index	1.9E+00	1.8E+01	1.4E-01	2.9E+01	1.6E+01	3.9E+01	1.0E+02
4.01	Inorganic	Mercury	1.2E+01	1.7E-01	4.6E-02	2.8E-07	5.9E+00	5.6E+00	1.6E+01	2.7E+01
4.01	Inorganic	Manganese	8.4E+02	2.6E-02	1.9E+01	7.3E-03	7.0E-02	5.2E-02	3.1E+00	2.3E+01
4.01	Inorganic	Nickel	2.0E+01	4.2E-03		1.8E-04	1.8E+00	2.7E-02	6.6E-02	1.9E+00
4.01	Inorganic	Zinc	6.5E+01	9.3E-04		5.3E-05	8.5E-01	3.8E-01	1.1E-01	1.3E+00
4.01	Inorganic	Arsenic	1.0E+01	1.4E-01		4.0E-03	1.6E-01	2.4E-01	1.9E-01	7.4E-01
4.01	Inorganic	Barium	7.9E+01	4.8E-03	1.8E-01	7.9E-04	4.7E-02	1.0E-03	1.9E-02	2.5E-01
4.01	Inorganic	Vanadium	1.6E+01	9.7E-03		1.1E-02	1.8E-01	1.9E-02	1.3E-02	2.3E-01
4.01	Inorganic	Chromium	1.8E+01	1.6E-02		9.0E-03	3.2E-03	1.3E-01	6.1E-02	2.2E-01
4.01	Inorganic	Selenium	3.8E-01	3.2E-04		8.5E-06	1.2E-01	5.3E-02	1.0E-02	1.8E-01
4.01	Inorganic	Silver	1.8E+00	1.5E-03		9.8E-05	4.2E-03	1.1E-02	9.3E-02	1.1E-01
4.01	Inorganic	Cadmium	6.5E-01	2.7E-03		3.2E-03	7.0E-02	1.2E-03	3.3E-02	1.1E-01
4.01	Organic	PCB-1254	4.0E-01	8.5E-02		1.1E-02	1.5E+01	2.1E+00	4.0E-01	1.8E+01
4.01			Hazard Index	4.6E-01	2.0E+01	4.7E-02	2.4E+01	8.7E+00	2.0E+01	7.3E+01
4.02	Inorganic	Manganese	6.7E+02	2.0E-02	1.5E+01	5.8E-03	5.5E-02	4.1E-02	2.4E+00	1.8E+01
4.02	Inorganic	Nickel	1.3E+01	2.8E-03		1.2E-04	1.3E+00	1.8E-02	4.5E-02	1.3E+00
4.02	Inorganic	Zinc	4.7E+01	6.6E-04		3.8E-05	6.1E-01	2.7E-01	8.0E-02	9.6E-01
4.02	Inorganic	Arsenic	1.1E+01	1.6E-01		4.5E-03	1.8E-01	2.7E-01	2.2E-01	8.3E-01

Table E57 (continued)

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Child Ingestion HQ	Child Inhalation HQ	Child Dermal HQ	Child Ingestion of Milk HQ	Child Ingestion of Meat HQ	Child Ingestion of Vegetables HQ	Total HIs Across Pathways
4.02	Inorganic	Mercury	3.4E-01	4.8E-03	1.3E-03	7.9E-09	1.7E-01	1.6E-01	4.4E-01	7.7E-01
4.02	Inorganic	Barium	1.1E+02	6.5E-03	2.5E-01	1.1E-03	6.4E-02	1.4E-03	2.6E-02	3.4E-01
4.02	Inorganic	Vanadium	1.2E+01	7.4E-03		8.5E-03	1.4E-01	1.4E-02	9.7E-03	1.8E-01
4.02	Inorganic	Chromium	1.4E+01	1.2E-02		7.0E-03	2.5E-03	1.0E-01	4.8E-02	1.7E-01
4.02			Hazard Index	2.1E-01	1.5E+01	2.7E-02	2.5E+00	8.7E-01	3.3E+00	2.2E+01
4.03	Inorganic	Manganese	1.6E+03	4.8E-02	3.6E+01	1.4E-02	1.3E-01	9.7E-02	5.8E+00	4.2E+01
4.03	Inorganic	Mercury	3.5E+00	5.0E-02	1.3E-02	8.2E-08	1.7E+00	1.6E+00	4.5E+00	8.0E+00
4.03	Inorganic	Nickel	4.0E+01	8.6E-03		3.6E-04	3.8E+00	5.5E-02	1.4E-01	4.0E+00
4.03	Inorganic	Zinc	1.1E+02	1.6E-03		9.3E-05	1.5E+00	6.6E-01	2.0E-01	2.3E+00
4.03	Inorganic	Arsenic	7.8E+00	1.1E-01		3.1E-03	1.3E-01	1.9E-01	1.5E-01	5.8E-01
4.03	Inorganic	Selenium	9.4E-01	8.0E-04		2.1E-05	2.9E-01	1.3E-01	2.5E-02	4.5E-01
4.03	Inorganic	Chromium	3.7E+01	3.1E-02		1.8E-02	6.4E-03	2.6E-01	1.2E-01	4.4E-01
4.03	Inorganic	Barium	1.3E+02	7.9E-03	3.0E-01	1.3E-03	7.7E-02	1.7E-03	3.1E-02	4.2E-01
4.03	Inorganic	Vanadium	2.7E+01	1.7E-02		1.9E-02	3.1E-01	3.2E-02	2.2E-02	4.0E-01
4.03	Inorganic	Cadmium	6.0E-01	2.5E-03		2.9E-03	6.5E-02	1.2E-03	3.1E-02	1.0E-01
4.03	Organic	PCB-1254	6.4E-02	1.4E-02		1.7E-03	2.4E+00	3.4E-01	6.4E-02	2.8E+00
4.03			Hazard Index	2.9E-01	3.6E+01	6.0E-02	1.0E+01	3.4E+00	1.1E+01	6.2E+01
4.04	Inorganic	Manganese	1.7E+03	5.1E-02	3.8E+01	1.5E-02	1.4E-01	1.0E-01	6.1E+00	4.5E+01

Table E57 (continued)

Reach	Chemical Type	Chemical	Representative concentration (mg/kg)	Child Ingestion HQ	Child Inhalation HQ	Child Dernal HQ	Child Ingestion of Milk HQ	Child Ingestion of Meat HQ	Child Ingestion of Vegetables HQ	Total HIs Across Pathways
4.04	Inorganic	Mercury	3.1E+00	4.3E-02	1.2E-02	7.1E-08	1.5E+00	1.4E+00	3.9E+00	6.9E+00
4.04	Inorganic	Nickel	3.6E+01	7.6E-03		3.2E-04	3.3E+00	4.9E-02	1.2E-01	3.5E+00
4.04	Inorganic	Zinc	1.4E+02	2.0E-03		1.2E-04	1.8E+00	8.2E-01	2.4E-01	2.9E+00
4.04	Inorganic	Arsenic	1.0E+01	1.5E-01		4.1E-03	1.7E-01	2.5E-01	2.0E-01	7.7E-01
4.04	Inorganic	Barium	1.4E+02	8.4E-03	3.2E-01	1.4E-03	8.2E-02	1.8E-03	3.3E-02	4.4E-01
4.04	Inorganic	Vanadium	2.9E+01	1.7E-02		2.0E-02	3.3E-01	3.4E-02	2.3E-02	4.2E-01
4.04	Inorganic	Selenium	8.4E-01	7.1E-04		1.9E-05	2.6E-01	1.2E-01	2.2E-02	4.0E-01
4.04	Inorganic	Chromium	2.6E+01	2.2E-02		1.3E-02	4.6E-03	1.8E-01	8.7E-02	3.1E-01
4.04	Inorganic	Cadmium	7.3E-01	3.1E-03		3.5E-03	7.8E-02	1.4E-03	3.8E-02	1.2E-01
4.04	Organic	PCB-1254	9.8E-01	2.1E-01		2.6E-02	3.7E+01	5.2E+00	9.8E-01	4.3E+01
4.04			Hazard Index	5.1E-01	3.8E+01	8.3E-02	4.5E+01	8.2E+00	1.2E+01	1.0E+02

E1. TOXICITY INFORMATION

E1.1 INORGANICS

Antimony (BEIAS 1994)

Antimony (Sb) is a naturally occurring metal that is used in various manufacturing processes. It exists in valence states of 3 and 5. Antimony is a common urban air pollutant. Exposure to antimony may be via inhalation, oral, and dermal routes.

Antimony is sparingly absorbed following ingestion or inhalation. Both gastrointestinal and pulmonary absorption are a function of compound solubility. Antimony is transported in the blood, its distribution varying among species and dependent on its valence state. Antimony is not metabolized but may bind to macromolecules and react covalently with sulfhydryl and phosphate groups. Excretion of antimony is primarily via the urine and feces, and is also dependent upon valence state.

Acute oral exposure of humans and animals to high doses of antimony or antimony-containing compounds (antimonials) may cause gastrointestinal disorders (vomiting, diarrhea), respiratory difficulties, and death at extremely high doses. Subchronic and chronic oral exposure may affect hematologic parameters. Long-term exposure to high doses of antimony or antimonials has been shown to adversely affect longevity in animals. Limited data suggest that prenatal and postnatal exposure of rats to antimony interferes with vasomotor responses.

Acute inhalation exposure of humans may cause gastrointestinal disorders (probably due to ingestion of airborne antimony). Exposure of animals to high concentrations of antimony and antimonials (especially stibine gas) may result in pulmonary edema and death. Long-term occupational exposure of humans has resulted in electrocardiac disorders, respiratory disorders, and possibly increased mortality. Antimony levels for these occupational exposure evaluations ranged from 2.2 to 11.98 mg Sb/m^3. Based on limited data, occupational exposure of women to metallic antimony and several antimonials has reportedly caused alterations in the menstrual cycle and an increased incidence of spontaneous abortions. Reproductive dysfunction has been demonstrated in rats exposed to antimony trioxide.

No data were available indicating that dermal exposure of humans to antimony or its compounds results in adverse effects. However, dermal application of high doses of antimony oxide (1584 mg Sb/kg) resulted in the death of rabbits within one day. Eye irritation due to exposure to stibine gas and several antimony oxides has been reported for humans.

The U.S. Environmental Protection Agency (EPA) has calculated subchronic and chronic oral reference doses (RfDs) of 4.0E−04 mg/kg/d based on decreased longevity and alteration of blood chemistry in rats chronically exposed to potassium antimony tartrate in the drinking water (5 ppm equivalent to 0.35 mg Sb/kg/d). An uncertainty factor of 1000 was applied: 10 for extrapolation from a lowest-observed-adverse-effect level (LOAEL) to a no-observable-adverse-effect level (NOAEL), 10 for extrapolation from animal data, and 10 for protection of sensitive populations.

The primary target organ for acute oral exposure to antimony appears to be the gastrointestinal tract (irritation, diarrhea, vomiting) and targets for long-term exposure are the blood (hematological disorders) and liver (mild hepatotoxicity). Inhalation exposure to antimony affects the respiratory tract (pneumoconiosis, restrictive airway disorders), with secondary targets being the cardiovascular system

(altered blood pressure and electrocardiograms) and kidneys (histological changes). Only limited evidence exists for reproductive disorders due to antimony exposure.

Although some data indicate that long-term exposure of rats to antimony trioxide and trisulfide increased the incidence of lung tumors, EPA has not evaluated antimony or antimonials for carcinogenicity, and a weight-of-evidence classification is currently unavailable.

Arsenic (BEIAS 1994)

The toxicity of inorganic arsenic depends on its valence state (-3, +3, or +5), and on the physical and chemical properties of the compound in which it occurs. Trivalent (As^{+3}) compounds are generally more toxic than pentavalent (As^{+5}) compounds. The more water-soluble compounds are usually more toxic and more likely to have systemic effects than the less soluble compounds, which are more likely to cause chronic pulmonary effects. One of the most toxic inorganic arsenic compounds is arsine gas (AsH_3). Laboratory animals are generally less sensitive than humans to the toxic effects of inorganic arsenic. In addition, in rodents the critical effects appear to be immunosuppression and hepato-renal dysfunction, whereas in humans the skin, vascular system, and peripheral nervous system are the primary target organs.

Water-soluble inorganic arsenic compounds are absorbed through the gastrointestinal (GI) tract (>90%) and lungs; distributed primarily to the liver, kidney, lung, spleen, aorta, and skin; and excreted mainly in the urine, at rates as high as 80% in 61 hours following oral dosing. Pentavalent arsenic is reduced to the trivalent form and then methylated in the liver to less toxic methylarsinic acids.

Symptoms of acute inorganic arsenic poisoning in humans are nausea, anorexia, vomiting, epigastric and abdominal pain, and diarrhea. Dermatitis (exfoliative erythroderma), muscle cramps, cardiac abnormalities, hepatotoxicity, bone marrow suppression and hematological abnormalities (anemia), vascular lesions, and peripheral neuropathy (motor dysfunction and paresthesia) have also been reported. Oral doses as low as 20–60 μg/kg/d have been reported to cause toxic effects in some individuals. Severe exposures can result in acute encephalopathy, congestive heart failure, stupor, convulsions, paralysis, coma, and death. The acute lethal dose to humans has been estimated at ~0.6 mg/kg/d. General symptoms of chronic arsenic poisoning in humans are weakness, general debility and lassitude, loss of appetite and energy, loss of hair, hoarseness of voice, loss of weight, and mental disorders. Primary target organs are the skin (hyperpigmentation and hyperkeratosis), nervous system (peripheral neuropathy), and vascular system. Anemia, leukopenia, hepatomegaly, and portal hypertension have also been reported. In addition, possible reproductive effects include a high male-to-female birth ratio.

The RfD for chronic oral exposures, 0.0003 mg/kg/d, is based on a NOAEL of 0.0008 mg/kg/d and a LOAEL of 0.014 mg/kg/d for hyperpigmentation, keratosis, and possible vascular complications in a human population consuming arsenic-contaminated drinking water. Because of uncertainties in the data, EPA states that "strong scientific arguments can be made for various values within a factor of 2 or 3 of the currently recommended RfD value." The subchronic RfD is the same as the chronic RfD, 0.0003 mg/kg/d.

Acute inhalation exposures to inorganic arsenic can damage mucous membranes; cause rhinitis, pharyngitis, and laryngitis; and result in nasal septum perforation. Chronic inhalation exposures, as occurring in the work place, can lead to rhino-pharyno-laryngitis, tracheobronchitis, dermatitis, hyperpigmentation, and hyperkeratosis; leukopenia; peripheral nerve dysfunction as indicated by abnormal nerve conduction velocities; and peripheral vascular disorders as indicated by Raynaud's syndrome and increased vasospastic reactivity in fingers exposed to low temperatures. Higher rates of

cardiovascular disease have also been reported in some workers exposed to arsenic. Possible reproductive effects include a high frequency of spontaneous abortions and reduced birth weights. Arsine gas (AsH_3) at concentrations as low as 3–10 ppm for several hours can cause toxic effects. Hemolysis, hemoglobinuria, jaundice, hemolytic anemia, and necrosis of the renal tubules have been reported in exposed workers.

Subchronic and chronic reference concentrations (RfCs) for inorganic arsenic have not been derived.

Epidemiological studies have revealed an association between arsenic concentrations in drinking water and increased incidence of skin cancers (including squamous cell carcinomas and multiple basal cell carcinomas), as well as cancers of the liver and bladder and respiratory and GI tracts. Occupational exposure studies have shown a clear correlation between exposure to arsenic and lung cancer mortality. EPA has placed inorganic arsenic in weight-of-evidence group A, human carcinogen. A drinking–water unit risk of $5 \times 10^{-5} (\mu g/L)^{-1}$ has been proposed, derived from drinking-water unit risks for females and males that are equivalent to slope factors (SFs) of 1.0×10^{-3} $(\mu g/kg/d)^{-1}$ (females) and 2.0×10^{-3} $(\mu g/kg/d)^{-1}$ (males). For inhalation exposures, a unit risk of 4.3×10^{-3} $(\mu g/m^3)^{-1}$ and an SF of 50 $(mg/kg/d)^{-1}$ have been derived.

Beryllium (BEIAS 1994)

Pure beryllium is a hard, grayish metal present in the earth's crust. It can be found in emissions from coal combustion; in surface water and soil; and in house dust, food, drinking water, and cigarette smoke. Industry employs beryllium in several ways, including in brake systems for airplanes, for neutron monochromatization, as window material for x-ray tubes, and in radiation detectors. Additionally, beryllium compounds are used in manufacturing ceramics and refractories, chemical reagents, and gas mantle hardeners. The highest risk for exposure to beryllium occurs among workers employed in beryllium manufacturing, fabricating, or reclaiming industries. However, people who live near these industries and are sensitive to extremely low concentrations of beryllium in the air are also at risk. In addition, smokers inhale unusually high concentrations of beryllium, depending on the source of tobacco.

A limited amount of data indicates that the oral toxicity of beryllium is low; however, the inhaled toxicity of beryllium is well documented. Humans inhaling massive doses of beryllium compounds may develop acute berylliosis. Additionally, beryllium and its compounds are presumed to have cancer-causing potential in the human lung when inhaled. The cancer-causing ability has been investigated in workers exposed to beryllium. The degree of harm depends on the amount and duration of exposure. Short-term exposure to beryllium may cause noncarcinogenic health effects, such as acute pneumonitis berylliosis, while long-term exposure may cause lung cancer.

Boron

Boron is a solid substance that widely occurs in nature and is present in air, water, and soil. Typically it is found in the environment combined with other substances to form compounds called borates. Borates are primarily used to produce glass; however, they are also used in the production of fire retardants, leather tanning, cosmetics, metals, pesticides, and high-energy fuel. Background levels of boron have been reported up to 5 ppm of boron in surface water and as high as 360 ppm in boron-rich deposit areas. Average daily intake of boron has been estimated at 10–25 mg. (ATSDR 1992)

Animal studies suggest boron readily enters the body when contacted with damaged skin and primarily leaves the body through urine. Small amounts of boron (4.1 mg/m^3) can irritate the nose, throat, and eyes when inhaled. Large amounts of boron (4161 ppm) consumed by humans over a short

period of time can affect the stomach, intestines, liver, kidney, and brain and can eventually lead to death. Animal studies also indicate that boron will affect in particular the male reproductive organs if large amounts are eaten or drunk for long or short periods of time. No information is available on whether boron causes cancer in humans; however, in animals no evidence of cancer has been found even when exposed over long periods of time. (ATDSR 1992)

Cadmium (BEIAS 1994)

Cadmium is a naturally occurring metal that is used in various chemical forms in metallurgical and other industrial processes and in the production of pigments. Environmental exposure can occur via the diet and drinking water.

Cadmium is absorbed more efficiently by the lungs (30 to 60%) than by the GI tract, the latter involving a saturable process. Cadmium is transported in the blood and widely distributed in the body but accumulates primarily in the liver and kidneys. Cadmium burden (especially in the kidneys and liver) tends to increase in a linear fashion up to ~50 or 60 years of age, after which the body burden remains relatively constant. Metabolic transformations of cadmium are limited to its binding to protein and nonprotein sulfhydryl groups and to various macromolecules, such as metallothionein, which is especially important in the kidneys and liver. Cadmium is excreted primarily in the urine.

Acute oral exposure to 20–30 g has caused fatalities in humans. Exposure to lower amounts may cause GI irritation, vomiting, abdominal pain, and diarrhea. An asymptomatic period of one-half to one hour may precede the onset of clinical signs. Longer-term exposure to cadmium primarily affects the kidneys, resulting in tubular proteinosis, although other conditions such as "itai-itai" disease may involve the skeletal system. Cadmium involvement in hypertension is not fully understood.

Inhalation exposure to cadmium and cadmium compounds may result in effects including headache, chest pains, muscular weakness, pulmonary edema, and death. The 1-minute and 10-minute lethal concentration of cadmium for humans has been estimated to be ~2500 and 250 mg/m^3, respectively. An 8-hour time-weighted-average exposure level of 5 mg/m^3 has been estimated for lethal effects of inhalation exposure to cadmium, and exposure to 1 mg/m^3 is considered to be immediately dangerous to human health. Renal toxicity (tubular proteinosis) may also result from inhalation exposure to cadmium.

Chronic oral RfDs of 5×10^{-4} and 1×10^{-3} mg/kg/d have been established for cadmium exposure via drinking water and food, respectively. Both values reflect incorporation of an uncertainty factor of 10. The RfDs are based on an extensive data base regarding toxicokinetics and toxicity in both human and animals, the critical effect being renal tubular proteinuria. Confidence in the RfD and data base is high. Inhalation reference concentration (RfC) values are currently not available.

The target organ for cadmium toxicity via oral exposure is the kidney. For inhalation exposure, both the lungs and kidneys are target organs for cadmium-induced toxicity.

There is limited evidence from epidemiologic studies for cadmium-related respiratory-tract cancer. An inhalation unit risk of 1.8×10^{-3} $(\mu g/m^3)^{-1}$ and an inhalation SF of 6.1 $(mg/kg/d)^{-1}$ are based on respiratory tract cancer associated with occupational exposure. Based on limited evidence from multiple occupational exposure studies and adequate animal data, cadmium is placed in weight-of-evidence group B1, probable human carcinogens.

Chromium, Chromium III, and Chromium VI (BEIAS 1994)

Elemental chromium does not occur in nature but is present in ores—primarily chromite. Chromium exhibits several oxidation states, but the most prominent of these is chromium VI and chromium III. Chromium VI in the environment is manmade as a result of industrial emissions; in solution, chromium VI exists as hydrochromate, chromate, and dichromate ionic species and reacts over time to form chromium III. Chromium VI is much more mobile and toxic than is chromium III. Chromium is useful in glucose and cholesterol metabolism and therefore is an essential element to humans and animals. Nonoccupational exposure to the metal occurs via the ingestion of chromium-containing food and water, whereas occupational exposure occurs via inhalation. Workers are exposed to chromium during its use in the production of dichromate; the chemical, stainless steel, refractory, and chromium-plating industries; and the production and use of alloys.

Chromium enters the body through the lungs, gastrointestinal tract, and, to a lesser extent, the skin. Inhalation is the most important route for occupational exposure. Workers exposed to chromium have developed nasal irritation, nasal ulcers, perforation of the nasal septum, and hypersensitivity reactions and "chrome holes" of the skin. Among the general population, contact dermatitis has been associated with the use of bleaches and detergents. Inhalation of chromium compounds has been associated with the development of cancer in workers in the chromate industry. Evidence also suggests an increased risk in developing nasal, pharyngeal, and gastrointestinal carcinomas. Based on sufficient evidence reporting that humans and animals are at risk of developing cancer, chromium VI has been assigned an EPA weight-of-evidence classification of A, human carcinogen.

Manganese (BEIAS 1994)

Manganese makes up about 0.10% of the earth's crust and is the 12th most abundant element. It can exist in oxidation states from -3 to +7, the most common being +4 in the chemical form of manganese dioxide. The oxides and peroxides are used in industry as oxidizers, and the metal is used for manufacturing metal alloys to increase hardness and corrosion resistance. Manganese is an essential trace element in humans, which can elicit a variety of serious toxic responses upon prolonged exposure to elevated concentrations either orally or by inhalation. The central nervous system is the primary target.

Initial symptoms of manganese exposure are insomnia, disorientation, anxiety, lethargy, and memory loss. These symptoms will progress with prolonged exposure and will eventually include motor disturbances, tremors, and walking difficulties similar to Parkinsonism. Effects on reproduction (decreased fertility, impotence) have been observed in humans with inhalation exposure and in animals with oral exposure at the same or similar doses that initiate the central nervous system effects. Data on possible carcinogenesis following injections in mice are inconclusive; however, the EPA weight-of-evidence classification is D, not classifiable as to human carcinogenicity based on no evidence in humans and inconclusive evidence in animals.

Mercury and Mercury Salts (BEIAS 1994)

Mercury is a naturally occurring element that may exist in elemental, inorganic, or organic forms and in various oxidation states. Mercury is used in a wide variety of products and processes, including pressure sensitive devices (thermometers, barometers), electrical apparatus (wiring, switches, batteries), paints, pharmaceuticals, and various chemicals. The oxidation state and chemical form of mercury are important in determining its toxicity, with mercurous salts being less toxic than mercuric salts. Organic materials such as methyl mercury are highly toxic. In the environment, mercury may undergo transformations among the various oxidation states and chemical forms. Both environmental and

occupational exposure are relevant to mercury and its compounds, although environmental exposure is unimportant for mercury vapor. Mercury intake from occupational exposure is of greater significance than that from environmental exposure. Environmental exposure to mercury may involve dietary intake (i.e., from fish) and possibly from dental amalgams, the latter being controversial and under dispute.

Ingestion of mercury metal is usually without effect, while ingestion of inorganic salts may cause severe gastrointestinal irritation, renal failure, and death. Mercury is also known to induce hypersensitivity reactions such as contact dermatitis and acrodynia (pink disease). Inhalation of mercury vapor may cause irritation of the respiratory tract, central nervous system effects characterized by neurobehavioral changes, peripheral nervous system toxicity, renal toxicity, and death. Toxicity resulting from subchronic and chronic exposure to mercury and mercury salts usually involves the kidneys and/or the nervous system. No data are available regarding the carcinogenicity of mercury in humans or animals. The EPA has placed inorganic mercury in weight-of-evidence classification D, not classifiable as to human carcinogenicity.

Nickel and Nickel Salts (BEIAS 1994)

Nickel is a naturally occurring metal existing in various mineral forms. Nickel may be found throughout the environment including rivers, lakes, oceans, soil, air, drinking water, plants, and animals. Soil and sediment are the primary receptacles for nickel, but mobilization may occur depending on physico-chemical characteristics of the soil. Nickel is used in a wide variety of metallurgical processes such as electroplating and alloy production, as well as in nickel-cadmium batteries. Some evidence suggests that nickel may be an essential trace element for mammals. As for most metals, the toxicity of nickel is dependent on the route of exposure and the solubility of the nickel compound.

Pulmonary absorption is the major route of concern for nickel-induced toxicity. Toxic effects of oral exposure to nickel usually involve the kidneys with some evidence from animal studies showing a possible development/reproductive toxicity effect. Inhalation exposure to some nickel compounds will cause toxic effects in the respiratory tract and immune system. Asthmatic conditions have also been documented for inhalation exposure to nickel. In addition, sensitivity reactions to nickel are well documented and usually involve contact dermatitis reactions resulting from contact with items such as cooking utensils, jewelry, coins, etc., containing nickel. Epidemiologic studies have shown that occupational inhalation exposure to nickel dust (primarily nickel subsulfide) at refineries has resulted in increased incidence of pulmonary and nasal cancer.

Selenium (BEIAS 1994)

Selenium is an essential trace element important in many biochemical and physiological processes including the biosynthesis of coenzyme Q (a component of mitochondrial electron transport systems), regulation of ion fluxes across membranes, maintenance of the integrity of keratins, stimulation of antibody synthesis, and activation of glutathione peroxidase (an enzyme involved in preventing oxidative damage to cells). Recommended human dietary allowances (average daily intake) for selenium are as follows: infants up to 1 year, 10–15 μg; children 1to 10 years, 20–30 μg; adult males 11 to 51+ years, 40–70 μg; adult females 11 to 51+ years, 45–55 μg; pregnant or lactating women, 65–75 μg. There appears to be a relatively narrow range between levels of selenium intake resulting in deficiency and those causing toxicity.

Selenium occurs in several valence states: −2 (hydrogen selenide, sodium selenide, dimethyl selenium, trimethyl selenium, and selenoamino acids such as selenomethionine; 0 (elemental selenium); +4 (selenium dioxide, selenious acid, and sodium selenite); and +6 (selenic acid and sodium selenate).

Toxicity of selenium varies with valence state and water solubility of the compound in which it occurs. The latter can affect gastrointestinal absorption rates.

Gastrointestinal absorption in animals and humans for various selenium compounds ranges from about 44% to 95% of the ingested dose. Respiratory tract absorption rates of 97% and 94% for aerosols of selenious acid have been reported for dogs and rats, respectively. Selenium is found in all tissues of the body; highest concentrations occur in the kidney, liver, spleen, and pancreas. Excretion is primarily via the urine (0–15 μg/L); however, excretory products can also be found in the feces, sweat, and expired air.

In humans, acute oral exposures can result in excessive salivation, garlic odor to the breath, shallow breathing, diarrhea, pulmonary edema, and death. Other reported signs and symptoms of acute selenosis include tachycardia, nausea, vomiting, abdominal pain, abnormal liver function, muscle aches and pains, irritability, chills, and tremors. Acute toxic effects observed in animals include pulmonary congestion, hemorrhages and edema, convulsions, altered blood chemistry (increased hemoglobin and hematocrit), liver congestion, and congestion and hemorrhage of the kidneys.

General signs and symptoms of chronic selenosis in humans include loss of hair and nails, acropachia (clubbing of the fingers), skin lesions (redness, swelling, blistering, and ulcerations), tooth decay (mottling, erosion and pitting), and nervous system abnormalities attributed to polyneuritis (peripheral anesthesia, acroparaethesia, pain in the extremities, hyperreflexia of the tendon, numbness, convulsions, paralysis, motor disturbances, and hemiplegia). In domesticated animals, subchronic and chronic oral exposures can result in loss of hair, malformed hooves, rough hair coat, and nervous system abnormalities (impaired vision and paralysis). Damage to the liver and kidneys and impaired immune responses have been reported to occur in rodents following subchronic and/or chronic oral exposures.

In humans, inhalation of selenium or selenium compounds primarily affects the respiratory system. Dusts of elemental selenium and selenium dioxide can cause irritation of the skin and mucous membranes of the nose and throat, coughing, nosebleed, loss of sense of smell, dyspnea, bronchial spasms, bronchitis, and chemical pneumonia. Other signs and symptoms following acute inhalation exposures include lacrimation, irritation and redness of the eyes, gastrointestinal distress (nausea and vomiting), depressed blood pressure, elevated pulse rate, headaches, dizziness, and malaise. In animals, acute inhalation exposures also result in severe respiratory effects including edema, hemorrhage, and interstitial pneumonitis as well as in splenic damage (congestion, fissuring red pulp, and increased polymorphonuclear leukocytes) and liver congestion and mild central atrophy. Information on toxicity of selenium in humans and animals following chronic inhalation exposures is not available, and subchronic and chronic inhalation RfCs have not been derived.

Epidemiologic studies in humans have failed to show a positive association between chronic oral exposures to selenium and an increased incidence of death due to neoplasms. Some studies have indicated that selenium may have anti-neoplastic properties. In studies on laboratory animals, selenites or selenates have not been found to be carcinogenic; however, selenium sulfide produced a significant increase in the incidence of hepatocellular carcinomas in male and female rats and in female mice and a significant increase in alveolar/bronchiolar carcinomas and adenomas in female mice following chronic oral exposures. EPA has placed selenium and selenious acid in Group D, not classifiable as to carcinogenicity in humans, while selenium sulfide is placed in Group B2, probable human carcinogen. Quantitative data are, however, insufficient to derive a SF for selenium sulfide. Pertinent data regarding the potential carcinogenicity of selenium by the inhalation route in humans or animals were not located in the available literature.

Silver (BEIAS 1994)

Silver is a relatively rare metal that occurs naturally in the earth's crust and is released to the environment from various industrial sources. Human exposure to silver and silver compounds can occur orally, dermally, or by inhalation. Silver is found in most tissues, but has no known physiologic function.

In humans, accidental or intentional ingestion of large doses of silver nitrate has produced corrosive damage of the gastrointestinal tract, abdominal pain, diarrhea, vomiting, shock, convulsions, and death. Respiratory irritation was noted following acute inhalation exposure to silver or silver compounds. Silver nitrate solutions are highly irritating to the skin, mucous membranes, and eyes.

Ingestion, inhalation, or dermal absorption of silver may cause argyria, the most common indicator of long-term exposure to silver or silver compounds in humans. Argyria is a gray or blue-gray, permanent discoloration of the skin and mucous membranes that is not a toxic effect per se, but is considered cosmetically disfiguring. Chronic inhalation exposure of workers to silver oxide and silver nitrate dusts resulted in upper and lower respiratory irritation, deposition of granular silver-containing deposits in the eyes, impaired night vision, and abdominal pain. Mild allergic responses have been attributed to dermal contact with silver.

In long-term oral studies with experimental animals, silver compounds have produced slight thickening of the basement membranes of the renal glomeruli, growth depression, shortened lifespan, and granular silver-containing deposits in skin, eyes, and internal organs. Hypoactivity was seen in rats subchronically exposed to silver nitrate in drinking water.

An RfD of 0.005 mg/kg/d for subchronic and chronic exposure was calculated from a LOAEL of 0.014 mg/kg/d for argyria observed in patients receiving intravenous injections of silver arsphenamine. Data are presently insufficient to derive an RfC for silver.

Data adequate for evaluating the carcinogenicity of silver to humans or animals by ingestion, inhalation, or other routes of exposure were not found. Based on EPA guidelines, silver is placed in weight-of-evidence group D, not classifiable as to human carcinogenicity.

Vanadium (BEIAS 1994)

Vanadium is a metallic element that occurs in six oxidation states and numerous inorganic compounds. Some of the more important compounds are vanadium pentoxide (V_2O_5), sodium metavanadate ($NaVO_3$), sodium orthovanadate (Na_3VO_4), vanadyl sulfate ($VOSO_4$), and ammonium vanadate (NH_4VO_3). Vanadium is used primarily as an alloying agent in steels and nonferrous metals. Vanadium compounds are also used as catalysts and in chemical, ceramic or specialty applications.

Vanadium compounds are poorly absorbed through the gastrointestinal system (0.5–2% of dietary amount), but slightly more readily absorbed through the lungs (20–25%). Absorbed vanadium is widely distributed in the body, but short-term localization occurs primarily in bone, kidneys, and liver. In the body, vanadium can undergo changes in oxidation state[(interconversion of vanadyl (+4) and vanadate (+5) forms] and it can also bind with blood protein (transferin). Vanadium is excreted primarily in the feces following oral exposures and primarily in the urine following inhalation exposures.

The toxicity of vanadium depends on its physico-chemical state; particularly on its valence state and solubility. Based on acute toxicity, pentavalent NH_4VO_3 has been reported to be more than twice as toxic as trivalent VCl_3 and more than six times as toxic as divalent VI_2. Pentavalent V_2O_5 has been

reported to be more than five times as toxic as trivalent V_2O_3. In animals, acutely toxic oral doses cause vasoconstriction, diffuse desquamative enteritis, congestion and fatty degeneration of the liver, and congestion and focal hemorrhages in the lungs and adrenal cortex. Minimal effects seen after subchronic oral exposures to animals include diarrhea, altered renal function, and decreases in erythrocyte counts, hemogloblin, and hematocrit. In humans, intestinal cramps and diarrhea may occur following subchronic oral exposures. These studies indicate that for subchronic and chronic oral exposures the primary targets are the digestive system, kidneys, and blood.

Reference doses for chronic oral exposures are 0.007 mg/kg/d for vanadium, 0.009 mg/kg/d for vanadium pentoxide, 0.02 mg/kg/d for vanadyl sulfate, and 0.001 mg/kg/d for sodium metavanadate. The subchronic RfDs for these compounds are the same as the chronic RfDs, except for sodium metavanadate, which is 0.01 mg/kg/d.

Inhalation exposures to vanadium and vanadium compounds result primarily in adverse effects to the respiratory system. In laboratory studies, minimal effects (throat irritation and coughing) occurred after an 8-h exposure to 0.1 mg V/m^3. In studies on workers occupationally exposed to vanadium, the most common reported symptoms were irritation of the respiratory tract, conjunctivitis, dermatitis, cough, bronchospasm, pulmonary congestion, and bronchitis. Quantitative data are, however, insufficient to derive a subchronic or chronic inhalation RfC for vanadium or vanadium compounds.

There is little evidence that vanadium or vanadium compounds are reproductive toxins or teratogens. There is also no evidence that any vanadium compound is carcinogenic; however, very few adequate studies are available for evaluation. Vanadium has not been classified as to carcinogenicity by the EPA.

Zinc (BEIAS 1994)

Zinc is an essential element and is used primarily in galvanized metals and metal alloys. In addition, various inorganic zinc salts have numerous commercial uses. Zinc oxide is used in the rubber industry as a vulcanization activator and accelerator and to slow down oxidation and also as a reinforcing agent, heat conductor, pigment, ultraviolet stabilizer, supplement in animal feeds and fertilizers, catalyst, chemical intermediate, and mildew inhibitor. Zinc sulfate is used in rayon manufacture, agriculture, zinc plating, and as a chemical intermediate and mordant. Zinc chloride is used in smoke bombs, in cements for metals, in wood preservatives, in flux for soldering; in manufacture of parchment paper, artificial silk, and glues; as a mordant in printing and dye textiles; and as a deodorant, antiseptic, and astringent. Zinc chromate is used as a pigment in paints, varnishes, and oil colors. In addition, zinc phosphide is used as a rodenticide, and zinc cyanide is used in electroplating. The toxicity of the latter two compounds is caused primarily by their anion component.

Gastrointestinal absorption of zinc is variable (20–80%) and depends on the chemical compound as well as on zinc levels in the body and dietary concentrations of other nutrients. Zinc is present in all tissues with the highest concentrations in the prostate, kidney, liver, heart, and pancreas. In humans, acutely toxic oral doses of zinc cause nausea, vomiting, diarrhea, and abdominal cramps and in some cases gastric bleeding. Gastrointestinal upset has also been reported in individuals taking dietary zinc supplements for up to 6 weeks. Limited evidence suggests that the human immune system may be impaired by subchronic exposures. Chronic oral exposures to zinc have resulted in hypochromic microcytic anemia associated with hypoceruloplasminemia, hypocupremia, and neutropenia in some individuals. Under occupational exposure conditions, inhalation of zinc compounds (mainly zinc oxide fumes) can result in a condition identified as "metal fume fever," which is characterized by nasal passage irritation, cough, rales, headache, altered taste, fever, weakness, hyperpnea, sweating, pains in the legs

and chest, leukocytosis, reduced lung volume, and decreased diffusing capacity of carbon monoxide. "Metal fume fever" is an acute and reversible effect that is unlikely to occur under chronic exposure conditions when zinc air concentrations are less that 8–12 mg/m^3. No case studies or epidemiologic evidence have been presented to suggest that zinc is carcinogenic in humans by the oral or inhalation route.

E1.2 ORGANICS

Aldrin

Aldrin is a common name for a compound used as an insecticide. Aldrin is a chemical made in the laboratory and does not occur naturally in the environment. The trade names used for aldrin include Aldrec, Aldrex, Drinox, Octalene, Seedrin, and Compound 118. Pure aldrin is a white powder, and technical-grade aldrin is a tan-colored powder. Aldrin evaporates slowly in the air and has a mild chemical odor. Aldrin can be found in the soil, in water, or in the air near hazardous waste sites. Aldrin can also be found in plants and animals near hazardous waste sites. (ATSDR 1993)

From the 1950s until 1970, aldrin was used extensively as an insecticide on crops such as corn and cotton. The USDA prohibited all uses of aldrin in 1970. In 1972, however, EPA approved aldrin for killing termites, and it was used for this purpose until 1987. In 1987, the manufacturer voluntarily canceled the registration for use in controlling termites. (ATSDR 1993)

Aldrin can enter the environment from accidental spills or leaks from storage containers at waste sites. In the past, aldrin entered the environment when farmers used it to kill pests on crops and exterminators used it to kill termites. Aldrin is still present in the environment from these past uses. Sunlight and bacteria can change aldrin to dieldrin; therefore, dieldrin will be found in places where aldrin was originally released. Dieldrin in soil or water breaks down slowly; it sticks to soil and sediments on the bottom of lakes very strongly and may stay there unchanged for many years. Dieldrin does not dissolve in water very easily; however, it can attach to dust particles and become airborne, and dieldrin can also be taken up in the roots of plants. Fish and animals that eat dieldrin-contaminated materials store a large amount of dieldrin in their fat. Animals or fish that eat other animals can concentrate dieldrin in their tissue. (ATSDR 1993)

Most human exposure to aldrin and dieldrin occurs when people eat foods such as fish from contaminated lakes or streams, root crops, dairy products, and meats. Exposure to aldrin and dieldrin occurs via drinking water, breathing, or contacting contaminated soil. Exposure to aldrin is limited because aldrin is changed very quickly to dieldrin in the environment. Dieldrin stays in the environment for a long time, usually in soil or in animal fat. Background levels of aldrin and dieldrin in air and water are ~0.000001 parts of aldrin or dieldrin in 1 million parts of air or water (i.e., ~0.000001 ppm). Background levels of dieldrin in soil are ~0.001 ppm, and background levels in water are very, very small. Contaminated soils average ~0.057 ppm for dieldrin and 0.019 ppm for aldrin; contaminated groundwater averages ~0.0004 ppm for dieldrin. Contaminated fish contained ~0.030–0.050 ppm of dieldrin. (ATSDR 1993)

Studies in animals show that both aldrin and dieldrin enter the body quickly after exposure. Once aldrin is inside the body, it quickly breaks down to dieldrin. Dieldrin stays in fat for a long time, but most dieldrin and its breakdown products leave the body in feces and urine. It can take many weeks or even years for all of the compound to leave the body. (ATSDR 1993)

Aldrin and dieldrin cause similar health effects. Exposure to very high levels of aldrin or dieldrin for a short time causes convulsions or kidney damage. Long–term exposure to lower levels can also cause convulsions because of the buildup of the contaminants in the body. Exposure to moderate levels of aldrin or dieldrin also causes headaches, dizziness, irritability, vomiting, or uncontrollable muscle movements. It is not known whether either contaminant causes birth defects or cancer in people. The International Agency for Research on Cancer has determined that the carcinogenicity of aldrin and dieldrin to humans is not classifiable. EPA has determined that aldrin and dieldrin are toxic contaminants and are probable human carcinogens (i.e., an EPA Class B2 carcinogen). The oral and inhalation SF for aldrin is 17 $(mg/kg/d)^{-1}$. The RfD for chronic oral exposures to aldrin is 0.00003 mg/kg/d and is used to evaluate potential noncancerous effects from exposure to aldrin. (ATSDR 1993)

Benzo[*a*]anthracene (BEIAS 1994)

Benz[*a*]anthracene, along with a number of other polycyclic aromatic hydrocarbons, are natural products produced by the incomplete combustion of organic material. The arrangement of the aromatic rings in the benz[*a*]anthracene molecule gives it a "bay region" often correlated with carcinogenic properties. In general, the bay-region polycyclic aromatic hydrocarbons and some of their metabolites are known to react with cellular macromolecules, including deoxyribonucleic acid (DNA), which may account for both their toxicity and carcinogenicity. The inducible mixed-function oxidase enzymes oxidize benz[*a*]anthracene to form metabolites with increased water solubility that can be efficiently excreted in the urine. A minor product of this oxidation, a bay-region diol epoxide, reacts readily with DNA and has been shown to be highly carcinogenic.

The toxic effects of benz[*a*]anthracene and similar polycyclic aromatic hydrocarbons are primarily directed toward tissues that contain proliferating cells. Animal studies indicate that exposure to bay-region polycyclic aromatic hydrocarbons can damage the hematopoietic system leading to progressive anemia as well as agranulocytosis. The lymphoid system can also be affected resulting in lymphopenia. Toxic effects have been observed in the rapidly dividing cells of the intestinal epithelium, spermatogonia and resting spermatocytes in the testis and primary oocytes of the ovary. Most of these effects have occurred following both oral and parenteral exposure. Epithelial proliferation and cell hyperplasia in the respiratory tract have been reported following subchronic inhalation exposure. However, because of the lack of quantitative data, neither a reference dose nor a reference concentration have been derived.

The primary concern with benz[*a*]anthracene exposure is its potential carcinogenicity. There is no unequivocal, direct evidence of the carcinogenicity of the compound to humans; however, benz[*a*]anthracene and other known carcinogenic polycyclic aromatic hydrocarbons are components of coal tar, soot, coke oven emissions and tobacco smoke. There is adequate evidence of its carcinogenic properties in animals. Oral exposures of mice to benz[*a*]anthracene have resulted in hepatomas, pulmonary adenomas and forestomach papillomas. The EPA weight-of-evidence classification is B2, probable human carcinogen, for both oral and inhalation exposure based on adequate animal evidence and no human evidence. An SF has not been derived specifically for benz[*a*]anthracene by the EPA. However, an oral SF of 7.3 $(mg/kg/d)^{-1}$ has been calculated for benzo[*a*]pyrene based on the incidence of stomach tumors in mice treated with benzo[*a*]pyrene. A drinking water unit risk of 2.1E-4 $(\mu g/L)^{-1}$ has also been calculated for benzo[*a*]pyrene. An inhalation SF of 6.1 $(mg/kg/d)^{-1}$ (U.S. EPA 1992b) was calculated for benzo[*a*]pyrene based on the incidence of respiratory tumors in golden hamsters treated with benzo[*a*]pyrene. An inhalation unit risk of 1.7E-03 $(\mu g/m^3)^{-1}$ has also been calculated for benzo[*a*]pyrene.

Benzo[*a*]pyrene (BEIAS 1994)

Benzo(a)pyrene is a polycyclic aromatic hydrocarbon (PAH) characterized by two or more fuzed benzene rings. Despite their high lipid solubility, most PAHs show little tendency to biomagnify in food chains, probably because they are rapidly metabolized in most biota. PAHs are ubiquitous in nature, produced by forest fires, microbial synthesis, and anthropogenic activities. PAHs are teratogenic, mutagenic, and carcinogenic, with the higher molecular weight compounds being less toxic than higher compounds.

The effects of benzo[*a*]pyrene on reproduction are shown in mice exposed to 10, 40, and 160 mg of benzo(a)pyrene per kg of body weight per day during days 7–16 of gestation. Benzo[*a*]pyrene exposure of 160 mg/kg/d significantly reduced pregnancy rates and percentage of viable litters. Pup weights were significantly reduced by all three dose levels. Total sterility was observed in 97% of offspring in the 40 and 160 mg/kg/d groups, and fertility was impaired among offspring in the 10 mg/kg/d group.

An oral SF of 7.3 $(mg/kg/d)^{-1}$ has been calculated for benzo[*a*]pyrene based on the incidence of stomach tumors in mice treated with benzo[*a*]pyrene. A drinking water unit risk of 2.1E-4 $(\mu g/L)^{-1}$ has also been calculated for benzo[*a*]pyrene. An inhalation SF of 6.1 $(mg/kg/d)^{-1}$ was calculated for benzo[*a*]pyrene based on the incidence of respiratory tumors in golden hamsters treated with benzo[*a*]pyrene. An inhalation unit risk of 1.7E-3 $(\mu g/m^3)^{-1}$ has also been calculated for benzo[*a*]pyrene.

Benzo[*b*]flouranthene (BEIAS 1994)

Benzo[*b*]fluoranthene, a crystalline solid with a chemical formula of $C_{20}H_{12}$ and a molecular weight of 252.32, is a PAH with one five-membered ring and four six-membered rings. There is no commercial production or known use of this compound. Benzo[*b*]fluoranthene is found in fossil fuels and occurs ubiquitously in products of incomplete combustion. It has been detected in mainstream cigarette smoke; urban air; gasoline engine exhaust; emissions from burning coal and from oil-fired heating; broiled and smoked food; oils and margarine; and in soils, groundwater, and surface waters at hazardous waste sites.

No absorption data were available for benzo[*b*]fluoranthene; however, by analogy to structurally related PAHs, primarily benzo[*a*]pyrene, it would be expected to be absorbed from the gastrointestinal tract, lungs, and skin. Major metabolites of benzo[*b*]fluoranthene formed in vitro in rat liver include dihydrodiols and monohydroxy derivatives and monohydroxy derivatives in mouse epidermis.

No data were found concerning the acute, subchronic, chronic, developmental, or reproductive toxicity of benzo[*b*]fluoranthene. No data were available for the derivation of an oral RfD or inhalation RfC.

No long-term oral or inhalation bioassays were available to assess the carcinogenicity of benzo[*b*]fluoranthene. Benzo[*b*]fluoranthene was tested for carcinogenicity in dermal application, lung implantation, subcutaneous (s.c.) injection, and intraperitoneal (i.p.) injection studies. Dermal applications of 0.01–0.5% solutions of benzo[*b*]fluoranthene for life produced a high incidence of skin papillomas and carcinomas in mice. In initiation-promotion assays, the compound was active as an initiator of skin carcinogenesis in mice. Sarcomas and carcinomas of the lungs and thorax were seen in rats receiving single lung implants of 0.1–1 mg benzo[*b*]fluoranthene. Newborn mice receiving 0.5 μmol benzo[*b*]fluoranthene via i.p. injection developed liver and lung tumors, and mice administered three s.c. injections of 0.6 mg benzo[*b*]fluoranthene developed injection-site sarcomas.

Based on no human data and sufficient evidence for carcinogenicity in animals, EPA has assigned a weight-of-evidence classification of B2, probable human carcinogen, to benzo[*b*]fluoranthene.

***Bis*(2-ethylhexyl)phthalate** (BEIAS 1994)

Bis(2-ethylhexyl)phthalate is a colorless oily liquid that is extensively used as a plasticizer in a wide variety of industrial, domestic and medical products. It is an environmental contaminant and has been detected in ground water, surface water, drinking water, air, soil, plants, fish and animals. It is rapidly absorbed from the gastrointestinal tract primarily as mono(2-ethylhexyl)phthalate. The diester can be absorbed through the skin and from the lungs. It is rapidly metabolized in the blood and tissues to the monoester, which can be excreted as a glucuronide conjugate or further hydrolyzed to phthalic acid and excreted.

Animal studies have indicated that the primary target organs are the liver and kidneys; however, higher doses are reported to result in testicular effects and decreased hemoglobin and packed cell volume. The primary intracellular effects of *bis*(2-ethylhexyl)phthalate in the liver and kidneys are an increase in the smooth endoplasmic reticulum and a proliferation in the number and size of peroxisomes. An epidemiological study reported no toxic effects from occupational exposure to air concentrations of *bis*(2-ethylhexyl)phthalate up to 0.16 mg/m^3. Other studies on occupational exposures to mixtures of phthalate esters containing *bis*(2-ethylhexyl)phthalate have reported polyneuritis and sensory-motor polyneuropathy with decreased thrombocytes, leukocytes, and hemoglobin in some exposed workers. Developmental toxicity studies with rats and mice have shown that *bis*(2-ethylhexyl)phthalate is fetotoxic and teratogenic when given orally during gestation. Oral exposure has also been shown to result in decreased sperm count in rats.

An RfD of 0.02 mg/kg/d for both subchronic and chronic oral exposure was calculated from a LOAEL of 19 mg/kg/d based on increased relative liver weight in guinea pigs given 0, 19, or 64 mg *bis*(2-ethylhexyl) phthalate/kg/d for 12 months in their diet. An RfC for inhalation exposure is not available.

Bis(2-ethylhexyl)phthalate is known to induce the proliferation of peroxisomes, which has been associated with carcinogenesis. Dose-dependent, statistically significant increases in the incidences of hepatocellular carcinomas and combined carcinomas and adenomas were seen in mice and rats exposed to *bis*(2-ethylhexyl)phthalate in their diet for 103 weeks. An increased incidence of neoplastic nodules and hepatocellular carcinomas was also reported in rats.

Based on EPA guidelines, *bis*(2-ethylhexyl)phthalate was assigned to weight-of-evidence Group B2, probable human carcinogen, on the basis of an increased incidence of liver tumors in rats and mice. A carcinogenicity SF (q_1*) of 0.014 $(mg/kg/d)^{-1}$ for oral exposure was based on the combined incidence of hepatocellular carcinomas and adenomas in male mice. A drinking water unit risk of 4.0E−07 $(\mu g/L)^{-1}$ was calculated based on the q_1*. A quantitative estimation of carcinogenic risk from inhalation exposure is not available.

Chlordane (BEAIS 1994)

Technical grade chlordane is a mixture of structurally related compounds including *trans*-chlordane, *cis*-chlordane, β-chlordene, heptachlor, and *trans*-nonachlor. Chlordane was used extensively as a pesticide in the United States from 1948 to 1988. Because the chemical is persistent in the environment, exposure can still occur from breathing the air of treated homes, consuming shellfish caught in contaminated waters, or eating food produced on contaminated farmlands. Chlordane is readily absorbed

after oral, inhalation, or dermal exposure and is stored in adipose tissue. The chemical is excreted in the feces from the bile, but metabolite residues have been detected in 46% of human milk samples from Arkansas/Mississippi, in 68% of samples from Mississippi, and in 100% of samples from Hawaii.

Death in humans from ingestion of chlordane was accompanied by vomiting, dry cough, agitation and restlessness, hemorrhagic gastritis, bronchopneumonia, muscle twitching, and convulsions. Nonlethal, accidental poisoning of children has resulted in convulsions, excitability, loss of coordination, dyspnea, and tachycardia; however, recovery was complete. When a municipal water supply was contaminated with chlordane in concentrations of up to 1.2 g/L, 13 persons had symptoms of gastrointestinal and neurological disorders. Signs of toxicity from chronic inhalation exposure in chlordane treated homes include sinusitis, bronchitis, dermatitis, neuritis, migraine, gastrointestinal distress, fatigue, memory deficits, personality changes, decreased attention span, numbness or paresthesias, disorientation, loss of coordination, dry eyes, and seizures. Blood dyscrasias, including production defects and thrombocytopenic purpura, have been described for both professional applicators and for home owners and their families following home termite treatment. An inhalation RfC for chlordane is under review by EPA.

Liver enlargement occurred in mice exposed to 10 mg/m^3 for 8 h/d, 5 d/week for 90 d. Increased liver weights were found in female rats (5.8 mg/m^3), increased liver and kidney weights occurred in male rats (28.2 mg/m^3), serum chemistry changes indicative of liver damage and hypersensitivity occurred in females (28.2 mg/m^3), and centrilobular hepatocyte enlargement occurred in males and females (28.2 mg/m^3) exposed to chlordane by inhalation 8 h/d, 5 d/week, for 28 d.

Long-term feeding studies with chlordane in laboratory animals resulted in significantly reduced weight gains in male (203.5 or 407.0 ppm, 80 weeks) and female (120.8 or 241.5 ppm, 80 weeks) rats, a dose-related trend in mortality of female rats and male mice (29.9 or 56.2 ppm, 80 weeks), and liver hypertrophy of female rats (≥5 ppm, 130 weeks). In a 24-month feeding study with mice, hepatocellular swelling and necrosis occurred in males and increased liver weights occurred in males and females fed 5 ppm. A chronic oral RfD of 6E-05 mg/kg/d for chlordane was calculated from a NOAEL of 0.055 mg/kg/d derived from a chronic feeding study with rats. The subchronic oral RfD is also 6E-05 mg/kg/d.

Altered endocrine and immune functions have been observed in rat pups exposed to chlordane in utero.

Exposure of humans from chlordane treated homes has been associated with leukemia, skin neoplasms, and neuroblastoma in children. An increased risk of non-Hodgkin's lymphoma has been found among farmers exposed to chlordane 20 or more days per year. Hepatic carcinomas and hepatocellular adenomas have been described for several strains of male and female mice and male rats given chlordane in the diet. EPA has classified chlordane as group B2, probable human carcinogen. The q_1* for oral exposure is 1.3E+0 $(mg/kg/d)^{-1}$ based on an increase of hepatocellular carcinomas in mice and hepatocellular adenomas in rats. A drinking water unit risk of 3.7E-05 $(\mu g/L)^{-1}$ was calculated on the basis of the q_1*. The q_1* for inhalation exposure is 1.3E+0 $(mg/kg/d)^{-1}$, and the inhalation unit risk value is 3.7E-04 $(\mu g/m^3)^{-1}$. The inhalation risk estimates were calculated from the oral data.

4,4'-DDT, 4,4'-DDD, 4,4'-DDE

DDT is a white odorless powder that was widely used as a pesticide until banned in the United States but continues to be used worldwide. DDT does not occur naturally in the environment and but is made from chloral hydrate, chlorobenzene, and sulfuric acid. In the United States, DDT mostly occurs in the environment from past use as an insecticide. DDD was also used as a pesticide on a more limited extent; however, DDE is found in the environment only as a result of contamination or breakdown of DDT. (ATSDR 1994)

Typically, individuals are exposed to a mixture of DDT, DDD, and DDE by eating foods containing small amounts of these compounds. Even though these compounds are no longer used, small amounts remain in the soil and in some imported foods that have been directly exposed. Nonetheless, the amount of DDT in the U.S. has decreased and is expected to continue in this decline. (ATSDR 1994)

4,4'-DDT and its metabolites may be absorbed via the respiratory tract and the gastrointestinal tract. Acute 4,4'-DDT poisoning may cause rashes; irritation of the eyes, nose, and throat; nervous system effects; muscle weakness; and death due to respiratory failure or ventricular fibrillation. Tremors are the most noticeable indication of chronic 4,4'-DDT exposure among humans. In animals, chronic exposure to high levels may result in symptoms of central nervous system and liver toxicity. 4,4'-DDT is well known for its ability to reduce the thickness of egg shells in birds, but no major reproductive or teratogenic effects have been reported in mammals. Although tests indicate that 4,4'-DDT is not mutagenic, an increase in the number of chromatic breaks was observed in insecticide workers during a peak spraying season. Liver tumors have been reported in animals orally exposed to 4,4'-DDT and its metabolites. Carcinogenicity has not been associated with human exposure to 4,4'-DDT, 4,4'-DDD, or 4,4'-DDE. (ATSDR 1994)

Dibenz[*a,h*]anthracene

Dibenz[*a,h*]anthracene is a chemical substance formed during the incomplete burning of fossil fuel, garbage, or any organic matter and is found in smoke in general; it condenses on dust particles and is distributed into water and soil and on crops. Dibenz[*a,h*]anthracene is a PAH and is also a component of coal tar pitch, which is used in industry as a binder for electrodes and in creosote used to preserve wood. PAHs are also found in limited amounts in bitumens and asphalt used in industry and for paving. As a pure chemical, dibenz[*a,h*]anthracene resembles colorless plates or leaflets. (ATSDR 1990)

Humans may be exposed to dibenz[*a,h*]anthracene in the environment in tobacco smoke; food products such as cereals, vegetables, fruits, meats, and beverages; in the air if the home is heated with wood or coal; in some drinking water supplies; in the soils and air in the work place; and by contact with creosote-treated wood, asphalt roads, or coal tar. (ATSDR 1990)

Dibenz[*a,h*]anthracene enters the body primarily through breathing polluted air or inhaling tobacco smoke. Drinking contaminated water or accidentally swallowing soil or dust particles can also result in dibenz[*a,h*]anthracene entering the body. Dibenz[*a,h*]anthracene can be formed in food that is smoked or charcoal-broiled and can then enter the body through the digestive system. It does not normally enter the body through the skin; however, small amounts could enter the body through contact with soil containing high levels of dibenz[*a,h*]anthracene or through contact with heavy oils. (ATSDR 1990)

Dibenz[*a,h*]anthracene is a toxic chemical and has caused cancer in laboratory animals when it is ingested or applied to their skin. Because dibenz[*a,h*]anthracene causes cancer in animals, it is possible that humans exposed in the same manner could develop cancer as well. Dibenz[*a,h*]anthracene has not

been well studied, and, consequently, it is not known whether breathing it could cause cancer or other harmful effects.(ATSDR 1990)

No information is available concerning the harmful effects of dibenz[*a,h*]anthracene in humans after breathing, eating, or skin application of this substance. The levels that caused tumors in animals that ingested dibenz[*a,h*]anthracene are unclear. Skin cancer has been found in mice that had 1.2×10^{-2} mg/kg/d applied to their skin throughout their lives. It is not known whether similar levels could cause cancer in humans. (ATSDR 1990)

Indeno[1,2,3-*cd*]pyrene (BEAIS 1994)

Indeno[1,2,3-*cd*]pyrene, a crystalline solid with a chemical formula of $C_{22}H_{12}$ and a molecular weight of 276.3, is a PAH. There is no commercial production or known use of this compound. Indeno[1,2,3-*cd*]pyrene is found in fossil fuels and occurs ubiquitously in products of incomplete combustion and has been identified in soils, groundwater, and surface waters at hazardous waste sites.

No absorption data were available for indeno[1,2,3-*cd*]pyrene; however, by analogy to structurally related PAHs, primarily benzo[*a*]pyrene, it would be expected to be absorbed from the gastrointestinal tract, lungs, and skin. In vivo metabolites identified in mouse skin include the *trans*-1,2-dihydrodiol and 8- and 9-hydroxy forms of indeno[1,2,3-*cd*]pyrene. Similar metabolites were formed in vitro in rat liver microsomes.

No data were found concerning the acute, subchronic, chronic, developmental, or reproductive toxicity of indeno[1,2,3-*cd*]pyrene. Because of a lack of toxicity data, an oral RfD or inhalation RfC has not been derived.

No long-term oral or inhalation bioassays were available to assess the carcinogenicity of indeno[1,2,3-*cd*]pyrene. The compound was tested for carcinogenicity in dermal application, lung implant, s.c. injection, and i.p. injection studies. Dermal application of 0.1–0.5% solutions of indeno[1,2,3-*cd*]pyrene in acetone produced skin papillomas and carcinomas in mice. In initiation-promotion assays, indeno[1,2,3-*cd*]pyrene was active as an initiator of skin carcinogenesis. Dose-related increases of epidermoid carcinomas of the lungs were reported in rats receiving single lung implants of 0.16–4.15 mg indeno[1,2,3-*cd*]pyrene. Injection site sarcomas developed in mice given three s.c. injections of 0.6 mg indeno[1,2,3-*cd*]pyrene. The compound was not tumorigenic when newborn mice received 2.1 μmol indeno[1,2,3-*cd*]pyrene via i.p. injection.

Based on no human data and sufficient evidence for carcinogenicity in animals, EPA has assigned a weight-of-evidence classification of B2, probable human carcinogen, to indeno[1,2,3-*cd*]pyrene.

Methylphenols (4-Methylphenol)

Methylphenols (cresols) occur as several closely related compounds, including 2-methylphenol (ortho-cresol), 3-methyl phenol (meta-cresol), 4-methylphenol (para-cresol) and 2,4-dimethylphenol. These compounds occur naturally and are found in many foods, human and animal urine, wood and tobacco smoke, crude oil, and coal tar. Man-made methylphenols are used as disinfectants and deodorizers, to dissolve substances, and in the manufacture of other chemicals. (ATSDR 1990b)

Methylphenols are highly irritating and corrosive to tissue. Systemically, methylphenols can affect the central nervous system, liver, lungs, kidneys, gastrointestinal tract, eyes, and heart. Effects in the blood-forming system, respiratory irritation, and sclerosis of the lungs have been reported in rats exposed

for intermediate durations. No studies are available on the potential chronic, reproductive, or teratogenic effects of methylphenols. One mutagenicity study on onion root tips reports negative results for 2-methylphenol, but 4-methylphenol produced cytological abnormalities and chromosome fragmentation. In an initiation-promotion study, methylphenols have promoted the tumorigenic action of a carcinogen when applied to mouse skin (ATSDR 1990b).

Polychlorinated Biphenyls (Aroclor 1254 and Aroclor 1260)

Polychlorinated biphenyls (PCBs) are a group of man-made chemicals that contain 209 individual compounds (known as congeners); they are either oily liquids or solids and are colorless to light yellow without any known smell or taste. Seven types of PCBs mixtures include 35% of all the different PCBs commercially produced and 98% of PCBs sold in the United States since 1970. Some commercial PCB mixtures are known in the United States by their industrial trade name, Aroclor (i.e., Aroclor 1254, Aroclor 1260). The name Aroclor 1254 signifies that the molecule contains 12 carbon atoms (the first two digits) and approximately 54% chlorine by weight (the second two digits). Polychlorinated biphenyls do not burn easily and are a good insulating material; therefore, they have been used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. However, in 1977, manufacture of PCBs stopped in the United States because evidence showed that PCBs tend to build up in the environment and cause harmful effects. (ATSDR 1993)

In the past, PCBs entered the environment through their manufacture and use. Today, they can enter the environment from poorly maintained hazardous waste sites, illegal or improper dumping of PCB wastes, leaks or releases from electrical transformers containing PCBs, and disposal of PCB-containing consumer products into municipal landfills rather than into landfills designed for hazardous waste. Polychlorinated biphenyls can exist in air as both solid and liquid aerosols and as vapor that eventually returns to the land and water by settling or washout by snow or rainwater. Even extremely small amounts of PCBs can remain in water for several years, and they will bind strongly with soil and remain bonded for several years. (ATSDR 1993)

PCBs can be ingested or inhaled and can cause skin and nose irritations. Although several health effects as a result of exposure to PCBs have been seen in rats (i.e., liver damage and sometimes death after ingesting large amounts of PCBs for a short period and liver, stomach, and thyroid gland injuries; anemia; acne; and damaged reproduction organs after ingesting smaller amounts of PCBs but for a longer period), little conclusive evidence concerning the effects of PCBs on humans is available. In addition, rats that ate certain PCB mixtures throughout their lives developed liver cancers; however, it is not known if the same effects would occur in people. After inhalation exposure, workers have exhibited respiratory tract and eye irritation, coughs, and tightness of the chest, as well as gastrointestinal symptoms (anorexia, weight loss, nausea, vomiting, and abdominal pain); none of these symptoms were reported in a great quantity and therefore results are inconclusive. (ATSDR 1993)

Studies of PCB-exposed workers provide inconclusive evidence for exposure-related cancer; however, an excess risk of cancer of the liver, biliary tract, and gall bladder has been reported in workers in two capacitor plants where PCB mixtures are commonly used. The International Agency for Research on Cancer has determined that PCBs are *probably* carcinogenic to humans, and the EPA has determined that PCBs are probable human carcinogens. (ATSDR 1993)

E1.3 RADIONUCLIDES

Radionuclides are unstable atoms of chemical elements that will emit charged particles to achieve a more stable state. These charged particles are termed "alpha and beta radiation" and "neutral gamma rays." Interaction of these charged particles (and gamma rays) with matter will produce ionization events, or radiation, which may cause living cell tissue damage. Because the deposition of energy by ionizing radiation is a random process, sufficient energy may be deposited (in a critical volume) within a cell and result in cell modification or death (ICRP 1991). In addition, ionizing radiation has sufficient energy that interactions with matter will produce an ejected electron and a positively charged ion (known as free radicals) that are highly reactive and may combine with other elements, or compounds within a cell, to produce toxins or otherwise disrupt the overall chemical balance of the cell (EPA 1991d). These free radicals can also react with deoxyribonucleic acid, causing genetic damage, cancer induction, or even cell death.

Radionuclides are characterized by the type and energy level of the radiation emitted. Radiation emissions fall into two major categories: particulate (electrons, alpha particles, beta particles, and protons) or electromagnetic radiation (gamma and x rays) (ATSDR 1989b). Therefore, all radionuclides are classified by the EPA as Group A carcinogens based on their property of emitting ionizing radiation and on the extensive weight of evidence provided by epidemiological studies of humans with cancers induced by high doses of radiation. Alpha particles are emitted at a characteristic energy level for differing radionuclides. The alpha particle has a charge of +2 and a comparably large size. Alpha particles have the ability to react (and/or ionize) with other molecules, but they have very little penetrating power and lack the ability to pass through a piece of paper or human skin. However, alpha-emitting radionuclides are of concern when there is a potential for inhalation or ingestion of the radionuclide. Alpha particles are directly ionizing and deposit their energy in dense concentrations [termed high linear energy transfer (high LET)], resulting in short paths of highly localized ionization reactions. The probability of cell damage increases as a result of the increase in ionization events occurring in smaller areas; this may also be the reason for increased cancer incidence caused by inhalation of decay products of radon gas. In addition, the cancer incidence in smokers may be directly attributed to the naturally occurring alpha emitter ^{210}Po in common tobacco products (Hammonds and Hoffman 1992).

Beta emissions generally refer to beta negative particle emissions. Radionuclides with an excess of neutrons achieve stability by beta decay. Beta radiation, like alpha radiation, is directly ionizing, but, unlike alpha activity, beta particles deposit their energy along a longer track length (low-LET), resulting in more space between ionization events (Hammonds and Hoffman 1992). Beta-emitting radionuclides can cause injury to the skin and superficial body tissue but are most destructive when inhaled or ingested. Many beta emitters are similar chemically to naturally occurring essential nutrients and will therefore tend to accumulate in certain specific tissues. For example, ^{90}Sr is chemically similar to calcium and, as a result, accumulates in the bones, where it causes continuous exposure. The health effects of beta particle emissions depend upon the target organ. Those seeking the bones would cause a prolonged exposure to the bone marrow and affect blood cell formation, possibly resulting in leukemia, other blood disorders, or bone cancers. Those seeking the liver would result in liver diseases or cancer, while those seeking the thyroid would cause thyroid and metabolic disorders. In addition, beta radiation may lead to damage of genetic material, causing hereditary defects.

Gamma emissions are the energy that has been released from transformations of the atomic nucleus. Gamma emitters and x rays behave similarly but differ in their origin: gamma emissions originate in nuclear transformations, and x rays result from changes in the orbiting electron structure. Radionuclides that emit gamma radiation can induce internal and external effects. Gamma rays have high penetrating

ability in living tissue and are capable of reaching all internal body organs. Without such sufficient shielding as lead, concrete, or steel, gamma radiation can penetrate the body from the outside and does not require ingestion or inhalation to penetrate sensitive organs. Gamma rays are characterized as low-LET radiation, as is beta radiation; however, the behavior of beta radiation differs from that of gamma radiation in that beta particles deposit most of their energy in the medium through which they pass, while gamma rays often escape the medium because of higher energies, thereby creating difficulties in determining actual internal exposure. For this reason, direct whole-body measurements are necessary to detect gamma radiation, while urine/fecal analyses are usually effective in detecting beta radiation (Hammonds and Hoffman 1992).

People receive gamma radiation continuously from naturally occurring radioactive decay processes going on in the earth's surface, from radiation naturally occurring inside their bodies, from the atmosphere as fallout from nuclear testing or explosions, and from space or cosmic sources. Cesium-137 (from nuclear fallout) decays to ^{137}Ba, the highest contributor to fallout-induced gamma radiation (NCRP 1977). Beta radiation from the soil is a less penetrating form of radiation but has many contributing sources. Potassium-40, ^{137}Cs, ^{214}Pb, and ^{214}Bi are among the most common environmental beta emitters. Tritium is also a beta emitter but contributes little to the soil beta radiation because of the low energy of its emission and its low concentration in the atmosphere (NCRP 1977). Alpha radiation is also emitted by the soil but is not measurable more than a few centimeters from the ground surface. The majority of alpha emissions are attributable to ^{222}Rn and ^{220}Rn and their decay products (NCRP 1977). This contributes to what is called background exposure to radiation (ATSDR 1989b).

The general health effects of radiation can be divided into stochastic (related to dose) and nonstochastic (not related to dose) effects. The risk of development of cancer from exposure to radiation is a stochastic effect. Examples of nonstochastic effects include acute radiation syndrome and cataract formation, which occur only at high levels of exposures (Killough and Eckerman 1983).

Radiation can damage cells in different ways. It can cause damage to genetic material within the cell, and the cell either may not be able to recover from this type of damage or may survive but function abnormally. If an abnormally functioning cell divides and reproduces, a tumor or mutation in the tissue may develop. The rapidly dividing cells that line the intestines and stomach and the blood cells in bone marrow are extremely sensitive to this damage. Organ damage results from the damage caused to the individual cells. This type of damage has been reported with doses of 10 to 500 rads (0.1 to 5.0 gray, in SI units). Acute radiation sickness is seen only after doses of >50 rads (0.5 gray), which is a dose rate usually achieved only in a nuclear accident (ATSDR 1989b).

When the radiation-damaged cells are reproductive cells, genetic damage can occur in the offspring of the person exposed. The developing fetus is especially sensitive to radiation. The type of malformation that may occur is related to the stage of fetal development and the cells that are differentiating at the time of exposure. Radiation damage to children exposed in the womb is related to the dose the pregnant mother receives. Mental retardation is a possible effect of fetal radiation exposure (ATSDR 1989b).

The most widely studied population that has had known exposure to radiation is the atomic bomb survivors of Hiroshima and Nagasaki, Japan. Data indicate an increase in the rate of leukemia and cancers in this population. However, the rate at which cancer incidence is significantly affected by low radiation exposures, such as results of exposure to natural background and industrially contaminated sites, is still undergoing study and is uncertain (Hammonds and Hoffman 1992). In studies conducted to determine the rate of cancer and leukemia increase, as well as genetic defects, several radionuclides must be considered.

Cesium-137

Cesium-137, a product of nuclear fission reactions, has a radioactive half-life of 30.2 years (Kocher 1981). In ~95% of the radioactive decay, ^{137}Cs emits a beta particle with a maximum energy of 0.514 MeV (Turner 1986) and is transformed to the metastable state of ^{137m}Ba. Barium-137m then decays 90% of the time by emitting a 0.662-MeV gamma ray.

The primary sources of contamination from ^{137}Cs at the ORR are the effluent streams from research reactors and seepage from burial grounds used to store radioactive wastes. In aquatic media, ^{137}Cs tends to accumulate in the sediment. However, uptake may also occur in fish and other biota. In the Clinch/Tennessee River environment, the primary routes of human exposure are external exposure to gamma rays from the decay of ^{137m}Ba in near-shore sediment and ingestion of ^{137}Cs in fish.

Cesium-137 entering the human body via ingestion behaves similarly to potassium. It is rapidly and almost completely absorbed from the GI tract and is distributed uniformly throughout the body (ICRP 1990). Because of its relatively short metabolic half-life (110 d), an acute dose of ^{137}Cs is almost completely excreted in the urine within a year of the initial exposure. However, when considering a potentially long-term (chronic) exposure, ^{137}Cs would always be present in the body.

The SF for ingestion of ^{137}Cs and its daughter products is 7.6×10^{-10} (risk/Bq), the SF for the inhalation of airborne ^{137}Cs and its daughters is 5.1×10^{-10} (risk/Bq), and the SF for the external exposure to ^{137}Cs and its daughters is 5.4×10^{-5} (risk/year per Bq/g soil).

Cobalt-60

Cobalt-60 is produced in nuclear reactors from neutron activation of stable cobalt atoms. These cobalt atoms are present as a corrosion impurity in the water used as the primary reactor coolant of the reactor (Eichholz 1983). Cobalt-60 has a radioactive half-life of 5.27 years and decays by emitting a 0.314-MeV beta particle and two gamma rays exhibiting energies of 1.33 and 1.17 MeV (Kocher 1981). Cobalt-60 enters the environment surrounding the ORR from the effluent streams from research reactors and seepage from burial grounds used to store radioactive wastes. Important routes of human exposure for ^{60}Co include external exposure resulting from high-energy gamma rays emitted from near-shore sediment and ingestion of contaminated fish, produce, and water. Internally absorbed ^{60}Co is assumed to be uniformly distributed throughout the body. The SFs for ^{60}Co are found in Table 5.8.

Strontium-90 (BEIAS 1994)

Strontium-90 is a radioactive isotope of strontium that is produced in nuclear fission. It is a low-energy β emitter with a physical half-life of approximately 28 years. In the environment, it is accompanied by its decay product, ^{90}Y, also a β emitter.

Metabolically, strontium is an analog of calcium. Strontium-90 is rapidly absorbed from the gastrointestinal tract or the lung into the bloodstream and is subsequently deposited in bone. Retention in the bone is long term, with yearly loss of the existing burden in adults of 7.5% from cortical bone and 30% from trabecular bone.

Oral intake at high levels of activity results in β irradiation of target organs and nearby tissues. At high exposures, death results from radiation-induced hemorrhagic syndrome; at lower exposures, death results from destruction of the bone marrow. As survival times increase at lower administered activities, these effects are accompanied by neoplasms. Oral administration to miniature swine at 115×10^6 Bq/d resulted

in radiation-induced hemorrhagic syndrome and death within 4 months. Lower intakes, 4.62×10^6 to 0.037×10^6 Bq/d induced effects on the hematopoietic system ranging from pancytopenia to neutropenia. Mean survival times were decreased in all exposure groups. Subchronic exposures (5.6×10^4 to 133×10^4 Bq/d) also resulted in cytopenias in beagle dogs. Median survival times were reduced, particularly at the two highest exposures. Doses in the latter study were estimated at 22.5 to 107 Gy. In a three-generation study of miniature swine, no effects were noted on litter size, the percentage of stillborn, or birth weight when dams received life-shortening exposures. The EPA has not calculated subchronic or chronic oral RfDs for radionuclides.

Inhalation of soluble forms of ^{90}Sr at high activity levels resulted in early death of beagle dogs from bone marrow hypoplasia, panleukocytopenia, terminal hemorrhage, and bacterial infection. Long-term bone burdens of 17×10^6 to 41×10^6 Bq were calculated. Acute pulmonary effects observed in mice exposed to high activity levels of insoluble ^{90}Sr were radiation pneumonitis and pulmonary fibrosis. The dose lethal to 50% of animals was 370 Gy. The EPA has not calculated subchronic or chronic inhalation RfCs for radionuclides.

The primary effect in animals surviving acute effects of ^{90}Sr exposure is neoplasia of bone and bone-related tissues. Soft tissue carcinomas in tissues near the bone were also observed above control levels. Chronic ingestion in beagle dogs and miniature swine also produced a high incidence of myeloproliferative disease, including frank leukemia. Orally administered activity levels of 0.1×10^4 to 133×10^4 Bq/d to beagle dogs, beginning in utero and continuing to 540 days of age induced primary bone sarcomas and myeloproliferative disorders at activity levels of $\geq 5.6 \times 10^4$ Bq/d. Bone sarcomas and hematopoietic neoplasms were induced in F_1 and F_2 generations of miniature swine that chronically ingested 4.62×10^6 Bq/d or 23.1×10^6 Bq/d. These generations were exposed in utero and gradually raised to the treatment level by 6 months of age. At higher exposure activities, mean survival time was drastically reduced (to less than tumor induction time); at lower exposure activities, 0.037×10^6 to 0.925×10^6 Bq/d, no bone sarcomas were observed, and survival times were increased to approximately that of controls.

The primary effect in adult beagle dogs administered ^{90}Sr in a single inhalation exposure and surviving more than 2 years was an excess of bone tumors. This effect was induced in dogs with long-term retained bone burdens of $\geq 1.0 \times 10^6$ Bq/kg.

Bone tumors were induced in two of seven adult monkeys administered ^{90}Sr by gavage (NCRP 1991), in adult beagle dogs administered ^{90}Sr by intravenous injection, and in mice administered ^{90}Sr by i.p. injection. Soft tissue sarcomas in tissues near the bone were observed in the beagle dogs. No tumors were observed over a 20-year period in young and adult Rhesus monkeys administered a single injection at activity levels of 0.13×10^6 to 6.21×10^6 Bq.

The EPA has classified all radionuclides as Group A carcinogens based on their property of emitting ionizing radiation and on the weight of evidence provided by epidemiological studies of radiation-induced tumors in humans. An SF of 8.9E-10 (risk/Bq) was calculated for oral ingestion. The combined oral SF for strontium-90 and yttrium-90 is 9.7E-10 (risk/Bq). For inhalation exposure, the SF for ^{90}Sr is 1.5E-09 (risk/Bq); the combined inhalation SF for ^{90}Sr plus ^{90}Y is 1.7E-09 (risk/Bq). Because of their low penetration ability, external exposures (risk/year per Bq/g soil) for ^{90}Sr and ^{90}Sr plus ^{90}Y are both 0.0E+00.

E2. UNCERTAINTY ANALYSIS: DESCRIPTION OF METHODS

E2.1 INTRODUCTION

This appendix focuses on a quantitative uncertainty analysis of (1) the potential detriment associated with the ingestion of selected radionuclides and chemicals as a result of human consumption of contaminated fish, and (2) the potential detriment associated with the dredging of deep sediment from the Clinch River and Poplar Creek. Parameter uncertainties are estimated and incorporated into the quantitative uncertainty analyses of human health risks. The equations used for assessing the risk of the fish ingestion pathway and the dredging scenario are presented in the following sections of this introduction. The uncertainties involved with the fish ingestion pathway are presented in Sect. E.2, and the uncertainties involved with the dredging scenario are discussed in Sect. E.3.

E2.1.1 Background on USEPA Methods for Risk Assessment for Ingestion of Fish

For a baseline risk assessment, the USEPA (1989) uses the following equation for determining the lifetime risk of excess cancer from ingesting radionuclides:

$$LR_{rad} = C \cdot I \cdot ED \cdot EF \cdot DCF \cdot RCF \qquad \text{(E.1)}$$

where,

Lr_{rad}	=	excess lifetime cancer risk from radionuclides (unitless),
C	=	concentration in the contaminated medium (Bq/kg),
I	=	estimated intake of the contaminated medium (kg/d),
ED	=	exposure duration (30 years),
EF	=	exposure frequency (350 days/year),
DCF	=	dose conversion factor for the radionuclide of interest (Sv/Bq),
and RCF	=	risk conversion factor (0.073/Sv) (ICRP 1991; NCRP 1993a).

The generic equations used in USEPA methods for determining the risk from chemicals are different for non-carcinogens and carcinogens. For non-carcinogens a quantity called the Hazard Quotient (HQ) is calculated for each chemical using the following formula.

$$HQ = \frac{C \cdot I \cdot ED \cdot EF}{BM \cdot AT \cdot RfD} \qquad \text{(E.2)}$$

where,

HQ	=	hazard quotient (unitless),
C	=	concentration in the contaminated medium (mg/kg),
I	=	estimated intake rate of the contaminant (kg/d),
ED	=	exposure duration (years),
EF	=	exposure frequency (350 d/year),
BM	=	body mass (70 kg),
AT	=	averaging time (d),
and RfD	=	reference dose for the chemical of interest (mg/kg/d).

If the HQ is below 1, then it is highly unlikely that chronic exposure to the chemical would lead to a health effect. If the HQ is greater than unity, remediation of the area may be warranted. The HQs for

various chemicals are summed for each exposure pathway to obtain a Hazard Index (*HI*) for a given area (USEPA 1989).

For carcinogenic chemicals, a lifetime cancer risk is calculated from the following formula.

$$LR_{chem} = \frac{C \cdot I \cdot ED \cdot EF \cdot SF}{BM \cdot AT} \tag{E.3}$$

where,

Lr_{chem}	=	excess lifetime cancer risk from chemicals (unitless),
C	=	concentration in the contaminated medium (mg/kg),
I	=	estimated intake of the contaminated medium (kg/d),
ED	=	exposure duration (30 years),
EF	=	exposure frequency (350 d/year),
SF	=	slope factor (or cancer potency factor) for the chemical of interest [$(mg/kg/d)^{-1}$],
BM	=	body mass (70 kg),
and AT	=	averaging time (25,550 d = 70 years).

A primary difference in evaluating risk between non-carcinogens and carcinogens is the threshold and no threshold assumption, respectively. For non-carcinogens, toxic effects occur after an exposure above a certain threshold value has occurred. It is assumed that any exposure below this threshold has no detrimental effect to the organism. For carcinogens, however, it is assumed that there is no threshold below which a risk is assumed to be zero. A carcinogen is defined as a substance for which any exposure results in a potential excess cancer risk.

These equations yield point estimates of the risks which obscure the inherent uncertainty in the calculations. If decisions concerning remediation of the contaminated area are based on point estimates, and if the true risk is either grossly overestimated or is associated with high uncertainty, the result may be inappropriate remedial efforts and/or misallocation of limited resources. Therefore, quantitative uncertainty analysis should be performed to quantify the degree of confidence in the estimate of risk. This requires analysis of the uncertainty associated with each parameter in the USEPA risk equations; the bounds of uncertainty, expressed as subjective probability distributions, must be estimated for each parameter. The term subjective probability distribution is used because of the application of judgment in the absence of relevant site specific data.

E2.1.2 Background for the Risk Assessment of the Dredging Scenario

The following equations were used in the analysis of the potential detriment resulting from contamination in the deep sediment of the Clinch River and Poplar Creek.

Ingestion of leafy vegetables:

$$HQ_{l,veg} = \frac{C_{sed} \cdot B_{v,leafy} \cdot D_l \cdot I_{veg,leafy} \cdot FI_{veg} \cdot EF_{veg} \cdot ED}{BW \cdot AT \cdot RfD} \tag{E.4}$$

where,

$Hq_{l,veg}$ = hazard quotient from leafy-vegetable ingestion (unitless),

C_{sed} = concentration of the contaminant in the dredged sediment (mg/kg),
$B_{v,leafy}$ = soil-plant uptake factor (unitless, fresh weight),
D_l = sediment dilution factor (unitless),
$I_{veg,leafy}$ = ingestion of leafy-vegetables (kg/year, fresh weight)
Fi_{veg} = fraction of vegetable ingestion that is from the contaminated site (unitless),
Ef_{ing} = exposure frequency (unitless),
ED = exposure duration (years),
BW = body weight (kg),
AT = averaging time (d),
and RfD = oral reference dose (mg/kg/d).

Ingestion of non-leafy vegetables:

$$HQ_{nl,veg} = \frac{C_{sed} \cdot B_{v,non\text{-}leafy} \cdot D_l \cdot I_{veg,nleafy} \cdot FI_{veg} \cdot EF_{ing} \cdot ED}{BW \cdot AT \cdot RfD} \qquad (E.5)$$

where,
$Hq_{nl,veg}$ = hazard quotient from non-leafy vegetable ingestion (unitless),
C_{sed} = concentration of the contaminant in the dredged sediment (mg/kg),
$B_{v,non\text{-}leafy}$ = soil-plant uptake factor (unitless, fresh weight),
D_l = sediment dilution factor (unitless),
$I_{veg,nleafy}$ = ingestion of non-leafy vegetables (kg/year, fresh weight)
Fi_{veg} = fraction of vegetable ingestion that is from the contaminated site (unitless),
Ef_{ing} = exposure frequency (unitless),
ED = exposure duration (years),
BW = body weight (kg),
AT = averaging time (d),
and RfD = oral reference dose (mg/kg/d).

Ingestion of milk:

$$HQ_{milk} = \frac{C_{sed} \cdot B_{v,past} \cdot D_l \cdot Q_m \cdot FI_Q \cdot F_m \cdot I_{milk} \cdot FI_{milk} \cdot EF_{ing} \cdot ED}{BW \cdot AT \cdot RfD} \qquad (E.6)$$

where,
Hq_{milk} = hazard quotient from milk ingestion (unitless),
C_{sed} = concentration of the contaminant in the dredged sediment (mg/kg),
$B_{v,past}$ = soil-plant uptake factor (unitless, dry weight),
Q_m = ingestion of pasture by dairy cow (kg/d),
FI_Q = fraction of the pasture ingestion that is from the contaminated source (unitless),
F_m = milk transfer coefficient (d/L),
D_l = sediment dilution factor (unitless),
I_{milk} = ingestion of milk (L/year)
Fi_{milk} = fraction of the milk ingestion that is from the contaminated source (unitless),
Ef_{ing} = exposure frequency (unitless),
ED = exposure duration (years),

BW = body weight (kg),
AT = averaging time (d),
and RfD = oral reference dose (mg/kg/d).

Ingestion of meat:

$$HQ_{meat} = \frac{C_{sed} \cdot B_{v,past} \cdot Q_f \cdot FI_Q \cdot F_f \cdot D_l \cdot I_{meat} \cdot FI_{beef} \cdot EF_{ing} \cdot ED}{BW \cdot AT \cdot RfD} \quad (E.7)$$

where,

Hq_{meat} = hazard quotient from meat ingestion (unitless),
C_{sed} = concentration of the contaminant in the dredged sediment (mg/kg),
$B_{v,past}$ = soil-plant uptake factor (unitless, dry weight),
Q_f = ingestion of pasture by beef cow (kg/d),
FI_Q = fraction of the pasture ingestion that is from the contaminated source (unitless),
F_f = meat transfer coefficient (d/kg),
D_l = sediment dilution factor (unitless),
I_{meat} = ingestion of meat (kg/year)
Fi_{beef} = fraction of the beef ingestion that is from the contaminated source (unitless),
ED = exposure duration (years),
Ef_{ing} = exposure frequency (unitless),
BW = body weight (kg),
AT = averaging time (d),
and RfD = oral reference dose (mg/kg/d).

External Exposure from Radionuclides:

$$LR_{ext(out)} = C_{sed} \cdot D_l \cdot \left(1 - \frac{e^{-\lambda_{eff} ED}}{\lambda_{eff}}\right) \cdot \rho_{soil} \cdot P_{out} \cdot EF_{ext} \cdot DCF_{ext} \cdot RCF \quad (E.8)$$

where,

$Lr_{ext(out)}$ = excess lifetime cancer risk from radionuclide exposure (unitless),
C_{sed} = concentration of the contaminant in the dredged sediment (Bq/kg),
D_l = sediment dilution factor (unitless),
λ_{eff} = loss rate from radioactive decay and from harvesting/leaching ($year^{-1}$),
ED = exposure duration (years),
Ef_{ext} = exposure frequency (unitless),
ρ_{soil} = soil density (kg/m^3),
P_{out} = percent of time spent outdoors (unitless),
DCF_{ext} = external dose rate conversion factor for a contaminated soil depth of 15 cm (Sv/year per Bq/m^3),
and RCF = risk conversion factor (Sv^{-1}).

E2.2 DESCRIPTION OF PARAMETER UNCERTAINTY IN THE FISH INGESTION PATHWAY

The subjective probability distributions used for each of the uncertain parameters in the risk assessment equations reflect the degree of belief that the true, but unknown, value for each parameter does not exceed a specified value for that parameter. Where data are limited, but uncertainty is relatively low (less than a factor of 10), a range is used to specify a uniform distribution. If there is knowledge about a most likely value or midpoint, in addition to a range, a triangular distribution is assigned. When the range of uncertainty exceeds a factor of 10, a log-uniform or log-triangular distribution is often used. The use of normal, log-normal, or empirical distributions is usually based on fits to available data. Piece-wise uniform or log-uniform distributions can also be used and are especially common when eliciting subjective judgment from a group of experts (IAEA 1989). Other distribution types suitable for Monte Carlo analysis include the gamma, beta, Poisson, Weibull, and a variety of discrete distributions (Decisioneering, Inc. 1994; Palisade Corp. 1991).

In this section, the uncertainty associated with the contaminant concentration in fish is discussed first, followed by discussion of exposure factors that are independent within a class (radionuclides, non-carcinogenic chemicals, and carcinogenic chemicals) of contaminants which include the daily intake, the exposure frequency, the exposure duration, the body mass, and the averaging time. Additional topics discussed in this section are the uncertainties involved with radionuclide specific parameters, the dose conversion factors and the risk conversion factor, and with chemical specific parameters, the slope factors and the reference doses. The subjective probability distributions and uncertainty ranges for all of the parameters used in the fish ingestion pathway except the concentrations of the contaminants in fish are summarized in Table E.58.

Table E.58. List of assumptions for the parameters used in the uncertainty analysis of the fish ingestion pathway

Parameter	Distribution	Minimum	Central Value	Maximum	Units
ED, carcinogens	Constant	---	30	---	years
ED, non-carc.	Constant	---	1	---	year
EF	Constant	---	350	---	days/year
I_m, adult	Triangular	0.113	0.230[a]	0.454	kg/fish-meal
I_m, child	Uniform	0.025	---	0.1	kg/fish-meal
I_f, non-carc.	Log-Uniform	0.033	---	0.571	fish-meal/d
I_f, carc.	Log-Uniform	0.033		0.286	fish-meal/d
AT, carcinogens	Constant	---	25,550	---	d
AT, non-carc.	Constant	---	365	---	d
Body Mass, adult	Constant	---	70	---	kg
Body Mass, child	Constant	---	20	---	kg
RfD, chlordane	Log-Triangular	6.0E-06	6.0E-05[a]	1.9E-03	mg/kg/d
RfD, MeHg	Log-Uniform	3.0E-05	---	9.5E-04	mg/kg/d
RfD, Aroclor-1254	Log-Uniform	2.0E-05	---	3.5E-04	mg/kg/d
SF, chlordane	Triangular	0	1.3[a]	5	$(mg/kg/d)^{-1}$
SF, Aroclor-1260	Triangular	0	7.7[a]	10	$(mg/kg/d)^{-1}$
DCF_{ing}, Cs-137	Log-Triangular	7.0E-09	1.4E-08[a]	2.8E-08	Sv/Bq
RCF	Log-Triangular	0.018	0.073[a]	0.292	risk/Sv

[a] mode.

E2.2.1 Concentration in Fish (*C*)

For this uncertainty analysis, only those concentrations where at least one measurement per reach (a section of the river or reservoir) was above detection limits are considered. The uncertainty bounds on the estimated arithmetic mean concentration were quantified for each selected contaminant in each reach. A distribution was obtained that represents the subjective uncertainty of the estimated arithmetic mean concentration. The following equation was used to estimate the uncertainty factor for the arithmetic mean concentrations.

$$UF_{mean} = \frac{UCL_{mean}}{\bar{X}_{est}} \qquad \text{(E.9)}$$

where,

Uf_{mean} = the uncertainty factor for the arithmetic mean,

UCL_{mean} = the 95% upper confidence limit on the mean,

and $_{est}$ = the arithmetic mean.

E2.2.1.1 Radionuclide concentrations

The selected radionuclide for this uncertainty analysis is Cs-137. The values for the arithmetic mean concentration of Cs-137 and the (upper confidence limit) UCL on the mean were obtained for Clinch River and Poplar Creek and are summarized by species in Table E.59. A uniform distribution was used to represent the uncertainty of the estimated arithmetic mean concentration for the radionuclide presented in Table E.59. The maximum value for the uniform distribution was set at the 95% UCL on the arithmetic mean, and the minimum value for the distribution was obtained by dividing the estimated arithmetic mean by the uncertainty factor. These values are also presented in Table E.59. By using this method to obtain the uncertainty range on the mean concentration, there is high confidence that the true mean will be between the (lower confidence limit) LCL and the UCL.

Table E.59. Summary statistics and estimates of uncertainty for radionuclide contaminant concentrations in largemouth bass of reach 2

Species	Radionuclide	Units	Ratio of detects to total samples	Estimated Mean	UCL mean	LCL est.
Largemouth bass	Cs-137	Bq/kg	8/8	2.4E+02	7.1E+02	8.3E+01

E2.2.1.2 Chemical concentrations

The selected chemical contaminants for this uncertainty analysis are mercury, chlordane, Aroclor-1254, and Aroclor-1260. Of these chemicals, mercury and Aroclor-1254 are non-carcinogens, chlordane is both a non-carcinogen and a carcinogen, and Aroclor-1260 is a carcinogen. A non-carcinogen is defined as a substance for which a toxic reaction results from exceeding a threshold level of exposure. A carcinogen is a substance that may cause cancer at any level of exposure. Carcinogens are classified according to the evidence of their carcinogenicity. Radionuclides are classified as "A" which denotes there is ample evidence derived from human epidemiological data. PCBs and chlordane are classified as "B2" carcinogens which implies no information from humans and all data comes from animals (USEPA 1988a).

Non-carcinogens. The values for the estimated arithmetic mean concentration and the UCL on the mean were obtained for the Clinch River and Poplar Creek and are summarized for chlordane, mercury, and Aroclor-1254 in Table E.60. The UCL concentrations and LCL concentrations were calculated as described in the previous section and are also presented in Table E.60. As with the radionuclide contaminants, a uniform distribution, for the interval between the lower and upper confidence limits, was used to represent the uncertainty of the arithmetic mean concentrations except for chlordane (reach 1, catfish and reach 4, S/H Bass) and PCB-1254 (reach 1, catfish) which has an uncertainty range greater than one order of magnitude. Due to the large degree of uncertainty in the estimate of the mean concentration, a log-uniform distribution was used.

Table E.60. Summary statistics and estimates of uncertainty for select non-carcinogenic contaminant concentrations (mg/kg) in fish where at least one measurement was above the detection limits

Fish	Contaminant	Reach	Ratio of detects to total samples	Estimated Mean	LCLest.	UCLmean
Bluegill	Mercury	3	64/67	4.1E-01	3.6E-01	4.6E-01
		4	40/59	1.5E-01	1.2E-01	1.9E-01
LMB[a]	Mercury	2	26/34	2.7E-01	1.8E-01	3.9E-01
		3	36/36	6.2E-01	5.1E-01	7.5E-01
		4	40/48	3.1E-01	2.0E-01	3.4E-01
	Chlordane	2	21/26	2.7E-01	1.8E-01	3.9E-01
		3	27/29	7.2E-02	6.7E-02	7.8E-02
		4	49/50	7.0E-02	6.6E-02	7.3E-02
	PCB-1254	2	16/26	1.6E-01	1.0E-01	2.5E-01
		3	27/29	3.3E-01	2.5E-01	4.3E-01
		4	49/50	2.0E-01	1.7E-01	2.3E-01
Catfish	Mercury	4	19/25	2.6E-01	1.7E-01	3.9E-01
	Chlordane	1	7/11	2.4E-01	9.2E-02	6.2E-01
		2	37/42	2.0E-01	1.5E-01	2.5E-01
		3	67/67	8.6E-02	7.9E-02	9.4E-02
		4	91/92	1.2E-01	1.1E-01	1.3E-01
	PCB-1254	1	11/11	9.8E-02	5.8E-02	1.6E-01
		2	37/38	6.7E-01	4.6E-01	9.6E-01
		3	64/64	3.2E-01	2.5E-01	4.1E-01
		4	88/92	6.0E-01	4.6E-01	7.9E-01
S/H Bass[b]	Chlordane	2	15/15	1.4E-01	1.3E-01	1.5E-01
		4	15/15	1.0E-01	9.3E-02	1.1E-01
	PCB-1254	2	15/15	5.6E-01	5.1E-01	6.1E-01
		4	15/15	4.5E-01	4.1E-01	5.0E-01

[a] LMB = largemouth bass.
[b] S/H Bass = Includes Striped bass, white bass, and hybrid of the two species.

Carcinogens. The estimated arithmetic mean concentrations and the UCLs on the mean for Aroclor-1260 and chlordane were also obtained for the Clinch River and Poplar Creek. These concentrations are summarized in Table E.61. The UCL concentrations and LCL concentrations were calculated as described in Sect. E.2.1 and are also presented in Table E.61.

Table E.61. Summary statistics and estimates of uncertainty for select carcinogenic chemical contaminant concentrations (mg/kg) in fish where at least one measurement was above the detection limits

Reach	Species	Contaminant	Ratio of detects to total	Estimated Mean	UCLmean	LCLest.
1	Catfish	Aroclor-1260	11/11	2.9E-01	4.1E-01	2.1E-01
	Catfish	Chlordane	7/11	2.4E-01	6.2E-01	9.2E-02
2	LMB	Aroclor-1260	16/26	1.6E-01	2.5E-01	1.1E-01
	Catfish	Aroclor-1260	42/42	1.0E+00	1.3E+00	8.3E-01
	S/H Bass	Aroclor-1260	15/15	3.9E-01	4.4E-01	3.4E-01
3	LMB	Aroclor-1260	27/29	3.4E-01	5.0E-01	2.2E-01
	Catfish	Aroclor-1260	69/69	7.0E-01	8.4E-01	5.9E-01
4	LMB	Aroclor-1260	48/50	2.0E-01	2.4E-01	1.7E-01
	Catfish	Aroclor-1260	91/92	8.5E-01	1.0E+00	7.0E-01
	S/H Bass	Aroclor-1260	15/15	7.0E-01	7.8E-01	6.2E-01

[a]A log-uniform distribution was used for this concentration.

As with the previously discussed contaminants, a uniform distribution was used to represent the uncertainty in the estimate of the arithmetic mean concentrations except for the chlordane concentration in catfish for Reach 1 which has an uncertainty range greater than one order of magnitude. Due to the large degree of uncertainty in the estimate of the mean concentration, a log-uniform distribution was used.

E2.2.2 Exposure Factors Independent of the Contaminant Type

Five exposure factors are used in the risk assessment models which are independent of specific radionuclides and chemicals: fish ingestion (daily intake) (*I*), exposure frequency (*EF*), exposure duration (*ED*), body mass (*BM*), and averaging time (*AT*). The subjective uncertainty bounds and probability distributions for these parameters were chosen such that the true but unknown value pertaining to the maximally exposed individual lies within the interval. Meetings were held with individuals having knowledge of these factors to discuss the uncertainty ranges for the parameters presented in this section. A literature review and moderate knowledge of the local behavior were used to determine the best estimate of uncertainty for each of these parameters.

E2.2.2.1 Fish ingestion (I), kg/d

The fish ingestion rate was defined in the following manner:

$$I = I_m \cdot I_f \tag{E.10}$$

where,

I_m = the mass of fish consumed per meal (kg/fish-meal)

and I_f = the frequency of meals consisting of fish caught in the Clinch River/Poplar Creek system (fish-meal/day).

A subjective probability distribution was formulated to represent the uncertainty in each individual parameter, i.e., distributions for I_m (same for both carcinogens and non-carcinogens) and I_f (different for carcinogens and non-carcinogens) were determined.

Fish ingestion (adult), kg/fish-meal. The amount of fish eaten per meal was estimated to be 0.230 kg/fish-meal for the Clinch River/Poplar Creek system. The 95th percentile value given for fin fish by the USEPA (1989) is 0.284 kg/fish-meal, obtained from a study by Pao et al. (1982). In addition, Rupp et al. (1980) analyzed fish consumption from several surveys performed in the late 1960s to early 1970s. Perhaps the most relevant of these was a survey done in 1966–67 on the Columbia River. This survey was restricted to households with at least one fisherman, and memory recall was used to estimate the fish consumption rate over a period of one year. The average fish meal was determined to be 0.200 kg, and the maximum fish meal was estimated at 0.313 kg.

After consideration of these surveys, a triangular distribution was used to represent the subjective uncertainty for I_m. For the avid fisherman, the most likely value (the mode) was estimated at 0.230 kg/fish-meal (this corresponds to approximately one-half of a pound). The Columbia River study was used as a starting point in the consideration of a range of uncertainty because of its direct applicability to the present assessment's target individual (the avid fisherman). A meeting was held for the purpose of determining the range of uncertainty. Risk assessors felt that it was unlikely that an avid fisherman would eat more than 0.454 kg/fish-meal (approximately one pound of fish per meal) or less than 0.113 kg/fish-meal (approximately one-quarter of a pound of fish per meal). Therefore, a maximum value of 0.454 kg/fish-meal and a minimum value of 0.113 kg/fish-meal were used for the triangular distribution.

Fish ingestion (child), kg/fish-meal. A review of several publications was performed (Rupp 1979; Müller and Pröhl 1993; Yang and Nelson 1986; SAIC 1993) in order to obtain the intake of various food products by children. The subjective probability distributions derived for each of the child's intake parameters are consistent with the values reported in the reviewed literature. The uncertainty was based primarily on subjective judgment of various risk assessors. Since each value is equally likely to be the true but unknown rate of intake, a uniform distribution was used to represent the uncertainty. The lower and upper limits used for the uniform distributions are values that target the reasonably maximally exposed child. Because it is highly unlikely that the upper bounds for each rate of intake will be sampled simultaneously and since the reasonable maximum exposure (RME) should provide a conservative estimate of exposure, no correction was made for the caloric intake of a child.

The lower bound for the ingestion of fish for children was determined by assuming that a maximally exposed child would consume no less than 5 kg/year (approximately 1/2 ounce of fish every day of the year). Assuming a child will consume a fish meal each time their parents do, the value of 200 fish meals

per year can be assumed. A child will therefore consume no less than 0.025 kg/meal. The upper bound for the ingestion of fish for a child who was an avid fish lover would not consume more than 20 kg/year (approximately 2 ounces of fish every day of the year). This would be approximately 0.1 kg/meal. These values are consistent with values reported in Rupp et al. (1980) and IAEA (in press).

Frequency of fish-meals used for carcinogens. For the frequency of meals (I_f), the uncertainty was based primarily on subjective judgment of various risk assessors. Because each value was equally likely to be the true but unknown number of meals per day, a log-uniform distribution was used to represent the uncertainty. An upper bound value was determined by assuming that an avid fisherman would not consume more than two meals per week of fish caught from the Clinch River and Poplar Creek system over a thirty year period. This results in a maximum frequency of 0.286 fish-meals/day. A lower bound was formulated by assuming that a fisherman would not consume less than one meal per month of fish caught from the Clinch River and Poplar Creek system. This value translates to 12 meals/year, which closely matches the average frequency of 14 meals/year obtained in the Columbia River survey (Rupp et al. 1980). This value results in a minimum frequency value of 0.033 fish-meals/day.

Note, these estimates exclude values for subsistence fishermen who may be obtaining a major portion of their dietary requirements from fish caught in the Clinch River and Poplar Creek. At the present time, the actual number of individuals in this category is not likely to be large and will not be considered in this uncertainty analysis. The target individual in this assessment is an avid fisherman, not a subsistence fisherman.

Frequency of fish-meals used for non-carcinogens. For non-carcinogens, where toxic effects are believed to occur above a threshold exposure, the uncertainty bounds for I_f must take into account the possibility of an avid fisherman consuming a substantial amount of fish during a one-year period. An upper-bound value was determined by assuming that an avid fisherman would not consume more than four meals per week of fish caught from the Clinch River and Poplar Creek over a one year period. A lower bound was determined by assuming that a fisherman would not consume less than one meal per month. Because of the lack of site specific data, a log-uniform distribution was chosen to represent the subjective uncertainty in I_f.

The uncertainty values for the I_m and the I_f parameters for carcinogens and non-carcinogens are summarized in Table E.62.

Table E.62. Summary information for the uncertainty in the parameters used to calculate daily intake

Class	Parameter	Distribution	Minimum	Maximum	Mode
Both[a], Adult	I_m *(kg/meal)*	Triangular	0.113	0.454	0.230
Both[a], Child	I_m *(kg/meal)*	Uniform	0.025	0.1	---
Carcinogens	I_f *(meal/day)*	Log-Uniform	0.033	0.286	---
Non-Carcinogens	I_f *(meal/day)*	Log-Uniform	0.033	0.571	---

[a] Both = Carcinogens and Noncarcinogens.

E2.2.2.2 Exposure frequency (*EF*), 350 days/year

The *EF* represents the average number of days out of a year that a person is exposed to the daily intake rate. The USEPA (1991) currently recommends the use of 350 days/year. This value takes into account 2 weeks of vacation per year during which the individual will not be exposed to the contaminant/pathway being studied. For this uncertainty analysis, the reasonable maximally exposed individual (RME) is defined as an avid fisherman who is exposed at a frequency of 350 days per year.

E2.2.2.3 Exposure duration (*ED*), years

The exposure duration *(ED)* represents the number of years that an individual will be exposed to the given exposure conditions, i.e., an estimate of the projected length of time that a person will live in the area under consideration.

For all carcinogens, USEPA (1989) recommends a value of 30 years for the *ED*. For this uncertainty analysis, the RME is defined as an avid fisherman who is exposed to carcinogens for thirty years.

For non-carcinogens, immediate toxic effects from over-exposure are of primary concern. These effects typically occur when a person has ingested too much of a contaminated medium. For this uncertainty analysis, the RME is defined as an avid fisherman who is exposed to non-carcinogens for one year.

E2.2.2.4 Body mass (*BM*), kg

The "average" value for the body mass of Reference Man is 70 kg (ICRP 1975). The child body weight is defined to be 15 kg. For this uncertainty analysis, the RME is defined as the reference individual. Therefore, the body mass will not be assigned any uncertainty.

E2.2.2.5 Averaging time (*AT*), days

The averaging time is defined as the period of time over which an exposure is averaged. Because it serves as a prorating parameter (USEP 1989), the values for the averaging time were fixed for this uncertainty analysis. For non-carcinogens, the averaging time is equal to the exposure duration. Therefore, *AT* for non-carcinogens is set at 365 days. For carcinogenic substances, where the effect from a single exposure could occur several years after the received dose, the exposure is averaged over a lifetime (70 years). Therefore, *AT* for carcinogens equals 25,550 days (70 years).

E2.2.3 Radionuclide Specific Factors

E2.2.3.1 Dose conversion factor (*DCF*), Sv/Bq

The committed effective dose per unit intake is defined as the *DCF* for this report. The committed effective dose (hereafter referred to as "dose") is defined by the International Commission on Radiological Protection (ICRP 1989) as the time integral of the dose-equivalent rate in a particular tissue that is received by an individual following an intake of radioactive material into the body. A 70-year lifetime was assumed in this calculation. For an adult, a body weight corresponding to Reference Man [70 kg (ICRP 1975)] and an averaging time of 50 years (ICRP 1989; ICRP 1991; NCRP 1993a) were assumed.

Dosimetric models and the parameters that are used to determine the "dose" vary with the intake pathway, the radionuclide, age at the time of exposure, gender, etc. Recent studies have used various biokinetic data, and in some cases (such as Pu) radionuclide-specific models have been used to obtain age-dependent doses to members of the public (ICRP 1989; ICRP in press).

Recently, members of the National Council on Radiation Protection and Measurements (NCRP) scientific committee 57-16 were asked to estimate the uncertainty factors associated with the ingestion and inhalation "dose" factors for a variety of radionuclides (NCRP, in press). These uncertainty factors were estimated for the application of ICRP-30 "dose" factors and might not apply to the more recent projected factors listed in ICRP-56 (ICRP 1989) or to current revisions of the ICRP-56 values (ICRP,in press). An uncertainty factor pertaining to Cs-137 was obtained by expert judgment (Eckerman 1993). The "dose" factor for Cs-137 and its associated uncertainty factor from both sources are summarized in Table E.63.

Table E.63. Dose conversion factors for the ingestion pathway and corresponding uncertainty factors for ^{137}Cs

Contaminant	*DCF* for Ingestion[a] (Sv/Bq)	Uncertainty Factor[b] A[c]	B[d]
Cs-137	1.4E-08	2	2

[a] ICRP (in press).
[b] These uncertainty factors apply to the adult male.
[c] NCRP (in press).
[d] Eckerman (1993).

The uncertainty factor values from both sources are the same for Cs-137. The primary source of uncertainty for Cs-137 is inaccuracy in the biokinetic data used to estimate the *DCF*.

A log-triangular distribution was used to represent the subjective uncertainty in the DCF value. The *DCF* value itself was used as the mode of the triangle. The maximum value was obtained by multiplying the *DCF* by the UF, and the minimum value by dividing the *DCF* by the UF. The mode, maximum, and minimum for Cs-137 are summarized below.

Mode	=	1.4E-08
Maximum	=	2.8E-08
Minimum	=	7.0E-09

E2.2.3.2 Risk conversion factor (*RCF*)

The risk conversion factor (*RCF*) as determined by the ICRP (1991) and the NCRP (1993a) is 0.073/Sv; this value is based primarily on extensive analyses of the atomic bomb survivors in Nagasaki and Hiroshima, Japan, by such scientific bodies as the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the National Research Council of the National Academy of Sciences (NRC/NAS). The *RCF* serves as a method of predicting the excess lifetime risk for genetic defects (1.3%/Sv), dying of cancer (5%/Sv), and a weighted risk for occurrences of non-fatal cancer (1%/Sv) (ICRP 1991; NCRP 1993a). The *RCF* is defined by the ICRP's definition of "detriment" where the risk of genetic defects and occurrences of cancer incidence are weighted against the number of fatalities (ICRP 1991).

There are several sources of uncertainty in the *RCF*, but two sources tend to dominate the overall estimate of uncertainty (NCRP 1993a). These are (1) the uncertainty in the *RCF* evaluated at high dose and high dose rate exposures, and (2) the uncertainty in extrapolating the *RCF* to low dose and low dose rate exposures. Of these, the uncertainty in extrapolating to low dose and low dose rate exposures appears to be the predominant uncertainty in the *RCF* at low doses (NCRP 1993a).

An uncertainty factor of approximately 2 is recommended for the uncertainty in the *RCF* at high dose and high dose rate exposures, and a UF of greater than or equal to 2 is recommended for the uncertainty involved in the extrapolation to low doses (NCRP 1993a). The possibility of the minimum value for the *RCF* being zero cannot be excluded, due to the absence of sufficient data to allow a significant analysis of the risk for exposure at low doses (NRC/NAS 1990; NCRP 1993a). However, for this uncertainty analysis, a minimum value of zero will not be used, on the assumption that the underlying model for the risk associated with radiation exposure is correct and that a threshold dose does not exist.

Based on the above information, an uncertainty factor of 4 was used for this analysis. *A log-triangular distribution was used to represent this subjective uncertainty.* The recommended *RCF* value of 0.073/Sv was used as the mode, the maximum was determined by multiplying the *RCF* by 4, and the minimum was obtained by dividing the *RCF* by 4. These values are summarized below.

Mode	=	0.073
Maximum	=	0.292
Minimum	=	0.018

E2.2.4 Chemical Specific Factors

E2.2.4.1 Non-carcinogens — reference doses

The risk from exposure to non-carcinogens is evaluated by calculating a quantity referred to as the Hazard Quotient. The potential exposure to an individual is divided by a value called the reference dose (*RfD*) to obtain this quotient. "A *RfD* is defined as an estimate of a daily exposure level (chronic) for the human population that is likely to be without an appreciable risk of deleterious effects" (USEPA 1989). Therefore, when the *HQ* is greater than 1, further study and perhaps remediation is recommended.

The *RfD* is obtained by dividing a NOAEL, which is obtained from the analysis of a human or more often an animal data set, by an uncertainty factor and a modifying factor (USEPA 1989). An uncertainty factor of 10 is applied to protect the most sensitive population, a value of 10 is used when extrapolating from animals to humans, a value of 10 is used when a NOAEL is obtained from a subchronic study, and a factor of 10 is applied when a LOAEL is obtained instead of a NOAEL (USEPA 1989). Finally, a modifying factor is applied based on best professional judgment. The following sections will discuss the uncertainties for the methyl-mercury, chlordane, and Aroclor-1254 *RfD*s.

Methyl-mercury. The *RfD* for methyl-mercury (MeHg) is 3.0E-04 mg/kg/d, and a safety factor of 10 is reported (USEPA 1992). This value was based on an animal study that was performed in the 1950s (Canady 1993).

There have been three major outbreaks of MeHg poisoning. The first two occurred in Minamata and Niigata, Japan during the late 1950s to early 1960s and were caused by industrial release of MeHg and other mercury compounds into Minamata Bay and the Agano River (WHO 1976). Although there were numerous people affected, this study has proven ineffective in obtaining a better *RfD* because of

the inability to relate an exposure level to the observed effect (Canady 1993). The third and largest recorded outbreak occurred in Iraq during the winter of 1971–1972 (WHO 1976). The people of Iraq used wheat and other grain seed which was treated with MeHg to make bread. Excessive ingestion of this bread due to their bad economic conditions resulted in a major poisoning epidemic. Studies have been performed to relate the concentration in hair and blood to the actual exposure (USEPA 1984; WHO 1976).

The USEPA is currently reevaluating the *RfD* for MeHg based on this Iraqi data (Canady 1993). A LOAEL value from the Iraq data set which approximates the NOAEL obtained in the rat study is under review. However, this LOAEL (which would be divided by 10 to obtain a value close to the current *RfD*) occurs with severe neurological effects. Less obvious effects to the central nervous system could be occurring that are being overlooked (Canady 1993). Therefore, a lower *RfD* value may be derived by the USEPA.

In the draft update on the "Toxicological Profile for Mercury" published by the Agency for Toxic Substances and Disease Registry (ATSDR 1992), an acute Minimum Risk Level (MRL) of 4.0E-05 mg/kg/d is recommended for methyl-mercury. This is an order of magnitude lower than the currently recommended chronic *RfD*.

A log-uniform distribution is used to represent the uncertainty in the RfD. To protect against more subtle neurological effects and to incorporate the latest recommendation by the ATSDR, a minimum value was obtained by dividing the *RfD* by the safety factor of 10 (3.0E-05 mg/kg/d), and a maximum value was determined by multiplying the *RfD* by the square root of the safety factor (9.5E-04 mg/kg/d). The uncertainty range determined for the methyl-mercury *RfD* was said to be a rational way to proceed by Dr. Kenneth Reuhl (1994).

Chlordane. The *RfD* for chlordane is 6.0E-05 mg/kg/d, and a safety factor of 1000 is given (USEPA 1988b). There is only one study that is reported with significant information to derive an *RfD* for chlordane (USEPA 1988b). The *RfD* was based on an unpublished report by the Velsicol Chemical Corporation (1983) describing the results obtained from a rat study. A LOAEL of 0.055 mg/kg/d which caused a significant increase in hepatocellular necrosis (liver tumors) in males was used to derive the *RfD* (USEPA 1988b; Velsicol Chemical Corp. 1983).

The Integrated Research Information System (IRIS) which is maintained by the USEPA was consulted to obtain names of experts on the *RfD* for chlordane. Two contacts were listed: Dr. William Burnam and Dr. Eric Clegg of the USEPA. Dr. Burnam and Dr. Clegg were contacted to obtain a range of uncertainty for the chlordane *RfD*. When Dr. Burnam was asked his opinion on the bounds of uncertainty for the chlordane *RfD*, he stated that he would have no problem setting the lower limit at the *RfD* and setting the upper limit at the NOEL obtained in the rat study. He said that no effect was seen until an exposure 5 times that of the NOEL was exceeded and that the effect which was observed is a very sensitive indicator (Burnam 1994). However, Dr. Clegg suggested bounding the *RfD* by an order of magnitude on either side (Clegg 1994).

Using the limited information pertaining to the chlordane *RfD* and the statements made by two experts listed in IRIS (Burnam 1994; Clegg 1994), the following uncertainties were determined. The *RfD* was multiplied by the square root of 1000 (the safety factor) to obtain a maximum value of 1.9E-03 which is an order of magnitude lower than the NOEL. The *RfD* was divided by a factor of ten (Clegg 1994) to obtain a minimum value of 6.0E-06. The reported *RfD* was used as the most likely value to occur (mode). *Therefore, a log-triangular distribution was used to represent the uncertainty in the*

RfD for chlordane with a mode of 6.0E-05 mg/kg/d, a minimum of 6.0E-06 mg/kg/d, and a maximum of 1.9E-03 mg/kg/d.

Aroclor-1254. The RfD for Aroclor-1254 is 2.0E-05 mg/kg/d, and a safety factor of 300 is given (IRIS 1994). This RfD value was based on studies of Aroclor-1254 ingestion by female Rhesus (*Macaca mulatta*) monkeys reported by Arnold et al. (1993a); (1993b); Tryphonas et al. (1989); (1991a); and (1991b). The safety factor consists of a 10-fold factor to account for sensitive individuals, a factor of 10 to account for the use of a LOAEL instead of a NOAEL, and a factor of three to extrapolate from Rhesus monkeys to humans. A full 10-fold factor for interspecies extrapolation is not assumed to be necessary due to similarities between monkeys and humans of toxic responses and metabolism of PCBs.

Based on a study of groups of 16 adult female Rhesus monkeys ingesting gelatin capsules containing Aroclor-1254 in 1:1 glycerol: cove oil vehicle daily at doses of 0, 5, 20, 40 or 80 mg/kg/d for over five years, the following results were reported. Monkeys that ingested 0.005–0.08 mg/kg/d doses of Aroclor-1254 showed ocular exudate, prominence and inflammation of the Meibomian glands and a distortion in their nail bed formation. Accidental oral ingestion of PCBs by humans have produced similar effects. From these studies a LOAEL of 0.005 mg/kg/d was established. This information is supported by Tryphonas et al. (1989); (1991a); (1991b); Arnold (1992); Arnold et al. (1993a); (1993b); Loo et al. (1989); and Luster et al. (1992).

In another study Aroclor-1254 was fed to groups of eight female and four male adult Rhesus monkeys once daily in dosages of 0, 5, 25, or 100 mg/kg for 14 months in order to conduct a reproduction study. No treatment related effects were observed in the low-dose adults or their infants, thus indicating a NOAEL of 0.005 mg/kg/d. A 15% reduction in birth weight of infants was observed for the mid-dose infants. At two months of age, these infants had a reduced body weight of 22% below controls. Some adults receiving 25 and 100 mg/kg/d, as well as their infants, had ocular and dermal signs characteristic of PCB intoxication. Based on these effects the 0.025 mg/kg/d dosage is a LOAEL. These results are supported by Levinskas et al. (1984).

A log-uniform distribution is used to represent the uncertainty in the RfD. The RfD, 2.0E-05 mg/kg/d, was used as the minimum value of the log-uniform distribution. It is believed to be conservative enough due to its safety factor of 300 and because another study conducted on monkeys exhibited no adverse effects at dosages of 0.005 mg/kg/d. A maximum value of 3.5E-04 mg/kg/d was determined by multiplying the RfD by the square root of the safety factor. A personal conference with Jeff Swartout (1995) confirmed that the RfD was conservative enough to be used as the minimum value.

E2.2.4.2 Carcinogens — slope factors

As is assumed for radionuclides, the risk from exposure to a chemical carcinogenic substance is believed to exist no matter how small the level of exposure. This implies the absence of a threshold below which there would be no risk. The potential excess lifetime risk of cancer from exposure to carcinogens is evaluated by relating a potential dose to risk. This "conversion" is determined by applying a quantity called the Slope Factor (*SF*).

There are several sources of uncertainty associated with the derivation of these *SF*s. Some of these include accuracy of the data in "sensitive" species at high doses, the extrapolation of a response at high doses to low doses, and extrapolation from animals to humans.

The following sections describe the subjective probability distributions chosen to represent the uncertainty in the *SF*s for PCBs and chlordane.

Poly-chlorinated Biphenyls. The *SF* for PCBs is reported as 7.7 $(mg/kg/d)^{-1}$ (USEPA 1992). This value is the highest determined *SF* from three studies of Aroclor-1260 (USEPA 1988a) tested on rats. One large area of uncertainty in the *SF* for PCBs is that a rat population is exposed to a known concentration of a specific Aroclor with a certain outcome. In reality, no one knows what form the human population is exposed to because of the transformation of PCBs in the environment (Cogliano 1993). In addition, Aroclor-1260 was chosen to be representative of all of the Aroclors (USEPA 1988a). However, recent studies suggest that this assumption may not be correct (Silberhorn et al. 1990).

Aroclor-1260 has been evaluated in three separate rat studies. From these studies, *SF*s of 3.9, 5.7, and 7.7 $(mg/kg/d)^{-1}$ have been determined (USEPA 1988a). These values differ by about a factor of 1.3-1.5. A UF of 1.3 was multiplied by the reported *SF* to obtain a maximum value. Because the only significant evidence of carcinogenicity exists in rats, the possibility of Aroclor-1260 not being a carcinogen in humans can not be ignored. Therefore, *a triangular distribution with a mode of 7.7 $(mg/kg/d)^{-1}$, a minimum of 0 $(mg/kg/d)^{-1}$, and a maximum of 10 $(mg/kg/d)^{-1}$ was used to represent the uncertainty in the SF for Aroclor-1260.*

The uncertainty distribution obtained using the "boot strap" method for PCBs (Evers et al. 1994) fell within the subjective probability distributions used in this analysis.

Chlordane. The reported *SF* for chlordane is 1.3 $(mg/kg/d)^{-1}$ (USEPA 1992). As with PCBs, there is considerable uncertainty due to the transformation of chlordane in the environment.

Slope factors have been evaluated for 4 mice studies and 1 rat study (USEPA 1986). The largest *SF* obtained from the 4 mice studies was 4.7 $(mg/kg/d)^{-1}$, and the smallest *SF* was 0.3 $(mg/kg/d)^{-1}$ (USEPA 1986). The USEPA *SF* of 1.3 $(mg/kg/d)^{-1}$ was derived by taking the geometric mean of these 4 mice studies. This value compares to the *SF* of 1.1 $(mg/kg/d)^{-1}$ which was derived from the rat study (USEPA 1986).

Because the studies were done for mice and rats exposed to technical chlordane, as with PCBs, the possibility of no carcinogenic effect in humans can not be ignored. A maximum uncertainty estimate of 5 for the SF was obtained by rounding the largest *SF* derived from the mice studies. Therefore, *a triangular distribution with a mode of 1.3 $(mg/kg/d)^{-1}$, a minimum of 0 $(mg/kg/d)^{-1}$, and a maximum of 5 $(mg/kg/d)^{-1}$ was used to describe the uncertainty in the SF for chlordane.*

The uncertainty distribution obtained using the "boot strap" method for chlordane (Evers et al. 1994) fell within the subjective probability distributions used in this analysis.

E2.3 DESCRIPTION OF PARAMETER UNCERTAINTY IN THE DREDGING SCENARIO

In this section, the uncertainty associated with the dredging scenario is discussed. This scenario includes the possibility that at some time in the future deep sediments the Clinch River and Poplar Creek which are contaminated with inorganic mercury and Cs-137 could be dredged and used on a farm. Several pathways are included in this scenario: 1) ingestion of leafy vegetables grown on contaminated soil, 2) ingestion of non-leafy vegetables grown on contaminated soil, 3) ingestion of milk from a dairy cow which has eaten contaminated pasture grass, 4) ingestion of meat from a beef cow which has eaten contaminated pasture grass, and 5) for Cs-137 only, external exposure from the dredged sediment.

The subjective probability distributions used for each of the uncertain parameters in the risk assessment equations reflect the degree of belief that the true but unknown value for each parameter does

not exceed a specified value for that parameter. Uncertainties for many parameters presented in Equations E.4 through E.8 have been previously researched (Hoffman and Baes 1979; Hoffman et al. 1982). The distributions that have been recommended in the past have been adopted for this analysis if they were consistent with the findings obtained from an independent review of various reported and/or default values provided in various publications.

The uncertainty associated with the concentration in the deep sediment is discussed first, followed by discussion of exposure factors that are independent of contaminant type which include intake rate, exposure frequency, exposure duration, percent of time outdoors/indoors, shielding factor, dilution factor, fraction ingested, and soil density. The final topics discussed in this section are the uncertainties involved with radionuclide and chemical specific parameters which include the soil/plant transfer factors, the milk/meat transfer factors, loss rate from harvesting/leaching, and the reference doses. The subjective probability distributions and uncertainty ranges for all of the parameters used in the dredging scenario are summarized in Table E.64.

Table E.64. List of assumptions for the parameters used in the uncertainty analysis of the dredging scenario

Parameter	Distribution	Minimum	Mean	Maximum	Units
C_{sed}	Uniform	240	---	500	Bq/kg
λ_{HL}	Log-Triangular	2.3E-02	2.4E-02[a]	3.2E-01	$year^{-1}$
ρ_{soil}	Triangular	1100	1300[a]	1600	kg/m^3
$ED_{carc.}$	Constant	---	30	---	year
$ED_{noncarc.}$	Constant	---	1	---	year
EF_{ext}	Uniform	0.23	---	0.96	unitless
EF_{ing}	Constant	---	0.96	---	unitless
P_{out}	Uniform	0.25	---	0.60	unitless
P_{in}	Uniform	$1-P_{out}$	---	$1-P_{out}$	unitless
S_f	Uniform	0.2	---	0.8	unitless
D_l	Uniform	0.30	---	1.00	unitless
Q_m	Uniform	11	---	21	kg/d
Q_f	Uniform	8	---	16	kg/d
FI_Q	Uniform	0.5	---	0.9	unitless
$I_{veg,\ leafy}$	Uniform	10	---	85	kg/year
$I_{veg,\ non\text{-}leafy}$	Uniform	40	---	165	kg/year
I_{milk}	Uniform	80	---	400	L/year
I_{meat}	Uniform	40	---	125	kg/year
FI_{veg}	Uniform	0.3	---	1.0	unitless
FI_{milk}	Uniform	0.5	---	1.0	unitless
FI_{meat}	Uniform	0.5	---	1.0	unitless
DCF_{ing} Cs-137	Log-Triangular	7.0E-09	1.4E-08[a]	2.8E-08	Sv/Bq
RCF	Log-Triangular	0.018	0.073[a]	0.292	risk/Sv
RfD, Mercury	Log-Uniform	3.0E-05	---	9.5E-04	mg/kg-d

[a] mode.

E2.3.1 Concentration of Select Contaminants in Deep Sediment

The selected radionuclide for this uncertainty analysis is Cs-137. Using lognormal statistics, an arithmetic mean was estimated for the sediment concentration for each subreach. The estimated mean and 95% UCL on the mean obtained from this analysis for each subreach to be studied are presented in Table E.65.

Table E.65. Summary statistics and estimates of uncertainty for ^{137}Cs concentrations in deep sediment

Pathway	Reach	Units	Ratio of detects to total samples	Estimated Mean	UCL mean	LCL est.
External	2.04	Bq/kg	4/4	3.7E+02	2.7E+03	4.8E+01
	3.04	Bq/kg	3/3	2.6E+02	1.9E+03	3.4E+01
	4.03	Bq/kg	3/3	5.2E+02	7.8E+02	3.4E+02

A uniform distribution was used to represent the uncertainty of the estimated arithmetic mean concentration for Reach 4.03. The upper bound of the uniform distribution was set at the 95% UCL on the arithmetic mean, and the lower bound of the distribution was obtained by dividing the estimated arithmetic mean by the uncertainty factor obtained from Equation E.10. Log-uniform distributions were used to represent the uncertainty of the estimated arithmetic mean concentration for Reaches 2.04 and 3.04 due to the large uncertainty in the data.

The selected chemical contaminant for the uncertainty analysis of the dredging scenario is mercury. The values for the estimated arithmetic mean concentration and the UCL on the mean were obtained for the Clinch River and Poplar Creek and are summarized in Table E.66. The UCL concentrations and LCL concentrations were calculated as described in Sect. E.2.1 and are also presented in Table E.66.

Table E.66. Summary statistics and estimates of uncertainty for inorganic mercury concentrations in deep sediment

Pathway	Reach	Units	Ratio of detects to total samples	Estimated Mean	UCL mean	LCL est.
Milk	3.04	mg/kg	3/3	1.4E+01	8.0E+01	2.5E+00
Meat	3.04	mg/kg	3/3	1.4E+01	8.0E+01	2.5E+00
Vegetables	3.04	mg/kg	3/3	1.4E+01	8.0E+01	2.5E+00

A log-uniform distribution was used to represent the uncertainty of the estimated arithmetic mean concentration for all inorganic mercury analyses.

E2.3.2 Exposure Factors Independent of the Contaminant Type

Several exposure factors are used in the risk assessment models which are element independent: intake rate, exposure frequency, exposure duration, dilution factor, and fraction ingested which is contaminated. The subjective uncertainty bounds and probability distributions for these parameters were chosen such that the true but unknown value pertaining to the maximally exposed individual lies within the interval. Meetings were held to discuss the uncertainty ranges for several parameters presented in this section. A literature review and moderate knowledge of the local behavior were used to determine the best estimate of uncertainty for each of these parameters.

E2.3.2.1 Intake rates

Various ingestion rates must be considered for the agricultural pathways of the dredging scenario. The rate of pasture ingestion by dairy and beef cows must be considered for the grass-cow-milk-human

and grass-cow-meat-human pathways. In addition, the amount of leafy vegetables, non-leafy vegetables, milk, and meat that a RME will eat or drink must be evaluated. These parameters are discussed below.

Intake of pasture by dairy (Q_m) and beef cows (Q_f)

When determining the amount of pasture that a cow will eat, a dry weight basis is used. Several studies have discussed the uncertainties with the pasture ingestion of dairy and beef cows (Hoffman and Baes 1979; Hoffman et al. 1982; Shor and Fields 1980). A uniform distribution was used to represent the uncertainty in the ingestion rate of dairy cows and beef cows. The upper limit and lower limit of the uniform distributions were obtained by using 16 kg/d and 12 kg/d as a midpoint for the dairy cow and the beef cow, respectively (IAEA 1982), and adding and subtracting two times the standard deviation, 2.6 kg/d (dairy) and 2.0 kg/d (beef) (Hoffman et al. 1982). The uncertainty ranges are summarized in Table E.64.

Intake of various food products by adults ($I_{veg,leafy}$, $I_{veg,non\text{-}leafy}$, I_{milk}, and I_{meat})

For the intake of various food products by humans, the uncertainty was based primarily on subjective judgment of various risk assessors. A review of several publications was conducted (Hoffman and Baes 1979; Hoffman et al. 1982; ICRP 1975; NCRP 1984; 1989; Rupp 1979; USEPA 1991), and the subjective probability distributions derived for each of the human intake parameters are consistent with the values reported in the reviewed literature. Because each value is equally likely to be the true but unknown rate of intake, a uniform distribution was used to represent the uncertainty. The lower and upper limits used for the uniform distributions are values that target the RME individual. Because it is highly unlikely that the upper bounds for each rate of intake will be sampled simultaneously and because the RME individual should provide a conservative estimate of exposure, no correction was made for the caloric intake of an individual.

The lower bound for the ingestion of leafy vegetables was determined by assuming that an individual would not consume less than 10 kg/year (approximately 1 ounce of leafy vegetables every day of the year). The upper bound for the ingestion of leafy vegetables was determined by assuming that an individual who loves vegetables would not consume more than 85 kg/year (approximately 8 ounces of leafy vegetables every day of the year). These values are consistent with survey ranges reported in Rupp (1979).

The lower bound for the ingestion of non-leafy vegetables was determined by assuming that an individual would not consume less than 40 kg/year (approximately 4 ounces of non-leafy vegetables every day of the year). The upper bound for the ingestion of non-leafy vegetables was determined by assuming that an individual who loves vegetables would not consume more than 165 kg/year (approximately 16 ounces of leafy vegetables every day of the year). These values are consistent with survey ranges reported in Rupp (1979).

The lower bound for the ingestion of milk was determined by assuming that an avid milk drinker would not consume less than 80 L/year (approximately 1 cup of milk every day of the year). The upper bound for the ingestion of milk was determined by assuming that an avid milk drinker would not consume more than 400 L/year (more than 1 liter of milk every day of the year). These values are consistent with survey ranges reported in Rupp (1979).

The lower bound for the ingestion of beef was determined by assuming that an avid meat lover would not consume less than 40 kg/year (approximately 4 ounces of beef every day of the year). The upper bound for the ingestion of beef was determined by assuming that an avid meat lover would not

consume more than 125 kg/year (approximately 12 ounces of beef every day of the year). These values are consistent with survey ranges reported in Rupp (1979).

Intake of various food products by children ($I_{veg,leafy}$, $I_{veg,non\text{-}leafy}$, I_{milk}, and I_{meat})

A review of several publications was performed (Rupp 1979; Müller and Pröhl 1993; Yang and Nelson 1986; and SAIC 1993) in order to obtain the intake of various food products by children. The subjective probability distributions derived for each of the child's intake parameters are consistent with the values reported in the reviewed literature. The uncertainty was based primarily on subjective judgment of various risk assessors. Since each value is equally likely to be the true but unknown rate of intake, a uniform distribution was used to represent the uncertainty. The lower and upper limits used for the uniform distributions are values that target the reasonably maximally exposed child. Because it is highly unlikely that the upper bounds for each rate of intake will be sampled simultaneously, and since the RME individual should provide a conservative estimate of exposure, no correction was made for the caloric intake of a child.

The lower bound for the ingestion of leafy vegetables was determined by assuming that a child, ages three to six, would consume no less than 5.5 kg/year (approximately 0.5 ounces of leafy vegetables every day of the year). The upper bound for the ingestion of leafy vegetables by children was determined by assuming a child who loves vegetables would not consume more than 36.5 kg/year (approximately 3.5 ounces of leafy vegetables every day of the year). The minimum value is based upon an average daily value of 15 g/d reported in (IAEA 1994). The maximum value is based upon data reported by Müller and Pröhl (1993) in which an average daily value of leafy vegetables consumed by a child would be 74 g/d. These values are also consistent with values reported in Rupp (1979).

The lower bound for the ingestion of non-leafy vegetables was determined by assuming that a child, ages three to six, would consume no less than 26 kg/year (approximately 2.6 ounces of non-leafy vegetables every day of the year). The upper bound for the ingestion of non-leafy vegetables by a child was determined by assuming a child who loves vegetables would not consume more than 44 kg/year (approximately 4.3 ounces of non-leafy vegetables every day of the year). The lower bound was based on the study reported by Rupp (1979) in which an average value of 80 g/d of non-leafy vegetables was reported to be consumed by a child. The upper bound was based on data reported by Müller and Pröhl (1993), in which an average daily intake of 95 g/d was reported to be consumed of non-leafy vegetables by a child. This value (95 g/d) was divided by our lower assumed value of 75 g/d and then multiplied by the average value of 95 g/d in order to produce an upper bound of 120 g/d.

The lower bound for the ingestion of milk was determined by assuming that a child between the ages of three to six years who was an avid milk drinker would consume no less than 130 L/year (approximately 1.5 cups of milk every day of the year). The upper bound for the ingestion of milk was determined by assuming that a child between the ages of three and six years who was an avid milk drinker would consume no more than 525 L/year (approximately 1.5 quarts of milk every day of the year). These values are consistent with survey ranges reported in Rupp (1979); ICRP (1975); IAEA (1994); (1995); and (in press).

The lower bound for the ingestion of beef for a child who is an avid meat lover would consume no less than 11 kg/year (approximately 1 ounce of beef every day of the year). The upper bound for the ingestion of meat for a child was determined by assuming that a child who is an avid beef lover would consume no more than 44 kg/year (approximately 4.2 ounces of beef every day of the year). A value of 30 g/d was assumed as a lower bound based on the average value of 38 g/d reported in Rupp (1979). An upper bound of 120 g/d was assumed based on the average value of 53 g/d reported by Müller and Pröhl

(1993) and the value of 64.6 g/d maximum likely exposure reported by Yang and Nelson (1986) and SAIC (1993).

E2.3.2.2 Exposure frequency (*EF*)

The *EF* represents the frequency at which the RME is exposed to the given situation. The exposure frequency is different for the external pathways and the agricultural pathways.

For the agricultural pathways, the USEPA (1991) currently recommends the use of 350 days/year. This value takes into account 2 weeks of vacation per year during which the individual will not be exposed to the contaminant/pathway being studied. For this uncertainty analysis, the reasonable maximally exposed individual (RME) is defined as an individual who is exposed at a frequency of 0.96 (EF_{ing}, 350 days/year).

For the external pathways, the number of hours that the RME may be on his/her property must be considered. To determine the lower and upper limits of the exposure frequency (EF_{ext}), a meeting was held with various risk assessors. From this meeting, a uniform distribution ranging between 0.23 and 0.96 was determined to represent the external exposure frequency. The lower limit was determined by rationalizing that an individual would spend at least 6 hours per day for 350 days each year on his property. The most time that an individual would conceivable stay on his property was determined to be 8400 hours (24 hours a day for 350 days of the year). Therefore, there is high confidence that the true exposure frequency for the RME is bounded by this uncertainty range.

E2.3.2.3 Exposure duration (*ED*)

The exposure duration *(ED)* represents the number of years that an individual will be exposed to the given exposure conditions, i.e., an estimate of the projected length of time that a person will live in the area under consideration. For all carcinogens, USEPA (1989) recommends a value of 30 years for the *ED*. For this uncertainty analysis, the RME is defined as an individual who is exposed to the contamination for thirty years. For all noncarcinogens, the *ED* is set at a value of one year.

E2.3.2.4 Sediment dilution factor (D_l)

Because it is unlikely that an individual would be able to dredge enough sediment such that mixing with topsoil would not occur, a sediment dilution factor was incorporated into each risk assessment equation. A meeting with various risk assessors was held to discuss the potential uncertainty in the sediment dilution factor. Soil mixing is most likely to occur in the top six inches. If two inches of dredged sediment were put on the farm and mixed with top soil, the concentration in the sediment would be diluted to one-third its original concentration. Therefore, a dilution factor of 0.3 was determined as the most dilution of the sediment concentration that would occur. To account for the most conservative scenario, it was assumed that the possibility existed that no dilution of the sediment concentration would occur. Therefore, a uniform distribution with a value greater than 0.3 and lower than 1.0 was used to represent the uncertainty in the dilution factor.

E2.3.2.5 Fraction ingested (FI)

Because it is unlikely that a cow will not be fed supplements, a fraction of contaminated pasture actually ingested (FI_Q) is incorporated into the grass-cow-milk-human and grass-cow-meat-human pathways. It is unlikely that FI_Q will exceed 90% or will be below 50%. Because this is based primarily on subjective judgment and the true value is equally likely between 50 and 90%, a uniform distribution

with a minimum value of 0.5 and a maximum value of 0.9 was used to represent the uncertainty associated with FI_Q.

In addition, it is unlikely that someone living on the farm will eat or drink all of his/her vegetables, milk, and meat from vegetables, milk, and meat produced on the farm. The uncertainties associated with the fraction of contaminated vegetables eaten, with the fraction of contaminated milk consumed, and with the fraction of contaminated meat eaten by an individual living on the farm were discussed in a meeting of risk assessors. From this meeting, it was determined that a person could possibly obtain all of his produce from his own contaminated farm (FI = 1) and would not obtain less than 50% of his milk and meat from the contaminated cows raised on his farm or less than 30% of his vegetables from his own garden. Because each value is equally likely to be the true fraction ingested, a uniform distribution was used to represent the uncertainty in the FIs. These uncertainties are summarized in Table E.64.

E2.3.2.6 Soil density (ρ_{soil})

The density of soil ranges from 1100 to 1600 kg/m^3 (Hillel 1980). Soils consisting of clay are around 1100 kg/m^3, and sandy soils have a density around 1600 kg/m^3. Because we are assuming that deep sediments will be mixed with topsoil, a density of 1300 kg/m^3 was chosen as a most likely value. A triangular distribution with a minimum value of 1100, a mode of 1300, and a maximum value of 1600 kg/m^3 was used to describe the uncertainty in the soil density.

E2.3.3 Factors Dependent on Contaminant

Uncertainties involved with radionuclide specific parameters such as the parameter specific to external exposure to Cs-137 and the reference dose for inorganic mercury are presented in this section. In addition, uncertainties pertaining to element specific parameters such as the soil/plant transfer factors and the milk/meat transfer factors are discussed in this section.

<u>Cs-137 specific parameters</u>

The dose conversion factor for external exposure (DCF_{ext}) to Cs-137 was obtained from Eckerman and Ryman (1993). A contaminated soil depth of 15cm was assumed for this analysis. Because Ba-137m is a short-lived daughter of Cs-137, the DCF_{ext} for Ba-137m must be added to the DCF_{ext} for Cs-137. Cs-137 decays to Ba-137m 95% of the time; therefore, the DCF_{ext} for Ba-137m is multiplied by 95% before it is added to the Cs-137 DCF_{ext}. The value obtained for the DCF_{ext} is 5.1E-10 Sv/year per Bq/m^3. The uncertainties with the scatter cross-sections for reference man and with the application of reference man to the RME are the two major contributions to the overall uncertainty in the DCF_{ext} (Leggett 1994). Because it is unlikely that the uncertainty in the DCF_{ext} is greater than the uncertainty in the internal DCF, an uncertainty factor of 2 is used to bound the range of uncertainty in DCF_{ext}. A log-triangular distribution with a mode of 5.1E-10, a lower limit of 2.6E-10 and an upper limit of 1.0E-09 was used to represent the uncertainty associated with the external DCF.

The uncertainties associated with the loss rate from decay and from harvesting/leaching (λ_{eff}) result from the uncertainty in the loss rate from harvesting/leaching. The loss rate from radiological decay is determined by dividing the natural log of 2 by the half-life of the radionuclide (Cs-137: 0.693/30 years = 2.3E-02 year^{-1}). The uncertainty estimates for λ_{eff} were determined by adding the radiological decay rate to the minimum, mean, and maximum value reported for the loss rate from harvesting and leaching in Hoffman et al. (1982). These values are summarized in Table E.64.

Reference Dose for Inorganic Mercury

The RfD for inorganic mercury (3.0E-04 mg/kg/d) is based on three studies. Currently, the EPA is reviewing this reference dose and the studies from which it is derived Rick Canady (1995).

Death from oral exposure to inorganic mercury is usually caused by shock, cardiovascular collapse, acute renal failure, and severe gastrointestinal damage (Gleason et al. 1957; Troen et al. 1951). In a study by Troen et al. (1951), eighteen cases of human poisoning were reported. Nine of the patients died following oral ingestion of single doses of mercuric chloride. The lethal doses varied from 29 to less than 50 mg mercury/kg. Gastrointestinal lesions and renal involvement were the most common findings (Toxicological Profile for Mercury).

A chronic exposure (350 days) of rates that were given 7 mg of mercury per kg/d as mercuric chloride in drinking water resulted in a positive inotropic response, increased blood pressure and cardiac contractility, and decreased baroreflex sensitivity (Carmignani et al. 1989). A case study reported by Pesce et al. (1977) involved a human patient who ingested a single dose of 15.8 mg mercury per kg as mercuric chlorides and exhibited a dramatic increase in urinary protein secretion. In a study with Fischer-344 male rats a significant increase in the absolute and relative kidney weights began at 1.9 mg/kg/d (NTP 1991).

Using the information pertaining to inorganic mercury from several studies and an interview with Rick Canady (1995), the following uncertainties were determined. Since the RfD is assumed to be a safe value, the minimum value was obtained by dividing the RfD by ten (3.0E-05) to protect against more subtle effects than those observed in several studies. The maximum value was obtained by personal communication with Rick Cannady and set to 9.5E-04. *A log-uniform distribution was used to represent the uncertainty in the RfD for inorganic mercury.*

Element dependent transfer factors

Several transfer factors are required for the agricultural pathways considered in the dredging scenario, including 1) the soil/plant concentration factors (B_v) for three different food crops (leafy vegetables and non-leafy vegetables for human consumption and pasture forage for cow consumption) and 2) the animal product transfer factors for cow's milk (F_m) and meat (F_f). For this analysis, all vegetable transfer factors are defined in terms of the wet weight of plants, while the pasture forage is given as dry weight.

The primary reference for the uncertainties in the soil-to-plant transfer factors and the animal product transfer factors for Cs-137 is a document that was prepared for the U. S. Nuclear Regulatory Commission (Hoffman et al. 1982). The selection of values for the soil/plant transfer factor and animal product transfer factor for Cs-137 was further supported by an intensive search of numerous publications (Kennedy and Strenge 1993; NCRP 1989; Ng 1982; Ng et al. 1979a; Ng et al. 1979b). From the reported values, an average of the reported values, the minimum reported value, and the maximum reported value were compared to the uncertainty estimates documented in Hoffman et al. (1982). Because these values were similar, the uncertainty estimates presented in Hoffman et al. (1982) were used in this uncertainty analysis. These values are summarized in Table E.67.

The soil-to-plant transfer factors and the animal product transfer factors are less studied for inorganic mercury. The largest source of uncertainty occurs due to the lack of knowledge about the solubility of the inorganic mercury. An in depth review of the available literature was performed, and the

uncertainty ranges and distributions for the factors pertaining to inorganic mercury are presented in Table E.67. Wide uncertainty bands were used for these factors due to the large lack of knowledge.

Table E.67. Ranges of plant-to-soil concentration ratios and transfer coefficients to cow's milk and beef *

	Units	Minimum	Estimated mean	Maximum	Assigned Distribution
Cesium-137					
Bv (leafy veg.)	unitless	1.0 E-04	5.5 E-03	8.0 E-02	Log-Triangular
Bv (non-leafy veg	unitless	1.0 E-05	5.0 E-03	1.0 E-01	Log-Triangular
Bv (pasture, dry	unitless	7.0 E-04	4.4 E-02	1.2 E+00	Log-Triangular
Ff (meat)	d/kg	3.0 E-03	2.1 E-02	2.0 E-01	Log-Triangular
Fm (milk)	d/L	3.7 E-03	6.7 E-03	5.0 E-02	Log-Triangular
Inorganic Mercury					
Bv (leafy veg.)	unitless	5.0 E-01	—	5.0 E-03	Log-Uniform
Bv (non-leafy veg	unitless	1.0 E-02	—	1.0 E-01	Log-Uniform
Bv (pasture, dry	unitless	1.0 E-02	—	2.0 E+00	Log-Uniform
Ff (meat)	d/kg	1.0 E-05	1.0 E-02	2.5 E-01	Log-Triangular
Fm (milk)	d/L	1.0 E-05	—	1.0 E-03	Log-Uniform

* Ranges taken from Hoffman et al. (1982) and subjective judgment.

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Appendix F

ECOLOGICAL RISK ASSESSMENT DATA

Appendix F1

ECOTOXICOLOGICAL PROFILES

F1. ECOTOXICOLOGICAL PROFILES

This section contains ecotoxicological profiles for the contaminants of potential ecological concern (COPECs) for the Clinch River/ Poplar Creek (CR/PC) Operable Unit (OU). The ecotoxicological information is presented for only those endpoints for which the chemicals are COPECs.

F1.1 INORGANIC CHEMICALS

F1.1.1 Aluminum

Toxicity of Aluminum in Water to Aquatic Biota. Aluminum can be highly toxic to aquatic biota under some circumstances, but its toxicity is strongly dependent on pH, hardness, and organic matter content. Aluminum is amphoteric, i.e., it is more soluble in both acidic and basic solutions than in approximately neutral solutions. The Environmental Protection Agency's (EPA's) water quality criteria for aluminum (EPA 1988-Al) assume a pH range of 6.5 to 9.0 within which aluminum occurs primarily in the form of monomeric, dimeric, and polymeric hydroxides. Toxicities of aluminum in the field may be substantially lower than indicated by dissolved aluminum analysis values because of complexation with humic and fulvic acids. At pH values below 6.5, however, aluminum may be substantially more toxic than indicated by the EPA criteria because low pH favors the formation and solubilization of cationic aluminum (Al^{3+}), but such values do not normally occur in the Clinch River and Poplar Creek system.

Between pH 6.5 and 9.0, acute toxicities of aluminum reported by EPA range between 1.9 mg/L (*Ceriodaphnia dubia*) and > 79.9 mg/L (midge larvae, *Tanytarsus dissimilis*) (Table F1.1). Acute toxicities for fish ranged from 3.6 mg/L (juvenile brook trout, *Salvelinus fontinalis*) to > 50.0 mg/L (juvenile green sunfish, *Lepomis cyanellus*). Chronic toxicities reported by EPA ranged from 0.742 mg/L (*Daphnia magna*) to 3.288 mg/L (fathead minnow, *Pimephales promelas*).

Toxicities to aquatic plants fall within roughly the same ranges: 6.48 mg/L caused mortality of the diatom *Cyclotella meneghiniana*, and concentrations from 0.40 to 0.90 mg/L were chronically toxic to *Cyclotella meneghiniana* and the green algae *Selenastrum capricornutum*. Bioconcentration factors from 50 to 231 were obtained in tests with young brook trout. Toxicities of body burdens were not determined. The acute and chronic National Ambient Water Quality Criteria (NAWQC) for the protection of aquatic organisms for aluminum are 0.750 and 0.087 mg/L, respectively.

Toxicity of Aluminum in Soil to Terrestrial Plants. Aluminum interferes with cell division in roots, decreases root respiration, fixes P in unavailable forms in roots, interferes with uptake, transport, and use of Ca, Mg, P, K, and water, and interferes with enzyme activities (Foy et al. 1978). Symptoms of toxicity include stubby, brittle roots, stunting, late maturity, and collapse of growing points. Seedlings are more susceptible to damage from aluminum toxicity than are older plants. Seedling establishment of white clover in a silt loam soil (pH 5.0) was reduced by approximately 30% by the addition of 50 ppm Al as $Al_2(SO_4)_3$ (Mackay et al. 1990), the lowest concentration tested.

Table F1.1. Toxicity of aluminum to aquatic animals

Concentration (mg/L)	Effect[a]
>79.9	Midge (*Tanytarsus dissimilis*) LC50
>50.0	Green sunfish (*Lepomis cyanellus*) LC50
>49.8	Yellow perch (*Perca flavescens*) LC50
>47.9	Channel catfish (*Ictalurus punctatus*) LC50
>40.0	Chinook salmon (*Oncorhynchus tshawytsca*) LC50
38	Cladoceran (*Daphnia magna*) EC50
35	Fathead minnow (*Pimephales promelas*) LC50
31	Snail (*Physa sp.*) LC50
>23.0	Planaria (*Dugasia tigrina*) LC50
>22.6	Stonefly (*Acroneuria sp.*) LC50
22	Amphipod (*Gammarus pseudolimnaeus*) LC50
10	Rainbow trout (*Oncorhynchus mykiss*) LC50
4	Caldoceran (*Ceriodaphnia sp.*) EC50
4	Brook trout (*Salvelinus fontinalis*) LC50
3	Fathead minnow (*Pimephales promelas*) CV
2	Cladoceran (*Ceriodaphnia dubia*) CV
2	Cladoceran (*Ceriodaphnia dubia*) EC50
1	Acute NAWQC
1	Cladoceran (*Daphnia magna*) CV
0	Chronic NAWQC

[a] LC = Lethal Concentration; EC = Effects Concentration; CV = Chronic Value; NAWQC = National Ambient Water Quality Criteria.

F1.1.2 Arsenic

Toxicity of Arsenic in Sediments to Benthic Invertebrates. Sediments of Waukegan Harbor, Wisconsin, which had more than 47 mg/kg arsenic, caused 34% mortality in *H. azteca*. Sediment from the Sheboygan River, Wisconsin, which had 2.7 mg/kg arsenic caused significant mortality to the freshwater prawn, *Macrobrachium rosenbergii*. However, this sediment also was contaminated with metals and polychlorinated biphenyls (PCBs). At two rivers in Illinois, a low number of benthic macroinvertebrate taxa was associated with arsenic concentrations of 7.4 and 3.7 mg/kg. However, a high number of taxa was associated with 5.9 and 5.0 mg/kg arsenic in the same two rivers (studies cited in Long and Morgan 1991).

Effects Range-Low (ER-L) and Effects Range-Medium (ER-M) values are 8.2 mg/kg and 70 mg/kg, respectively. Only 11% of the documented studies in Long et al (1995) indicated biological effects at concentrations between the ER-L and ER-M, while 63% of the studies at concentrations above the ER-M indicated biological effects.

Toxicity of Arsenic to Wildlife. Arsenic is present in the earth's crust at approximately 2 ppm, but tissues of animals generally contain an average of <0.5 ppm (Venugopal and Luckey 1978). Arsenic may be a required micronutrient; growth, survival, and reproduction of goats are poor if the diet contains <0.05 ppm arsenic (NAS 1977).

Arsenic is a carcinogen and teratogen. Other effects include reduced growth, hearing/sight loss, liver/kidney damage, and death (Eisler 1988a). Inorganic arsenic is usually more toxic than organic arsenic compounds. Wildlife mortality and malformations have been observed for chronic doses of 1–10 mg arsenic/kg body weight (bw) and dietary concentrations of 5–50 ppm (Eisler 1988a). Acute LD_{50}s for mammals of 35–100 mg calcium arsenate/kg bw and 10–50 mg lead arsenate/kg bw have been reported (NRCC 1978).

Schroeder and Mitchner (1971) exposed mice to 5 ppm sodium arsenite in drinking water for three generations. While mice fed arsenic survived well, litter size decreased in subsequent generations. A dose of 0.38 mg arsenic/kg over a lifetime was sufficient to cause a slight decrease in the median lifespan of laboratory mice (Schroeder and Balassa 1967), but it had no effect on growth. As little as 3 mg arsenic trioxide/kg bw or 1 mg sodium arsenite/kg bw can be lethal (NAS 1977).

Because metabolism of arsenic in rats is unlike that in other animals, results of toxicity studies using rats generally should not be extrapolated to other species (Eisler 1988a).

Among birds, LD_{50} levels for arsenic compounds range from 17.4 to 3300 mg/kg bw (Eisler 1988a). While no mortality was observed among mallard ducks fed a diet containing 100 ppm sodium arsenite for 128 days, 12% to 92% mortality was observed for ducks fed diets containing 250 to 1000 ppm arsenite (USFWS 1964). Camardese et al. (1990) and Whitworth et al. (1991) fed mallards diets containing 30, 100, or 300 ppm sodium arsenate. While no effects were observed on behavior, growth was reduced for male ducks consuming 300 ppm arsenic and for female ducks at all exposure levels.

Toxicity of Arsenic in Soil to Plants. Arsenic is not essential for plant growth. It is taken up actively by roots, with arsenate being more easily absorbed than arsenite. Arsenic and phosphate ions are likely taken up by the same carrier (Asher and Reay 1979). The phytotoxicity is strongly affected by the form in which it occurs in soils. Arsenite (III) is more toxic than arsenate (V), and both are considerably more toxic than organic forms (Peterson et al. 1981). In experiments with toxic levels of arsenic, rice and

legumes appear to be more sensitive than other plants. Symptoms include wilting of new-cycle leaves, followed by retardation of root and top growth, and leaf necrosis (Aller et al. 1990). Arsenic is chemically similar to P, it is translocated in the plant in a similar manner and is able to replace P in many cell reactions. Arsenic (III) probably reacts with sulphydryl enzymes leading to membrane degradation and cell death. Arsenic (V) is known to uncouple phosphorylation and affect enzyme systems (Peterson et al. 1981). The mechanism of toxicity of organo-arsenicals is unclear.

Soil type affected the toxicity of arsenic (III) added to two soils on the shoot weight of cotton and soybeans grown from seed for 6 weeks (Deuel and Swoboda 1972). In a sandy loam soil, shoot weights of both crops were reduced (cotton 22%; soybeans 45%) by 11 ppm arsenic (the lowest concentration tested). Soybean growth in a clay soil was reduced 28% by 22.4 ppm arsenic (lowest concentration tested). Cotton growth in this soil was reduced 29% by 89.6 ppm arsenic. The source of arsenic (V) has been shown to influence the effect on corn grown from seed for 4 weeks in a loamy sand (pH 7.1). Plant weight reductions rose from less than 10% with the addition of 10 ppm arsenic in any form, to almost 100% for NaH_2AsO_4, more than 75% for $Al(H_2AsO_4)_3$, and about 65% for $Ca(H_2AsO_4)_2$ with the addition of 100 ppm arsenic (Woolson et al. 1971).

F1.1.3 Barium

Toxicity of Barium in Water to Aquatic Life. There is relatively little information of the aquatic toxicity of barium, and none has been found for fish. Only one test using a standard organism was found: an acute value of 410 mg/L was reported for *Daphnia magna* (LeBlanc 1980 cited in Suter and Mabrey 1994). Barium sulfate and chloride were lethal to yellow crabs (*Cancer anthonyi*) in 7-day exposures at 1,000 and 100 mg/L, respectively (MacDonald et al. 1988). Barium inhibited growth of duckweed by 50% at 102 to 400 mg/L in various ambient waters (Wang 1988). Barium inhibited calcification of the freshwater green alga *Goeotaenium* at 50.0 mg/L (Prasad 1984). The state of Illinois has a water quality standard for indigenous aquatic life of 5.0 mg/L (Wang 1988). Barium is bioconcentrated from water by algae and vascular plants, but is not bioaccumulated through food chains (Moore 1991).

Toxicity of Barium in Sediment to Benthic Invertebrates. The benchmarks used for barium are based on background because sediment toxicity data were not found (Hull and Suter 1994). The EPA Region V Sediment Classifications of Nonpolluted (less than 20 mg/kg), Moderately Polluted (between 20 and 60 mg/kg), and Heavily Polluted (greater than 60 mg/kg) are poorly founded scientifically and considered adequate only for determining the suitability of dredged material for open water disposal.

Toxicity of Barium to Wildlife. The soluble salts of barium, an alkaline earth metal, are toxic in mammalian systems. At low doses, barium acts as a muscle stimulant and at higher doses affects the nervous system, eventually leading to paralysis. The LD_{50} for rats is listed as 630 mg/kg for barium carbonate, 118 mg/kg for barium chloride, and 921 mg/kg for barium acetate (Lewis and Sweet 1984).

Schroeder and Mitchener (1975a, b) exposed rats and mice to 5 mg barium/L in drinking water for their lifetime. There was a slight but significant reduction in longevity of treated male mice when measured as the mean age at death of the last surviving 10% of animals. The overall average life span of the group, however, was about the same as the control group. In another study, Perry et al. (1983) exposed rats to 0, 1, 10, or 100 ppm barium for up to 16 months. A significant increase in average blood pressure was observed in the highest dose group; a slight but statistically significant increase was seen in the 10 ppm dose group. Information on developmental and reproductive toxicity of barium to mammals is not available.

The LD_{50} of barium to chickens is 623 mg/kg (Johnson et al., 1960). Johnson et al. (1960) report that while chickens will tolerate 1000 ppm barium in their diet without adverse effects, 2000 ppm reduces growth, 8000 ppm produces 50% mortality in 4 weeks, and diets containing 16,000 or 32,000 ppm barium are 100% lethal.

F1.1.4 Boron

Toxicity of Boron in Water to Aquatic Life. Relatively little aquatic toxicity information is available for boron. The only standard data are LC50s and CVs for *Daphnia magna* exposed to boric acid in relatively hard water. Lewis and Valentine (1981) reported an LC50 of 226 mg/L and a CV of 8.83 mg/L and Gersich (1984) reported an LC50 of 133 mg/L and a CV of 9.33 mg/L. Toxic concentrations from nonstandard and poorly documented tests fall within this range.

Toxicity of Boron in Soil to Plants. Boron is a plant micronutrient involved in transport of sugars across membranes, synthesis of nucleic acids, and protein utilization. It is rapidly taken up, mainly as the neutral $B(OH)_3$ molecule and equally distributed between roots and shoots (Wallace and Romney 1977a). Toxicity symptoms include needle tip necrosis and discoloration in pines (Neary et al. 1975) and burning of leaf edges in other plants. Grasses and legumes appear to have greater than average tolerance to high B concentrations (Gupta 1984), and pines appear to be particularly sensitive (Stone and Baird 1956).

John et al. (1977) investigated the effects of B added as H_3BO_3 on shoot weight of corn seedlings grown 7 weeks in muck and two silt loam soils. Addition of 50 ppm B to the muck soil (pH 4.5; % organic matter 56) resulted in a 56% reduction in plant growth (10 ppm B had no effect). Growth was reduced 37% by the addition of the lowest concentration tested (0.5 ppm) in one silt loam soil (pH 5.7; % organic matter 6), and 83% by the addition of 50 ppm B in the other (pH 5.7; % organic matter 3) (10 ppm had no effect).

F1.1.5 Cadmium

Toxicity of Cadmium in Water to Aquatic Life. Cadmium occurs predominately in the form of a free divalent cation in most well oxygenated, low organic matter, fresh waters (EPA 1985-Cd). However, both particulate matter and dissolved organic matter can bind cadmium in biologically unavailable forms.

There is no evidence that cadmium is a biologically essential or beneficial element (Eisler 1985a). Cd toxicity is related to water hardness, with a reduction in toxicity associated with increased water hardness (EPA 1985-Cd). Therefore, the cadmium toxicity values presented in Table F1.2 that are not from tests conducted in waters of moderate hardness (within the range found in the Clinch River) are normalized to 100 mg/L using the slopes calculated by the EPA (1985-Cd). Aquatic organisms are able to bioconcentrate Cd, although there is evidence that only the lower trophic levels can biomagnify this element.

Toxicity of Cadmium in Sediment to Benthic Organisms. Fertilized eggs of the goldfish, leopard frog, and largemouth bass were placed in natural stream sediment spiked with cadmium (Francis et al. 1984) and maintained until 4 days posthatching, which resulted in a total exposure duration of 6 to 7 days. Sediments with 1000 mg/kg cadmium were not toxic to goldfish or leopard frog but resulted in 25% mortality during 4 days posthatching for largemouth bass. A sediment concentration of 100 mg/kg cadmium was not toxic to the largemouth bass. Organic matter content of the sediment was 2.3%.

Table F1.2. Aqueous concentrations of cadmium causing effects on freshwater aquatic biota at hardness equivalent to Clinch River and Poplar Creek

Concentration (mg/L)[a]	Effect[b]
24.6	goldfish (*Carassius auratus*) LC50
18.0	stonefly LC50[c]
17.7	mayfly (*Ephemerella grandis*) LC50
17.3	Tubificid worm (*Rhyacodrilus montana*) LC50
16.8	mosquitofish ((*Gambusia affinis*) LC50
16.5	white perch (*Morone americana*) LC50
15.1	Tubificid worm (*Stylodrilus heringlanus*) LC50
12.7	bluegill (*Lepomis macrochirus*) LC50
12.5	channel catfish (*Ictalurus punctatus*) LC50
12.4	Tubificid worm (*Spirosperma nikolskyl*) LC50
10.9	threespine stickleback (*Gasterosteus aculeatus*) LC50
10.4	Tubificid worm (*Varichaeta pacifica*) LC50
9.62	Tubificid worm (*Spirosperma ferox*) LC50
8.79	Tubificid worm (*Quistadrilus multisetosus*) LC50
8.79	Tubificid worm (*Tubifex tubifex*) LC50
8.30	snail (*Amicola* sp.) LC50
7.80	guppy (*Poecilla reticulata*) LC50
7.68	white sucker (*Catostomus commersoni*) LC50
7.43	caddisfly LC50
6.86	green sunfish (*Lepomis cyanellus*) LC50
6.59	Tubificid worm (*Branchiura sowerbyl*) LC50
6.31	flagfish (*Jordanella floridae*) LC50
5.24	northern squawfish (*Ptychochellus oregonensis*) LC50
5.05	mayfly (*Paraleptophlebia praepedita*) LC50
4.67	Tubificid worm (*Limnodrilus hoffmelsterl*) LC50
3.71	worm (*Nals* sp.) LC50
2.94	pumpkinseed (*Lepomus gibbosus*) LC50
2.62	midge (*Chironomus* sp.) LC50
1.61	American eel (*Anguilla rostrata*) LC50
0.875	isopod (*Asellus bicrenata*) LC50
0.705	crayfish (*Orconectes limosus*) LC50
0.484	bryozoan (*Plumatella emarginata*) LC50
0.471	common carp (*Cyprinus carpio*) LC50
0.448	amphipod (*Hyalella azteca*) LC50
0.343	snail (*Physa gyrina*) LC50

Table F1.2 (continued)

Concentration (mg/L)[a]	Effect[b]
0.311	bryozoan (*Pectinatella magnifica*) LC50
0.227	snail (*Aplexa hypnorum*) LC50
0.216	banded killifish (*Fundulus diaphanus*) LC50
0.181	*Ceriodaphnia reticulata* EC50
0.153	amphipod (*Gammarus* sp.) LC50
0.132	amphipod (*Gammarus pseudolimnaeus*) LC50
0.122	*Daphnia pulex* EC50
0.100	cladoceran (*Simocephalus serralatus*) EC50
0.0935	isopod (*Lirceus alabamae*) LC50
0091.0	cladoceran (*Simocephalus vetulus*) EC50
0.0891	cladoceran (*Molina macrocopa*) EC50
0.0720	fathead minnow (*Pimephales promelas*) LC50
0.0667	bryozoan (*Lophopodella carteri*) LC50
0.0281	bluegill (*Lepomis macrochirus*) CV
0.0266	*Daphnia magna* EC50
0.0262	fathead minnow (*Pimephales promelas*) CV
0.0141	Atlantic salmon (*Salmo salar*) CV
0.0141	smallmouth bass (*Micropterus dolomieui*) CV
0.0140	Northern pike (*Esox lucius*) CV
0.0140	lake trout (*Salvelinus namaycush*) CV
0.0135	white sucker (*Catostomas commersoni*) CV
0.0129	coho salmon (*Oncorhynchus kisutch*) LC50
0.0127	brown trout (*Salmo trutta*) CV
0.00930	chinook salmon (*Oncorhynchus tshawytscha*) LC50
0.00920	flagfish (*Jordanella floridae*) CV
0.00834	snail (*Aplexa hypnorum*) CV
0.00784	rainbow trout (*Oncorhynchus mykiss*) LC50
0.00739	coho salmon (*Oncorhynchus kisutch*) CV
0.00678	cladoceran (*Ceriodaphnia reticulata*) CV
0.00464	chinook salmon (*Oncorhynchus kisutch*) CV
0.00407	brook trout (*Salvelinus fontinalis*) CV
0.00390	acute NAWQC
0.00358	brown trout (*Salmo trutta*) LC50
0.00110	chronic NAWQC
0.000330	cladoceran (*Molna macrocopa*) CV
0.000233	cladoceran (*Daphnia magna*) CV

[a] Effect levels were converted based on a 100 mg/L water hardness. Slopes used for the conversion were associated with individual species, where specified in the Criteria document. Otherwise, 1.128 and 0.7852 were the slopes for the acute and chronic test conversions, respectively.
[b] LC = Lethal Concentration; EC = Effects Concentration; CV = Chronic Value; NAWQC = National Ambient Water Quality Criteria.
[c] The stonefly acute test did not specify the hardness of the water.

Spiked sediment toxicity tests were performed using sediment from Steele's Run (organic carbon content of 2.3%), a stream in the Kentucky River drainage system. Treatment was of early-life-stage rainbow trout, in which the test was initiated at the early eyed-egg stage and continued through 10 days posthatching, giving an exposure period of 20 days. Sediment concentrations of between 2 and 13 mg/kg resulted in between 47 and 63% mortality relative to controls. A concentration of 121 mg/kg resulted in 89% mortality (Birge et al. 1979).

An Illinois harbor sediment containing 2.5 mg/kg cadmium resulted in 34% mortality of *Hyalella azteca*. A concentration of 1.98 mg/kg caused 95% mortality to *Hyalella azteca* in a Washington lake sediment. Significant mortality to the prawn *Macrobrachium rosenbergii* resulted from 2.8 mg/kg cadmium in a Wisconsin river (studies cited in Long and Morgan 1991).

Confidence in the Long and Morgan (1991) ER-L and ER-M is very high, because data are available from many approaches, from multiple methods for some approaches, and are relatively consistent (Long and Morgan 1991). The updated ER-L and ER-M (Long et al. 1995), which do not include freshwater data, also show good consistency. That is, 37% of the documented studies indicated biological effects at concentrations between the ER-L and ER-M, and 66% of the studies at concentrations above the ER-M indicated biological effects. However, resistance to cadmium is higher among marine species than among freshwater species (Eisler 1985a).

Toxicity of Cadmium to Wildlife. While there is little information to indicate that this relatively rare metal is biologically essential or beneficial, Cd has been suggested as the cause of various deleterious effects to wildlife (Eisler 1985a). Mammals and birds are comparatively resistant to the biocidal properties of Cd, which include growth retardation, anemia, and testicular damage. Cd tends to bioaccumulate in the liver and kidney, eventually acting as a cumulative toxin. Cd residues of 2 ppm whole body fresh weight are evidence of Cd contamination, and residues >5 ppm whole animal fresh weight may be life-threatening (Eisler 1985a).

The lowest oral dose resulting in death for rats was 250 mg Cd/kg bw (EPA 1980a). Weigel et al. (1987) fed rats 0.24, 0.85, or 2.25 mg/kg Cd in diet for 8 weeks. Concentrations $\geq$0.85 mg/kg resulted in reduced food intake, reduced body weights, and reduced enzyme activity, but no hematological effects were noted. Ma et al. (1991) determined that an average cadmium intake of 15 mg/kg/day corresponded with critical renal metal loads of 120 mg/kg, a level indicative of adverse health effects. Rats on a diet with 5 ppm Cd suffered shortened lifespans (Schroeder et al. 1965). Cd at 50 ppm in the diet depleted iron from rat livers (Whanger 1973). Rats eating diets with 7.15 ppm Cd (as CdO) exhibited growth reductions, but those consuming a diet with 2.80 ppm Cd did not (Weigel et al. 1984). In a 3 generation reproductive study, the population of mice exposed to 1 ppm $CdCl_2$ in their drinking water died out after the second generation (Schroeder and Mitchner 1971). Rats receiving >6 mg Cd/kg bw daily during pregnancy gave birth to malformed fetuses (Ferm and Layton 1981).

No mortality was observed among adult mallard ducks fed diets containing 0, 2, 20, and 200 ppm Cd; however, egg production was significantly reduced in the group consuming 200 ppm Cd (White and Finley 1978). In addition, the testes of males in the 200 ppm Cd group atrophied and the spermatogenic process was disrupted (White et al. 1978). Among mallard ducklings, 20 ppm Cd in the diet produces mild to severe kidney lesions, reduces packed cell volume and hemoglobin concentrations in the blood (Cain et al. 1983). Avoidance behavior of black ducklings is impaired by diets containing 40 ppm Cd (Heinz and Haseltine 1983).

Toxicity of Cadmium in Soil to Plants. Cadmium is not essential for plant growth. If present in available form, it is readily taken up by the roots, translocated through the plant, and accumulated.

Cadmium is chemically similar to Zn, an essential element. Competition between the two for organic ligands may explain some of the toxic effects of Cd, and the ameliorative effects of Zn on Cd toxicity. Cadmium depresses uptake of Fe, Mn, and probably Ca, Mg, and N (Wallace et al. 1977e; Iwai et al. 1975). Cadmium is toxic at low concentrations. Symptoms resemble Fe chlorosis and include necrosis, wilting, reduced Zn levels, and reduction in growth. The mechanisms of toxicity include reduced photosynthetic rate, poor root system development, reduced conductivity of stems, and ion interactions in the plant. Agronomic crops are more sensitive to Cd toxicity than trees (Adriano 1986).

A number of researchers have measured reductions in growth of a variety of plants in different soils with 10 ppm or less of Cd added to soil as soluble salts. Plants tested include sycamore and spruce trees, wild flowering plants, and crops and horticultural plants (corn, lettuce, radish, wheat). Soils range from light sands to heavy silty clay loams in the acid to neutral pH range. There are no clear trends in responses indicating that any particular type of plant is more sensitive to Cd (reductions in growth range from 23 to 45%), or that growth conditions (pH and soil texture) consistently affected toxicity. Grasses appear to be generally less sensitive than several other plant groups with growth adversely affected at concentrations greater than 10 ppm (up to 160 ppm for oats) under a variety of growth conditions. The following paragraphs give information on representative experiments conducted to evaluate the effects of Cd on plant growth.

Miles and Parker (1979a) investigated the effects of Cd added as $CdCl_2$ on seed germination, and root and shoot weights of a variety of native plants grown from seed for 6 weeks in a sandy soil (pH 4.8, % organic matter 2). Seed germination of black-eyed Susan, and growth of black-eyed Susan, rough blazing star, long-fruited thimbleweed, and wild bergamot were reduced by more than 20% with the addition of 10 ppm Cd, the lowest concentration tested. Growth of Kentucky bluegrass roots and shoots, little bluestem roots, and poison-ivy roots and shoots was reduced by approximately 90%, 60%, and 70%, respectively, with the addition of 30 ppm Cd where 10 ppm Cd did not have an effect.

Experiments evaluating effects of Cd on tree growth show variable responses. Dixon (1988) measured the response of red oak seedlings grown for 16 weeks in a sandy loam soil (pH 6, % organic matter 1.5) with the addition of Cd ($CdCl_2$). Cadmium at 20 ppm reduced tree weight by 28%, while 10 ppm had no effect. Carlson and Bazzaz (1977) measured root, woody stem, green stem and foliage weights, and main stem diameter of 2 to 3-year old American sycamore saplings associated with 90 days exposure to Cd as $CdCl_2$ added to a silty clay loam soil. The lowest concentration tested (5 ppm Cd) was responsible for a 30% reduction in leaf weight. Burton et al. (1984) grew Sitka-spruce seedlings from 4 weeks of age in a mixture of acidic peaty gley soil and sand with Cd added (0.1, 0.4, 1, 2, 4, 8, and 16 ppm as $CdCl_2$). Two ppm Cd lead to a reduction of about 45% in root and shoot weight of the 18-week old seedlings.

Sadana and Singh (1987a and b) investigated the effects of Cd added to a loamy sand soil (pH 8.4, % organic matter 1) on lettuce and grain yield of wheat grown from seed to maturity. Lettuce growth was reduced 23% by the addition of 4 ppm Cd and wheat grain yield was reduced by 28% by 10 ppm Cd (lowest concentration tested).

The effects of a range of Cd concentrations added as $CdSO_4$ on a variety of crops (spinach, radish, lettuce, carrot, soybean, curlycress, corn, turnip, field bean, wheat, tomato, zucchini, and cabbage) grown from seed to maturity in a silt loam soil (pH 7.5) was evaluated by Bingham et al. (1975). Concentrations causing a 25% reduction in plant weights ranged from 4 (spinach) to 170 (cabbage).

Haghiri (1973) determined the effects of additions of 2 to 100 ppm Cd as $CdCl_2$ to a silty clay loam soil (pH 6.7, % organic matter 4) on dry matter yield (26 to 37 d) of lettuce, radish, wheat, and soybean.

Concentrations causing reductions in plant weights ranged from 2 (40 and 36% reductions in lettuce and radish) to 10 (50% reduction in soybean).

In two studies using Brown earth soils, Khan and Frankland investigated the effects of Cd added as $CdCl_2$, the less soluble CdO, or a combination, on growth (42 d) of radish (1983, 1984), wheat and oats (1984). Radish growth was reduced 22% by the addition of 10 ppm Cd as $CdCl_2$, or 100 ppm as CdO (29%), to a soil having a pH of 5.4 (1983). Addition of 50 ppm as $CdCl_2$+CdO (1:1) reduced radish root growth 43% in soil having a pH of 4.6 (1984). Wheat growth was reduced 61% by the addition of 50 ppm Cd as $CdCl_2$ and 47% by the addition of 100 ppm CdO. Oat growth was reduced 25% by the addition of 10 ppm Cd as $CdCl_2$. All concentrations were the lowest tested.

F1.1.6 Chromium

Toxicity of Chromium in Water to Aquatic Life. Inorganic chromium occurs as two forms in ambient water, chromium (III) and chromium (VI) (EPA 1985-Cr). Toxicity appears to be quite different for each state and has not been shown to be additive. For this reason trivalent and hexavalent chromium are treated as separate materials. Acute values for chromium (III) are available for 18 animal genera ranging from 2.2 mg/L for a mayfly to 71 mg/L for a caddisfly. Chronic values ranged from <0.044 mg/L for a cladoceran to 1.025 mg/L for the fathead minnow. Acute values for chromium (VI) are available for 27 genera and range from 0.23 mg/L for a cladoceran to 1,870 mg/L for a stonefly. Daphnids appear to be especially sensitive to chromium (VI). Chronic values for rainbow trout and brook trout were both 0.264 mg/L, as compared to the chronic value of 1.987 mg/L for the fathead minnow. Both valences of chromium appear to increase in toxicity with decreasing hardness. Green algae are quite sensitive to chromium (VI) and were affected by a concentration of 0.397 mg/L of chromium (III) in soft water. The bioconcentration factor for chromium (VI) was approximately one for rainbow trout in two studies (Table F1.3). No bioconcentration factor was available for chromium (III) in fresh water.

Toxicity of Chromium in Sediment to Benthic Organisms. There is relatively little consistency in the effects data presented in the NOAA report (Long and Morgan 1991). This may be due to the lack of chromium speciation data in the NOAA studies. All of the data were reported as total chromium, whereas the hexavalent form has been reported to be the most toxic. In Lake Union, Washington, a concentration of 20 mg/kg resulted in 95% mortality of *Hyalella azteca*. However, in the Dupage and Kishwaukee rivers in Illinois chromium levels of 34 and 29 mg/kg, respectively, had the highest number of benthic macroinvertebrate taxa, while concentrations of 60 and 43 mg/kg, respectively, has the lowest number of benthic macroinvertebrate taxa. In the Keweenaw Waterway of Michigan, 36 mg/kg chromium was not toxic to *Daphnia magna,* but levels of 109 mg/kg were significantly toxic. In Torch Lake, Michigan, concentrations of 180 mg/kg chromium resulted in significant mortality to *Daphnia magna* and *Hexagenia* sp. (studies cited in Long and Morgan, 1991).

Toxicity of Chromium in Soil to Plants. Chromium is not an essential element in plants. The (VI) form is more soluble and available to plants than the (III) form and is considered the more toxic form (Smith, et al., 1989). In soils within a normal Eh and pH range, Cr(VI), a strong oxidant, is likely to be reduced to the less available Cr(III) form although the (III) form may be oxidized to the (VI) form in the presence of oxidized Mn (Bartlett and James, 1979). In nutrient solution, however, both forms are about equally taken up by plants and toxic to plants (McGrath, 1982). Cr(VI), as CrO_4^{2-}, may share a root membrane carrier with SO_4^{2-}. Cr(VI) is more mobile in plants than Cr(III) but translocation varies with plant type. After plant uptake it generally remains in the roots because of the many binding sites in the cell wall capable of binding especially the Cr(III) ions (Smith et al., 1989). Within the plant Cr(VI) may be reduced to the +3 form and complexed as an anion with organic molecules. Symptoms of toxicity include

Table F1.3. Toxicity of chromium to aquatic animals

Concentration (mg/L)	Effect[a]
	Chromium(VI)
1,870	Stonefly (*Neophasganophora capitata*) LC50
176	Crayfish (*Orconectes rusticus*) LC50
140	Damselfly (*Enallagma aspersum*) LC50
133	Bluegill (*Lepomis macrochirus*) LC50
120	Goldfish (*Carassius auratus*) LC50
115	Green sunfish (*Lepomis cyanellus*) LC50
86	Striped shiner (*Notropis chrysocephalus*) LC50
75	Sand shiner (*Notropis stramineus*) LC50
73	White crappie (*Pomoxis annularis*) LC50
69	Rainbow trout (*Oncorhynchus mykiss*) LC50
61	Midge (*Chironomus tentans*) LC50
59	Brook trout (*Salvelinus fontinalis*) LC50
57	Midge (*Tanytarsus dissimilis*) LC50
54	Bluntnose minnow (*Pimephales notatus*) LC50
51	Central stoneroller (*Campostoma anomalum*) LC50
50	Silverjaw minnow (*Ericymba buccata*) LC50
48	Emerald shiner (*Notropis atherinoides*) LC50
46	Johnny darter (*Etheostoma nigrum*) LC50
41	Fathead minnow (*Pimephales promelas*) LC50
36	Yellow perch (*Perca flavescens*) LC50
30	Striped bass (*Morone saxatilis*) LC50
30	Guppy (*Powcilia reticulata*) LC50
23	Snail (*Physa heterostropha*) LC50

Table F1.3 (continued)

Concentration (mg/L)	Effect[a]
2	Fathead minnow (*Pimephales promelas*) CV
2	Bryozoan (*Lophopodella carteri*) LC50
1	Bryozoan (*Pectinatella magnifica*) LC50
1	Bryozoan (*Plumatella emarginata*) LC50
1	Amphipod (*Hyalella azteca*) LC50
0	Rainbow trout (*Oncorhyncus mykiss*) CV
0	Brook trout (*Salvelinus fontinalis*) CV
0	Rainbow trout (*Oncorhyncus mykiss*) CV
0	Amphipod (*Gammarus pseudolimnaeus*) LC50
0	Cladoceran (*Ceriodaphnia reticulata*) EC50
0	Cladoceran (*Simocephalus serrulatus*) EC50
0	Cladoceran (*Ceriodaphnia reticulata*) CV
0	Cladoceran (*Daphnia pulex*) EC50
0	Cladoceran (*Simocephalus vetulus*) EC50
0	Cladoceran (*Daphnia magna*) EC50
0	Cladoceran (*Simocephalus serrulatus*) CV
0	Acute NAWQC
0	Chronic NAWQC
0	Cladoceran (*Daphnia pulex*) CV
0	Cladoceran (*Simocephalus vetulus*) CV
Chromium(III)	
139	Caddisfly (*Hydropsyche betteni*) LC50
88	Caddisfly (unidentified) LC50
76	Damselfly (unidentified) LC50
32	Goldfish (*Carassius auratus*) LC50

Table F1.3 (continued)

Concentration (mg/L)	Effect[a]
29	Rainbow trout (*Oncorhynchus mykiss*) LC50
27	Stiped bass (*Morone saxatilis*) LC50
26	Guppy (*Poecilia reticulata*) LC50
26	Pumpkinseed (*Lepomis gibbosus*) LC50
26	Banded killifish (*Fundulus diaphanus*) LC50
22	White perch (*Morone americana*) LC50
22	Common carp (*Cyprinus carpo*) LC50
21	American eel (*Anguilla rostrata*) LC50
19	Midge (*Chironomus sp.*) LC50
18	Snail (*Amnicola sp.*) LC50
16	Worm (*Nais sp.*) LC50
9	Cladoceran (*Daphnia magna*) EC50
6	Fathead minnow (*Pimephales promelas*) LC50
6	Amphipod (*Gammarus sp.*) LC50
5	Bluegill (*Lepomis macrochirus*) LC50
4	May fly (*Ephemerella subvaria*) LC50
2	Acute NAWQC
1	Fathead minnow (*Pimephales promelas*) CV
0	Chronic NAWQC
0	Rainbow trout (*Oncorhyncus mykiss*) CV
0	Cladoceran (*Daphnia magna*) CV
0	Cladoceran (*Daphnia magna*) CV

[a]LC = Lethal Concentration; EC = Effects Concentration; CV = Chronic Value; NAWQC = National Ambient Water Quality Criteria.

stunted growth, poorly developed roots, and leaf curling. Chromium may interfere with C, N, P, Fe, and Mo metabolism, and enzyme reactions (Kabata-Pendias and Pendias, 1984).

Turner and Rust (1971) investigated the effect of Cr added as Cr(VI) on soybean seedlings grown 3 days in a loam soil. Fresh shoot weight was reduced 30% by 30 ppm Cr, while 10 ppm had no effect. Adema and Henzen (1989) calculated EC_{50} concentrations for effects of Cr added as Cr(VI) on lettuce, tomato and oats grown in a growth chamber from seed for 14 days. The EC_{50} for lettuce in a humic sand soil (pH 5.1, % organic matter 3.7) was greater than 11 ppm, while in a loam soil (pH 7.4, % organic matter 1.4) it was 1.8 ppm Cr. The EC_{50} for tomato in the humic sand soil was 21 ppm, while in the loam soil it was 6.8 ppm Cr. The EC_{50} for oats in the humic sand soil was 31 ppm, while in the loam soil it was 7.4 ppm Cr. Results of these experiments show the ameliorating effects of organic matter on Cr (VI) toxicity.

F1.1.7 Cobalt

Toxicity of Cobalt in Water to Aquatic Life. Comparatively little is known about the toxicity of cobalt (Kimball, date unknown). Acute and chronic toxicity tests using fathead minnows (*Pimephales promelas*) and *Daphnia magna* were conducted in relatively hard water. Acute toxicity values for cobalt ranged from 3.61 mg/L for fathead minnows to 6.68 mg/L for *D. magna*. Chronic toxicity values ranged from .0011 mg/L for fathead minnows to .0051 mg/L for *D. magna*.

F1.1.8 Copper

Toxicity of Copper in Water to Aquatic Life. Copper occurs in natural waters primarily as the divalent cupric ion in free and complexed forms (EPA 1985-Cu). Copper is a minor nutrient for both plants and animals at low concentrations but is toxic to aquatic life at concentrations only slightly higher. Concentrations of 1 to 10 μg/L are usually reported for unpolluted surface waters in the United States.

The toxicity of copper to aquatic life is related primarily to activity of the cupric (Cu^{2+}) ion, and possibly to the hydroxy complexes. The cupric ion is highly reactive, forms moderate to strong complexes and precipitates with inorganic and organic constituents (e.g., carbonate, phosphate, amino acids), and is readily sorbed onto surfaces of suspended solids. The proportion of free cupric ion may be less than 1 percent in eutrophic waters where complexation predominates. These complexes appear to be much less toxic than free cupric ions, thus reducing toxicity. Hence, even dissolved copper measurements may overestimate copper exposure relative to laboratory test waters due to dissolved organic and inorganic ligands (EPA 1985-Cu, Benson et al. 1994).

Toxicity of copper appears to be a function of calcium hardness and associated carbonate alkalinity. Therefore, only those acute LC50 and EC50 values that were determined in waters with hardness falling in the range observed in the Clinch River/Poplar Creek OU are used in this assessment (Table F1.4). Because only one chronic toxicity test was conducted in such waters, other chronic values are presented that are corrected for a hardness of 100 mg/L using slope values from EPA (1985-Cu) (Table F1.4). Acute and chronic NAWQC for 100 mg/L hardness are also presented. The sensitivities of the aquatic plants are highly variable, bracketing those of animals (Table F1.4). Copper is not known to be appreciably bioaccumulated by fish, but some algae and bivalve molluscs do bioconcentrate or bioaccumulate copper by factors of over 1000 (EPA 1985-Cu).

Toxicity of Copper in Sediments to Benthic Organisms. A concentration of 156 mg/kg Cu caused 95% mortality to *Hyalella azteca* at Lake Union, Washington. In Waukegan Harbor, Illinois, there was 34% mortality to the same species at a concentration of 19.5 mg/kg. In Illinois, a high number of benthic

Table F1.4. Aqueous concentrations of copper causing effects on freshwater aquatic biota at hardness equivalent to Clinch River and Poplar Creek. Effects reported for CVs are those occurring at the upper bound on the CV (the LOEC)[a]. Unadjusted values from EPA (1985).

Concentration (mg/L)	Effect[b]
8.0[c]	Highest plant value, growth inhibition in *Chlamydomonas sp.*
3.0	Crayfish (*Orconectes rusticus*) LC50
1.5	Tilapia (*Tilapia mossambica*) LC50
1.5	Pumpkinseed (*Lepomis gibbosus*) LC50
0.30	Midge (*Chironomus tentans*) LC50
0.12[d]	Northern pike ELS CV [100% early life-stage mortality][e]
0.11	Snail (*Gyraulus circumstriatus*) LC50
0.069	Snail (*Physa heterostropha*) LC50
0.068	Coho salmon mean LC50
0.060[d]	Lake trout ELS CV [~60% reduction in juvenile standing crop][e]
0.057[d]	Bluegill sunfish CV [57% reduction in larval survival][f]
0.056	*Salmo mean* LC50
0.043	*Daphnia* mean EC50
0.041	Amphipod (*Gammarus pulex*) LC50
0.041[d]	White sucker ELS CV [100% early life-stage mortality][e]
0.038[d]	Rainbow trout ELS CV [100% early life-stage mortality][e]
0.033[d]	Caddisfly (*Clistornia magnifica*) CV [30% adult emergence][g]
0.029	*Daphnia magna* CV [unspecified effect][h]
0.024[d]	Brook trout CV [100% alevin mortality][i]
0.022[d]	Snails (*Physa integra* and *Campeloma decisum*) CVs [>90% reduction in survival][j]
0.019[d]	Fathead minnow CV [100% spawning inhibition][k]
0.018[d]	Acute NAWQC

Table F1.4 (continued)

Concentration (mg/L)	Effect[b]
0.012[d]	Chronic NAWQC
0.012[d]	Amphipod (*Gammarus pseudolimnaeus*) CV [>90% reduction in survival and fecundity][j]
0.005[d]	Bluntnose minnow CV [80% reduction in fecundity][l]
0.001[c]	Lowest plant value, growth lag in *Chlorella pyrenoidosa*

[a] LOEC = Lowest Observed Effect Concentration.
[b] LC = Lethal Concentration; CV = Chronic Value; EC = Effects Concentration; NAWQC = National Ambient Water Quality Criteria.
[c] Hardness unspecified.
[d] Corrected for a hardness of 100 mg/L.
[e] McKim et al. (1978).
[f] Benoit (1975).
[g] Nebeker et al. (1984).
[h] Chapman et al. n.d.
[i] McKim and Benoit (1971).
[j] Arthur and Leonard (1970).
[k] Mount (1968), Mount and Stephan (1969).
[l] Horning and Neiheisel (1979).

invertebrate taxa were found in one river with a sediment copper concentration of 62 mg/kg; although another Illinois river had a high number of taxa at 19.5 mg/kg and a low number of taxa at a concentration of 45 mg/kg (studies cited in Long and Morgan 1991).

Toxicity of Copper to Wildlife. Copper occurs naturally in elemental form and as a component of many minerals. It is an essential nutrient that is normally present in a wide variety of tissues (ATSDR 1990; EPA 1987). Because of its high electrical and thermal conductivity, it is widely used in the manufacture of electrical equipment. Common copper salts, such as the sulfate, carbonate, cyanide, oxide, and sulfide are used as fungicides, as components of ceramics and pyrotechnics, for electroplating, and for numerous other industrial applications (ACGIH 1986). The largest anthropogenic releases of copper to the environment result from mining operations, agriculture, solid waste, and sludge from sewage treatment plants. Natural discharges to air and water, such as windblown dust and volcanic eruptions, may be significant (ATSDR 1990).

Copper is a component of a number of metalloenzymes such as catalase, peroxidases, and cytochrome oxidase and is essential for the utilization of iron (Goyer 1991; Stokinger 1981). Although most copper salts occur in two valence states, as cuprous (Cu^{+}) or cupric (Cu^{2+}) ions, the biological availability and toxicity of copper is most likely associated with the divalent state (ATSDR 1990). Copper sulfate is the most common copper salt. Copper is soluble in nitric acid and hot sulfuric acid, very slightly soluble in hydrochloric acid and ammonia, and insoluble in water (Stokinger 1981).

The metabolism of copper involves mainly its transfer to and from various organic ligands, most notably sulfhydryl and imidazole groups on amino acids and proteins (ATSDR 1990). The liver is one of the main organs involved in the storage and metabolism of copper. Absorption of ingested copper

occurs primarily in the upper gastrointestinal tract (EPA 1987). Soluble copper compounds (oxides, hydroxides, citrates) are readily absorbed but water-insoluble compounds (sulfides) are poorly absorbed (Venugopal and Luckey 1978). Zinc, molybdenum, and other metals may decrease dietary copper absorption (USAF 1990).

In animal studies, oral exposure to copper caused hepatic and renal accumulation of copper, liver and kidney necrosis at doses of ≥100 mg/kg/day, and hematological effects at doses of 40 mg/kg/day (EPA 1986; Haywood 1985; Rana and Kumar 1978; Gopinath et al. 1974; Kline et al. 1971). Oral or intravenous administration of copper sulfate can increase fetal mortality and developmental abnormalities in experimental animals (Lecyk 1980; Ferm and Hanlon 1974). Rat oral LD_{50} values for various copper compounds are 140 mg/kg for copper chloride ($CuCl_2$); 470 mg/kg for copper oxide (Cu_2O); 940 mg/kg for copper nitrate ($Cu(NO_3)_2 \cdot 3H_2O$); and 960 mg/kg for copper sulfate ($CuSO_4 \cdot 5 H_2O$) (Stokinger 1981). Deaths in animals given lethal doses of copper have been attributed to extensive hepatic centrilobular necrosis (USAF 1990).

In a 90-day subchronic study with copper cyanide (CuCN), high mortality, attributed to hemolytic anemia, was seen in both male and female rats receiving 50 mg/kg/day by gavage, but not in those receiving ≤ 5 mg/kg/day (EPA 1986c). In general, male rats appeared to be more sensitive to the effects of CuCN than female rats. Rats receiving 500 ppm copper in their diet (about 5 mg/day) appeared normal, while rats receiving 1000 ppm exhibited depressed growth, those at 2000 ppm hardly grew at all, and those on a 4000 ppm diet lost weight rapidly and died (Boyden et al. 1938). Salt licks containing 5–9% copper sulfate caused anorexia, hemolytic anemia, icterus, and hemoglobinuria, followed by death within 2 days in sheep using the licks (Gopinath et al. 1974). The estimated ingested dose was 40–49 g over a 25- to 86-day period. Lecyk (1980) observed reduced litter size, decreased fetal weights, and skeletal abnormalities in the offspring of mice fed diets supplemented with 3000 or 4000 ppm copper sulfate (155 or 207 mg copper/kg/day, respectively) for one month prior to gestation and on days 0–19 of gestation.

Aulerich et al. (1982) reported an increased mortality rate in the offspring of minks fed a diet supplemented with >3 mg copper/kg/day as copper sulfate for 50 weeks. Although kit mortality was greater and litter mass was reduced relative to controls, reproductive performance of mink fed diets supplemented with up to 200 ppm copper for 357 days was within the normal range for the species (Aulerich et al. 1982). Lifetime exposure to 42.4 mg copper/kg/day (as copper gluconate) in drinking water caused a 12.8% decrease in the maximal lifespan in mice (Massie and Aiello 1984).

Domestic chicks on diets ≥324 ppm copper grew slowly; mortality increased with dietary copper concentrations of 1270 ppm (Mayo et al. 1956). Arthur et al. (1958) observed no ill effects in chicks fed ≤500 ppm copper in diet up to 8 weeks of age. Dietary copper levels from 588–1176 ppm for 10 weeks exerted a toxic effect on chick growth; the minimum toxic level of copper appeared to be about 500 ppm (Mehring et al. 1960). Turkey poults tolerated 676 ppm copper in starter diets for 21 days with no deleterious effects, but copper was definitely toxic at levels >1620 ppm (Vohra and Kratzer 1968). Chickens given a daily dose of >70 mg/kg of $CuCO_3$ died while those receiving <60 mg/kg exhibited slight symptoms of copper poisoning but survived (Pullar, 1940). No symptoms of copper poisoning were observed in domestic mallards ingesting ≤29 mg/kg/day of $CuCO_3$, but daily intakes ≥55 mg/kg/day were toxic (Pullar 1940).

F1.1.9 Iron

Toxicity of Iron in Water to Aquatic Life. Because iron is the fourth most abundant element in the earth's crust, it commonly occurs at high concentrations in whole water analyses. Dissolved

concentrations in water are dependent on redox conditions and pH. The most common dissolved inorganic form of iron is $Fe(OH)_2^+$ (Dave 1984). Toxicity of iron to aquatic organisms has received little attention because it is observed in unusual circumstances such as acid mine drainage or discharge of acidic metal working wastes.

Iron is acutely toxic to freshwater fish and invertebrates at concentrations ranging from 300 µg/L to 2000 µg/L (Train 1979, cited in Dave 1984). Reproduction of *Daphnia magna* was stimulated at concentrations up to 1 µg/L, and reproduction and survival were inhibited by iron at 158 µg/L and 256 µg/L, respectively (Dave 1984). This is considerably lower than the 4,380 µg/L concentration causing 16% reproductive decrement in another test with *Daphnia magna* (Biesinger and Christensen 1972). Dave argued that his result was more applicable to a situation in which "an acidic iron-containing waste water is discharged into a lake or a river" where it is neutralized, but Biesinger and Christensen's (1972) result "is probably more close to the steady-state situation in natural freshwater without any point source of iron." Survival of brown trout alevin (swim-up fry) and eyed-eggs was reduced at an average iron concentration of 5170 µg/L (Geertz-Hansen and Mortensen 1983).

Toxicity of iron to aquatic plants was not reported. Bioconcentration factors and toxicities of body burdens were also not determined for iron. The chronic NAWQC for freshwater aquatic life of 1000 µg/L is not based on the standard method for criteria derivation. Rather, it is based on effects observed at acid mine drainage sites.

Toxicity of Iron in Sediments to Benthic Organisms. There is minimal information on the toxicity of iron in sediment to benthic invertebrates. However, Hull and Suter (1994) describe sediment criteria which are utilized as screening benchmarks. The Ontario Ministry of the Environment (MOE) has prepared provincial sediment quality guidelines (SQGs). These values are based on Ontario sediments and benthic species from a wide range of geographical areas within the province. The lowest effect level (low) is the level at which actual ecotoxic effects become apparent. The severe effects level (severe) represents contaminant levels that could potentially eliminate most of the benthic organisms. These "low" and "severe" effects levels are 3% (30,000 mg/kg) and 4% (40,000 mg/kg), respectively (Hull and Suter 1994).

Beak Consultants in Canada also developed potential SQGs for Ontario MOE using the background approach. A SQG of 5.9% (59,000 mg/kg) represents a background level to which the site contaminant concentration should be compared. This sediment guideline is not based on/or related to biological effects (Hull and Suter 1994).

The EPA Region V Sediment Classification guidelines are for sediments of Great Lakes Harbors. The "polluted" values ranging from 17,000-25,000 mg/kg are qualified as being "moderately polluted" in the guidelines. The Region V values are poorly founded scientifically and are considered adequate only for determining the suitability of dredged material for open water disposal (Hull and Suter 1994).

F1.1.10 Lead

Toxicity of Lead in Water to Aquatic Life. Although lead occurs in a variety of forms in the aquatic environment, the relative toxicities of these forms are not well defined (EPA 1985-Pb). Acute and chronic lead toxicity increases as hardness decreases (EPA 1985-Pb). Therefore, the lead toxicity values presented in Table F1.5 that are not from tests conducted in waters of moderate hardness (within the range found in the Clinch River) are normalized to 100 mg/L using the slopes calculated by the EPA (1985-Pb). Bioconcentration was observed in four invertebrate and two fish species with concentration factors ranging from 42 to 1700. Toxicities of body burdens were not determined. The acute and chronic NAWQC for lead are 0.082 mg/L and 0.0032 mg/L at a hardness of 100 mg/L as $CaCO_3$.

Toxicity of Lead in Sediment to Benthic Organisms. Although a relatively large amount of data exists for lead and measures of effects in sediments, there are no spiked sediment bioassays and there is a wide concentration range associated with effects (Long and Morgan 1991). Also, freshwater biota may be more sensitive to lead than marine species (Eisler 1988).

Significant effects were observed in *Daphnia magna* exposed to Keweenaw Waterway sediments containing 27 mg/kg lead. Taxa richness of macroinvertebrate communities in the Kishwaukee River were reduced in sediments containing 31 mg/kg and taxa-rich in sediment containing 21 mg/kg. Significant toxicity to *D. magna* and *H. limbata* was observed at 110 mg/kg in sediments of Torch Lake, Michigan (studies cited in Long and Morgan 1991).

Table F1.5. Toxicity of lead to aquatic animals

Concentration (mg/L)	Effect[a]
784	Goldfish (*Carassius auratus*) LC50
600	Midge (*Tanytarsus dissimilis*) LC50
513	Guppy (*Poecilia reticulata*) LC50
14	Brook trout (*Salvelinus fontinalis*)LC50
12	Rainbow trout (*Oncorhynchus mykiss*) LC50
10	Bluegill (*Lepomis macrochirus*) LC50
6	Snail (*Aplexa hypnorm*) LC50
5	Fathead minnow (*Pimephales promelas*) LC50
0	Rainbow trout (*Oncorhynchus mykiss*) CV
0	Amphipod (*Gammarus pseudolimnaeus*) LC50
0	Cladoceran (*Daphnia magna*) EC50
0	Brook trout (*Salvelinus fontinalis*) CV
0	Cladoceran (*Daphnia magna*) CV
0	Rainbow trout (*Oncorhynchus mykiss*) CV
0	Acute NAWQC
0	Cladoceran (*Daphnia magna*) CV
0	Cladoceran (*Daphnia magna*) CV
0	Snail (*Lymnaea palustris*) CV
0	Chronic NAWQC

[a]LC = Lethal Concentration; CV = Chronic Value; EC = Effects Concentration; NAWQC = National Ambient Water Quality Criteria.

F1.1.11 Manganese

Toxicity of Manganese in Water to Aquatic Life. There is evidence that manganese occurs in surface waters both in suspension in the quadrivalent state and in the trivalent state in a relatively stable, soluble complex (APHA 1989). Comparatively little is known about the toxicity of manganese (Kimball date unknown).

Acute and chronic toxicity tests using fathead minnows and *Daphnia magna* were conducted in relatively hard water. Acute toxicity values for manganese ranged from 17.48 mg/L for *D. magna* to 33.80 mg/L for fathead minnow. Manganese toxicity was increased by the presence of food during the *D. magna* acute toxicity tests. Chronic toxicity values ranged from <1.10 mg/L for *D. magna* to 1.77 mg/L for fathead minnows.

Toxicity of manganese to aquatic plants was not reported. Bioconcentration factors and toxicities of body burdens were also not determined for manganese. There are no NAWQC for manganese.

Toxicity of Manganese in Sediment to Benthic Organisms. Very little sediment toxicity information is available for manganese. The Ontario Ministry of the Environment has estimated that most benthic organisms in that region will not be adversely affected by concentrations of 460 mg/kg, which is consistent with the Great Lakes pre-colonial sediments background level of 400 mg/kg. A concentration of 1,110 mg/kg is estimated to be toxic to most benthic organisms (Persaud et al. 1990).

Toxicity of Manganese to Wildlife. Manganese makes up about 0.10% of the earth's crust and is the 12th most abundant element (NAS 1980). It can exist in oxidation states from -3 to +7, the most common being +4 in the chemical form of manganese dioxide (Keen and Leach 1988). The oxides and peroxides are used in industry as oxidizers, and the metal is used for manufacturing metal alloys to increases hardness and corrosion resistance. In living systems, manganese is an essential element that is found most often in the +2 valence state.

Normal nutritional requirements of manganese are satisfied through the diet, which is the normal source of the element, with minor contributions from water and air. Manganese is absorbed throughout the intestinal tract. It can elicit a variety of serious toxic responses upon prolonged exposure to elevated concentrations either orally or by inhalation. The central nervous system is the primary target. Manganese and iron are mutually antagonistic; therefore, animals with low iron intake are more sensitive to manganese toxicity (NAS 1980).

Effects on reproduction (decreased fertility, impotence) have been observed in humans with inhalation exposure and in animals with oral exposure at the same or similar doses that initiate the central nervous system effects.

In a 120-day study, Grummer et al. (1955) suggested that the critical level of manganese required by growing pigs was approximately 12–20 ppm. There were no significant differences in reproductive performance among sows fed a diet supplemented with 40, 80, or 160 ppm manganese (Grummer et al. 1955), but addition of 500 ppm manganese to the diet slowed growth and caused stiffness of limbs. Swine may be somewhat more sensitive than other mammals; ingesting excess manganese at levels as high as 1000 ppm resulted in metabolic deviations but almost no effects on growth or other indicators of toxicosis in most experiments were reported in NAS (1980). Cunningham et al. (1966) suggested that the minimum toxic level of manganese was between 820 and 2460 ppm based on 84-day experiments with calves, but they noted the influence of decreased food intake at higher levels of manganese. In a second study controlling daily feed intake, no significant differences in average daily weight gain were

observed in calves on diets containing up to 3000 ppm manganese (Cunningham et al. 1966). Adverse effects are more commonly observed at levels >2000 ppm (NAS 1980). When pregnant rats were fed a diet with 3550 ppm manganese beginning at day 2 of gestation, their offspring, fed the same diet to age 225 days, exhibited decreased fertility (Laskey et al. 1982).

Diets containing 1000 mg/kg of manganese as manganese carbonate fed to chicks for 20 weeks caused no adverse effects (Gallup and Norris 1939). Assuming a body weight of 0.556 kg (Opresko et al. 1994) and a daily ingestion rate of 0.04 kg [from the allometric relationship described by Nagy (1987)], the dietary concentration would be equivalent to a dose of 72 mg/kg-day. Turkey poults tolerated manganese levels of 3600 ppm in starter diets for 21 days with no deleterious effects, but growth depression was observed at 4800 ppm (Vohra and Kratzer 1968). Gallup and Norris (1939) concluded that a minimum of 30–50 ppm manganese in the diet would be necessary to prevent perosis, a disease involving manganese deficiency, depending on the breed of chicken studied.

Toxicity of Manganese in Soil to Plants. Manganese occurs in relatively high concentrations in soils as oxides and hydroxides, nodules, and coatings on other soil particles. These forms are not readily available to plants. Manganese is essential for plant growth. It is involved in N assimilation, as a catalyst in plant metabolism, and functions with Fe in the synthesis of chlorophyll (Labanauskas 1966). Toxicity symptoms include marginal chlorosis and necrosis of leaves, and root browning. Excess Mn interferes with enzymes, decreases respiration, and is involved in the destruction of auxin (Foy et al. 1978). Growth of beans was reduced 29% by the addition of 500 ppm Mn to soil (Wallace et al. 1977a). Wong and Bradshaw (1982) measured a 70% reduction in root length of ryegrass in response to 0.75 ppm in solution. The benchmark for Mn in soil is 500 ppm, and in solution, 4 ppm.

F1.1.12 Mercury

Toxicity of Mercury in Water to Aquatic Life. Mercury in the environment commonly occurs as mercury (II) and methylmercury (EPA 1985-Hg). Elemental mercury is oxidized to mercury (II) under natural conditions, and mercury (II) can be methylated by both aerobic and anaerobic bacteria. Mercury (II) can also be methylated in the slime coat, liver, and intestines of fish, but methylation apparently does not occur in other tissues or in plants. Numerous factors such as alkalinity, ascorbic acid, chloride, dissolved oxygen, hardness, organic complexing agents, pH, sediment, and temperature probably affect the acute and chronic toxicity and bioaccumulation of the various forms of mercury. Because methyl mercury was not detected in water the summary of mercury toxicity data includes only inorganic mercury (Table F1.6).

Toxicity of Mercury in Sediment to Benthic Organisms. Sediments from the Little Grizzly Creek system in California, which had 0.8 to 3.5 (mean 1.5) mg/kg mercury and an organic carbon content of approximately 1%, caused greater than 90% mortality in *Daphnia magna* and *Hexagenia limbata* (mayfly larva) (Maleug et al, 1984). A Michigan lake sediment in the same study, with an organic carbon content of 2.2% and mercury concentration of 0.29 mg/kg, caused 100% mortality in *D. magna* and 40% mortality in *H. limbata*. However, sediments from the Phillips Chain of Lakes in Wisconsin, with mercury concentrations from 0.8 to 9.4 mg/kg, resulted in less than 20% mortality in both species. These sediments had a high organic carbon content of approximately 15% (studies cited in Long and Morgan 1991).

Sediments from Waukegan Harbor, Illinois, with a mercury concentration of 0.1 mg/kg resulted in 34% mortality to *Hyalella azteca*. A study of benthic macroinvertebrate communities in Illinois rivers conducted by the Illinois Environmental Protection Agency found that the lowest number of benthic

Table F1.6. Aqueous concentrations of mercuric chloride causing effects on freshwater aquatic biota

Concentration (mg/L)	Effect[a]
2.00	Mayfly (*Ephemerella subvaria*) LC50
2.00	Stonefly (*Acroneuria lycorias*) LC50
2.00	Caddisfly (*Hydropsyche betteni*) LC50
1.00	Mozambique tilapia (*Tilapia mossambica*) LC50
0.500	Tubificid worm (*Spirosperma nikolskyi*) LC50
0.370	Snail (*Aplexa hypnorum*) LC50
0.330	Tubificid worm (*Spirosperma ferox*) LC50
0.275	Rainbow trout (*Oncorhynchus mykiss*) LC50
0.250	Tubificid worm (*Quistadrilus multisetosus*) LC50
0.240	Tubificid worm (*Rhyacodrilus montana*) LC50
0.240	Coho salmon (*Oncorhynchus kisutch*) LC50
0.180	Tubificid worm (*Limnodrilus hoffmelsteri*) LC50
0.180	mosquitofish (*Gambusia affinis*) LC50
0.160	bluegill (*Lepomis macrochirus*) LC50
0.159	fathead minnow (*Pimephales promelas*) LC50
0.140	Tubificid worm (*Stylodrilus heringianus)* LC50
0.140	Tubificid worm (*Tubifex tubifex*) LC50
0.100	Tubificid worm (*Varichaeta pacifica*) LC50
0.080	Tubificid worm (*Branchiura sowerbyi*) LC50
0.050	Crayfish (*Orconectes limosus*) LC50
0.030	guppy (*Poecilla reticulata)*LC50
0.020	Crayfish (*Faxonella clypeatus*) LC50
0.00316	Cladoceran (*Daphnia magna*) EC50
0.00243	acute NAWQC (Hg^{++})
0.00222	Cladoceran (*Daphnia pulex*) EC50
0.00130	final chronic value (Hg^{++})
0.00111	Cladoceran (*Daphnia magna*) CV
0.00024	fathead minnow (*Pimephales promelas*) CV

[a] LC = Lethal Concentration; EC = Effects Concentration; NAWQC = National Ambient Water Quality Criteria;b CV = Chronic Value.

macroinvertebrate taxa occurred at a site with 1.6 mg/kg mercury, while the highest number of taxa occurred at a site with 0.3 mg/kg mercury (studies cited in Long and Morgan 1991).

ER-L and ER-M values are 0.15 mg/kg and 0.71 mg/kg, respectively. Biological effects were observed in only 42% of the documented studies with concentrations greater than the ER-M (Long et al. 1995).

Toxicity of Mercury to Wildlife. Mercury has no known biological function and is potentially toxic to fish and wildlife. Mercury is a mutagen, teratogen, and carcinogen that adversely affects the central nervous, renal, and reproductive systems of wildlife (Eisler 1987). Inorganic mercury compounds in aquatic systems are readily converted to organomercury by microbial action (Berlin 1979), with organomercury compounds being more toxic than inorganic mercury compounds. Biota bioconcentrate mercury compounds can be further biomagnified through food chains (Wren 1986).

Daily doses of 0.1–0.5 mg/kg bw/day and dietary concentrations of 1.0–5.0 ppm are lethal to sensitive mammals (Eisler 1987). Central nervous system toxicity, weight loss, and mortality were observed among rats fed a diet containing 250 ppm methyl mercury (MeHg) for 2 weeks (Verschuuren et al. 1976a). Rats consuming 2.5 ppm MeHg in the diet for 2 years displayed reduced growth, increased kidney weight, and altered kidney histochemistry (Verschuuren et al. 1976b). To study effects on reproduction, Verschuuren et al. (1976c) fed rats a diet containing 0, 0.1, 0.5, and 2.5 ppm MeHg for three generations. While no effects were observed among rats fed 0.1 or 0.5 ppm MeHg, offspring viability was reduced among rats in the 2.5 ppm treatment. Among mink, 93-day consumption of diets containing 1.8 to 15.0 ppm MeHg produced mortality, ataxia, anorexia, and paralysis (Wobeser et al. 1976), with the highest exposures showing the greatest effects.

The LD_{50} for MeHg for *Coturnix* quail ranges from 14.4 to 33.7 mg/kg bw (Eisler 1987). Growth was decreased and mortality increased among leghorn cockerels fed diets containing 6 to 18 ppm MeHg (Fimreite 1970). Ring-necked pheasants fed diets of MeHg-treated grains displayed reduced egg production and hatchability and laid more shell-less eggs than controls (Fimreite 1971). Heinz (1979) fed mallard ducks a diet containing 0.5 ppm MeHg for three generations. While MeHg consumption did not affect adult weights or weight change during the reproductive season, MeHg-exposed females laid fewer eggs (with more eggs outside the nest box), produced fewer young, and displayed slightly thinner eggshells. Young of MeHg-treated adults were less responsive to maternal calls and hyper-responsive to fright stimuli.

Toxicity of Mercury in Soil to Plants. Mercury in soil is strongly associated with organic matter, and to a lesser extent, clay and Fe and Mn oxides. In general, little Hg is found in soil solution available to plants. Mercury and its compounds taken up by roots are translocated to only a limited extent in plants. Organic forms of Hg may be translocated to a greater degree than inorganic forms in some plants (Huckabee and Blaylock 1973). Gay (1975) reports that pea plants form methylmercury as an intermediate product from Hg added to the soil in organic and inorganic forms. There was no primary reference data describing toxicity of Hg to plants grown in soil. Kloke (1979) report unspecified toxic effects on plants grown in a surface soil with the addition of 0.3 ppm Hg and this has been chosen as the benchmark concentration for all mercury species (inorganic and organic) in soil.

F1.1.13 Molybdenum

Toxicity of Molybedenum to Soil to Plants. Molybdenum is required for symbiotic N_2 fixation by legumes and for growth of nonleguminous plants. The most important functions of molybdenum in plants are related to enzymes active in N metabolism (activation of nitrogenase and nitrate reductase).

The majority of molybdenum taken up by the root system tends to remain in the roots, although significant amounts may be translocated to the shoots in some cases (Wallace and Romney 1977a). Toxicity symptoms include chlorosis, apparently due to interference with Fe metabolism (Warington 1954).

F1.1.14 Nickel

Toxicity of Nickel in Water to Aquatic Life. Although nickel can exist in several oxidation states, the divalent cation state predominates and is generally considered the most toxic form (EPA 1986-Ni). As with many metals the toxicity of nickel increases as hardness decreases. Fish and invertebrates have approximately the same range of sensitivity. Nickel bioconcentration factors range from 0.8 for fish muscle to 193 for a cladoceran. Toxic effects of nickel are summarized in Table F1.7.

Table F1.7. Aqueous concentrations of nickel causing effects on freshwater aquatic biota at hardness equivalent to Clinch River and Poplar Creek

Concentration (mg/L)[a]	Effect[b]
77.7	banded killifish (*Fundulus diaphanus*) LC50
72.7	stonefly (*Acroneuria lycorias*) LC50
54.3	caddisfly LC50
38.3	goldfish (*Carassius auratus*) LC50
38.1	damselfly LC50
25.3	Worm (*Nals* sp.) LC50
24.1	rainbow trout (*Oncorhyncus mykiss*) LC50
23.4	amphipod (*Gammarus* sp.) LC50
23.3	white perch (*Morone americana*) LC50
23.0	snail (*Amnicola* sp.) LC50
21.9	American eel (*Anguilla rostrata*) LC50
19.4	bluegill (*Lepomis macrochirus*) LC50
17.6	common carp (*Cyprinus carpio*) LC50
17.4	guppy (*Poecilla reticulata*) LC50
14.3	fathead minnow (*Pimephales promelas*) LC50
13.6	pumpkinseed (*Lepomis gibbosus*) LC50
12.2	striped bass (*Morone saxatillis*) LC50
8.33	Mayfly (*Ephemerella subvaria*) LC50
7.75	rock bass (*Ambioplites rupestris*) LC50
3.67	*Daphnia pulicaria* EC50
2.50	*Daphnia magna* EC50
1.42	acute NAWQC
0.502	fathead minnow (*Pimephales promelas*) CV
0.231	Caddisfly (*Clistoronia magnifica*) CV
0.162	rainbow trout (*Oncorhynchus mykiss*) CV
0.158	chronic NAWQC

Table F1.7 (continued)

Concentration (mg/L)[a]	Effect[b]
0.0809 0.0106	*Daphnia magna* CV *Ceriodaphnia dubia* CV [100% mortality]
0.0106	*Ceriodaphnia dubia* CV[c]

[a] Effect levels were converted based on a 100 mg/L water hardness. Slopes used for the conversion were associated with individual species, where specified in the Criteria document. Otherwise, 0.846 was the slope for both acute and chronic test conversions.

[b] LC = Lethal Concentration; EC = Effects Concentration; NAWQC = National Ambient Water Quality Criteria; CV = Chronic Value.

[c] Seven day test at 117 mg/L hardness from Kszos et al. (1992).

Toxicity of Nickel in Sediment to Benthic Organisms. No information is available from spiked sediment toxicity tests for nickel; data are only from field studies (Long and Morgan 1991). In sediments of Lake Union, Washington, 88 mg/kg resulted in 95% mortality of *Hyalella azteca* (Long and Morgan 1991). Sediments with between 22 and 63 (mean of 40) mg/kg nickel from the Little Grizzly Creek system in California caused greater than 90% mortality in *Daphnia magna* and *Hexagenia limbata* (Maleug et al. 1984). This lake had an organic carbon content of 1%. A Michigan lake sediment in the same study, with an organic carbon content of 2.2% and a nickel concentration of 150 mg/kg, caused 100% mortality in *D. magna* and 40% mortality in *H. limbata*. However, sediments from the Phillips Chain of Lakes in Wisconsin, with a high organic carbon content of approximately 15% and nickel concentrations from 140 to 350 mg/kg, resulted in less than 20% mortality in both species (studies cited in Long and Morgan 1991).

ER-L and ER-M values are 20.9 mg/kg and 51.6 mg/kg, respectively. A relatively low percentage (17%) of the documented studies in Long et al (1995) indicated an incidence of biological effects at concentrations greater than the ER-M.

Toxicity of Nickel in Soil to Plants. Nickel is not generally considered to be an essential element for plants. However, it may be required by nodulated legumes for internal N transport as part of the urease enzyme (Aller et al. 1990). It is generally adsorbed as the Ni(II) ion and translocated in xylem and phloem with an organic chelate (Hutchinson 1981). Nickel is fairly uniformly distributed between roots and shoots (Wallace and Romney 1977a). Symptoms of Ni toxicity are generally Fe-deficiency induced chlorosis and foliar necrosis (Khalid and Tinsley 1980). Excess nickel affects nutrient absorption by roots, root development, and metabolism, and it inhibits photosynthesis and transpiration. Nickel can replace Co and other heavy metals located at active sites in metallo-enzymes and disrupt their functioning.

A limited number of studies have evaluated the effects of Ni on oak, rye grass, corn, cotton, and beans. Dixon (1988) measured a 30% weight reduction of red oak seedlings grown for 16 weeks in a sandy loam soil (pH 6, % organic matter 1.5) with addition of 50 ppm Ni ($NiCl_2$) (no effect at 20 ppm Ni). Oats grown from seed for 110 d in the presence of 50 ppm Ni (as $NiCl_2$) in soil (pH 6.1, % organic matter 1.4) had reductions of 38 and 63% in grain and straw weight (Halstead et al. 1969). In a second soil (pH 5.7, % organic matter 4.1) only straw weight was reduced (45%) by addition of 100 ppm Ni (50 ppm had no effect). Traynor and Knezek (1973) measured a 21% reduction in corn plant weight with the addition of 294 ppm Ni (as $NiCl_2$) to a sandy soil (pH 5, % organic matter 2) in which the plants had been grown for 5 weeks from seed. Addition of 220 ppm had no effect.

Wallace et al. (1977b) report the results of experiments on the effects of Ni (as $NiSO_4$) on seedlings of a variety of plants grown in a loam soil at several pHs. Corn grown in soil at pH 4.2, 5.6, and 7.5 experienced 74, 80, and 50% reductions in shoot weight after 14 days growth with the addition of 250 ppm Ni. Ni at 100 ppm had no effect. At pH 5.8, bush beans grown for 16 days had a 64% reduction in shoot weight with the addition of 100 ppm (lowest concentration tested). At pH 7.5, a 36% reduction in plant weight occurred with 250 ppm Ni, while 100 ppm had no effect. After 28 days growth in a loam soil at pH 5.8, bush bean leaf weight was reduced 45% by the addition of 100 ppm Ni, while 25 ppm had no effect. For barley under these same growth conditions, 25 ppm Ni (lowest concentration tested) reduced shoot weight 88%.

F1.1.15 Selenium

Toxicity of Selenium to Wildlife. While selenium is an essential nutrient that interacts with Vitamin E and maintains muscle integrity, it has a very narrow tolerance range; in humans, while 0.04–0.1 ppm is required in diet, 4 ppm may produce toxic effects (Eisler 1985b). In mammals, chronic selenium poisoning is induced by diets containing 1–44 ppm selenium (Harr 1978). Symptoms include liver cirrhosis, lameness, loss of hair, emaciation, reduced conception, and increased fetal resorption. Plants convert inorganic selenium to organic selenium compounds, thereby increasing their biological availability (Lo and Sandi 1980).

To evaluate the effects of selenium on reproduction, Schroeder and Mitchner (1971) exposed mice to 3 ppm selenate in drinking water for three generations. This dosage level increased juvenile mortality, number of runts, and resulted in reproductive failure by the third generation. In another study, exposure to 3 ppm selenate or selenite in water for a lifetime had no effect on mouse longevity and no tumorigenicity was observed (Schroeder and Mitchner 1972).

Selenium is both embryotoxic and teratogenic to birds, with organic selenium (selenomethionine) being more toxic than inorganic selenium (Hoffman and Heinz 1988). Mallard ducks were fed diets containing 1, 5, 10, 25, or 100 ppm selenite (Heinz et al. 1987) or 1, 2, 4, 8, or 16 ppm selenomethionine (Heinz et al. 1989) for about 10 weeks. Exposure to 1, 5, or 10 ppm selenite or 1, 2, or 4 ppm selenomethionine in the diet had no effect on survival, growth, or reproductive success of adults. The diet containing 100 ppm selenite killed 11 of 12 adults. While only one adult receiving the 25 ppm diet died, time to laying and interval between eggs was increased, and duckling survivorship was reduced in this treatment (Heinz et al. 1987). Diets containing 8 and 16 ppm selenomethionine resulted in 6.8% and 67.9% malformed embryos, respectively. In addition, duckling survival was significantly reduced (Heinz et al. 1989).

The most visible incident of environmental selenium toxicity occurred at the Kesterson National Wildlife Refuge in California. Agricultural wastewater containing approximately 0.3 ppm selenium was used for marsh management at the refuge (Ohlendorf et al. 1986). Mean selenium concentrations in plants, invertebrates, and fish at the site were 22–175 ppm (dry weight). As a result, reproductive success among water birds was poor, and the incidence of embryo mortality and developmental abnormalities was dramatically increased. Raccoons on the refuge were found to bioaccumulate selenium (Clark et al. 1989). While peak births at the refuge was 2 months later than reported at other locations, no adverse effects on raccoon reproduction were observed.

Metabolism of selenium may be significantly modified through interactions with heavy metals, and selenium may provide some protection from adverse effects associated with various metals, including cadmium and mercury (Eisler 1985b). Arsenite inhibits methylation of selenium but increases fecal excretion of selenite (Venugopal and Luckey 1978).

Toxicity of Selenium in Soil to Plants. Selenium is not proven to be essential for plant growth. It is absorbed by plants as selenite (IV), selenate (VI), or in organic form and the selenate may be the more toxic. It is believed that selenate is taken up actively, while selenite uptake is largely passive (Peterson et al. 1981). Selenium is translocated to all parts of the plant, including the seed, in low molecular weight compounds (Broyer et al. 1972). Toxicity symptoms include chlorosis, stunting and yellowing of the leaves. The mechanism of toxicity is thought to be indiscriminate replacement of S by Se in proteins and nucleic acids with disruptions in metabolism (Trelease et al. 1960). Wan et al. (1988) measured 30 to 85% reductions in shoot weight of alfalfa grown in soils containing 1.5 ppm Se. Shoot weights of alfalfa (Soltanpour and Workman 1980) and sorghum (Carlson et al. 1991) were reduced approximately 25–90% and 55% by 2 and 1 ppm Se in various soils. The benchmark for Se in soil is 1 ppm.

F1.1.16 Silver

Toxicity of Silver in Water to Aquatic Life. Toxicity of silver to freshwater fish and invertebrates is dependent on water hardness and chloride content, with silver being more toxic in soft and low chloride water (EPA 1980-Ag). Toxicity of silver is dependent upon the form of the element. In tests with fathead minnow, free silver ion is the form of silver most acutely toxic to fish, with a 96-h LC_{50} of 0.016 mg/L, followed by silver thiosulfate complex (280-360 mg/L), and silver sulfide (>240 mg/L). The aqueous toxicity of silver is summarized in Table F1.8.

Toxicity of Silver in Sediment to Benthic Organisms. Effects were not observed in association with silver concentrations less than approximately 0.6 mg/kg (Long and Morgan 1991). No data were available for freshwater systems. At concentrations of 2.1 to 2.6 mg/kg in marine systems, there was an absence of *Macoma balthica* in Fraser River sediments, low arthropod abundance and low species richness in southern California benthos, and increased burrowing time of *M. balthica* exposed to Strait of Georgia sediments (studies cited in Long and Morgan 1991).

ER-L and ER-M values are 1.0 mg/kg and 3.7 mg/kg, respectively. A high percentage (92.8%) of the documented studies in Long et al (1995) indicated an incidence of biological effects at concentrations greater than the ER-M.

Toxicity of Silver in Soil to Plants. Silver taken up by plants remains in the root system precipitated with phosphate or chloride (Ward et al. 1979). The toxicity of Ag is related to the binding potential of Ag^+ ions to enzymes and other active molecules at cell surfaces (Cooper and Jolly 1970).

There was no primary reference data showing toxicity of Ag to plants grown in soil. Linzon (1978) reported unspecified toxic effects on plants grown in a surface soil with the addition of 2 ppm Ag.

F1.1.17 Thallium

Toxicity of Thallium to Wildlife. Thallium is a widely distributed metal, occurring at concentrations of approximately 1 ppm in the earths crust (Kazantzis 1979). Principal systems affected by Tl exposure include nervous and digestive; renal damage and hair loss have also been observed. Thallium sulfate, which has been widely used as a rodenticide, has an acute oral LD_{50} of 16 mg/kg (Ware 1978). In chronic studies, rats tolerated a dose of 10 mg Tl acetate/ kg, while 30 mg/kg was lethal to males by 15 weeks. All rats fed a daily dose of 0.45 mg Tl/kg died after 4 months (Kazantzis 1979). Rats exposed to 10 ppm Tl in drinking water for 2 mo accumulated Tl in testis and exhibited signs of testicular toxicity including reduced sperm motility (Formigli et al. 1986).

Table F1.8. Aqueous concentrations of silver causing effects on freshwater aquatic biota at hardness equivalent to Clinch River and Poplar Creek

Concentration (mg/L)[a]	Effect[b]
15.9	scud (*Gammarus pseudolimnaeus*) LC50
15.2	rotifer (*Philodina acuticornis*) LC50
11.3	midge (*Tanytarsus dissimilis*) LC50
0.309	bluegill (*Lepomis macrochirus*) LC50
0.046	rainbow trout (*Oncorhynchus mykiss*) LC50
0.0339	flagfish (*Jordanella floridae*) LC50
0.0271	fathead minnow (*Pimephales promelas*) LC50
0.011	mottled sculpin (*Cottus bairdi*) LC50
0.0106	speckled dace (*Rhinichthys osculus*) LC50
0.00791	cladoceran (*Daphnia magna*) CV
0.00683	cladoceran (*Daphnia magna*) EC50
0.0041	NAWQC acute value
0.0012	rainbow trout (*Oncorhynchus mykiss*) CV

[a] Acute effect levels were converted based on a 100 mg/L water hardness. Slopes used for the conversion were associated with individual species, where specified in the Criteria document. Otherwise, 1.72 was used. Chronic values were not converted based on water hardness because no correlation was evident. A chronic NAWQC has not been determined.
[b] LC = Lethal Concentration; CV = Chronic Value; EC = Effects Concentration; NAWQC = National Ambient Water Quality Criteria.

Bean and Hudson (1976) orally dosed 3 golden eagles with 60 and 120 mg Tl_2SO_4/kg bw; the bird receiving 60 mg Tl_2SO_4/kg survived while the two dosed with 120 mg Tl_2SO_4/kg died, suggesting an LD_{50} between the doses. Oral LD_{50}'s for quail, geese, and ducks are 12, 15, and 30 mg/kg, respectively (Shaw 1933). No long-term studies of thallium toxicity to birds are currently available.

F1.1.18 Uranium

Toxicity of Uranium in Water to Aquatic Life. Relatively little aquatic toxicity data are available for uranium. The only standard data are LC50s for fathead minnow with values for various uranium salts ranging from 2.8 to 135 mg/L (Cushman et al. 1977). Toxic concentrations from nonstandard and poorly documented tests fall within this range.

Toxicity of Uranium in Soil to Plants. Uranium exists in the water-soluble fraction of plant tissue, probably as the uranyl ion and bound to cell wall proteins (Whitehead et al. 1971). The mechanisms of U phytotoxicity involve inhibition of enzyme systems and possibly binding to nucleic acids (Feldman et al. 1967). The minimal amount of radiation measured in the experimental plants has led researchers to the conclusion that toxic effects are the result of the element rather than radiation (Sheppard et al. 1983). Sheppard et al. (1983) grew swiss chard in a sandy (pH 6.4) and a peaty (pH 3, % organic matter 92) soil to test the effects of ^{238}U added as uranyl nitrate $[UO_2(NO_3)_2]$. In the sandy soil, root weight was

reduced 23% by 5 ppm U (lowest concentration tested), while shoot weight was not affected. In the peaty soil, root weight was reduced 44% by 10 ppm U (lowest concentration tested), while shoot weight was not affected.

F1.1.19 Vanadium

Toxicity of Vanadium to Wildlife. Vanadium is a metallic element that occurs in six oxidation states and numerous inorganic compounds. The toxicity of vanadium depends on its physico-chemical state, particularly on its valence state and solubility. Based on acute toxicity, pentavalent NH_4VO_3 has been reported to be more than twice as toxic as trivalent VCl_3 and more than 6 times as toxic as divalent VI_2. Pentavalent V_2O_5 has been reported to be more than 5 times as toxic as trivalent V_2O_3 (Roshchin 1967). In animals, acutely toxic oral doses cause vasoconstriction, diffuse desquamative enteritis, congestion and fatty degeneration of the liver, and congestion and focal hemorrhages in the lungs and adrenal cortex (Gosselin et al. 1984). Minimal effects seen after subchronic oral exposures to animals include diarrhea, altered renal function, and decreases in erythrocyte counts, hemoglobin, and hematocrit (Domingo et al. 1985; Zaporowska and Wasilewski 1990).

A vanadyl sulfate concentration of 5 μg/mL in drinking water, plus a vanadium level of 3.2 μg/g in the diet (4.1 mg V/kg total) of mice, was reported to cause no adverse effects over a lifetime exposure period (Schroeder and Balassa 1967). In similar lifetime studies, rats and mice exhibited no adverse effects when exposed to 5 ppm vanadium (as vanadyl sulfate) in drinking water (Schroeder et al. 1970; Schroeder and Mitchner 1975b). The estimated dose levels were 0.7 mg V/kg/day for rats and 0.9 mg V/kg/day for mice. Vanadium pentoxide in the diet of rats at levels of 10 and 100 ppm for their entire lifetime resulted in no significant toxicological effects except for a reduction in hair cystine content (Stokinger 1981).

White and Dieter (1978) observed no mortality among mallard ducks fed diets containing 1, 10, or 100 ppm vanadyl sulfate for 12 weeks. Altered lipid metabolism was observed among birds fed 100 ppm vanadium; no other effects were observed. Among chickens, 200 to 400 ppm $Ca_2(VO_4)_2$ in the diet produced 100% mortality; weight gain decreased among chicks fed 20 to 40 ppm $Ca_2(VO_4)_2$ (Romoser et al. 1961).

Toxicity of Vanadium in Soil to Plants. Vanadium is not known to be essential for plant growth, although it may be involved in N_2 fixation in nodules of legume roots. Toxicity symptoms include chlorosis, dwarfing, and inhibited root growth (Pratt 1966). Vanadium inhibits various enzyme systems while stimulating others, the overall effect on plant growth being negative (Peterson and Girling 1981). After uptake, it remains in the root system in insoluble form with Ca (Wallace and Romney 1977a). There was no primary reference data describing toxicity of V to plants grown in soil. Kloke (1979) reports unspecified toxic effects on plants grown in a surface soil with the addition of 50 ppm V. Vanadium added at a concentration of 2.5 ppm was toxic to plants in a study reported by EPA (1975).

F1.1.20 Zinc

Toxicity of Zinc in Water to Aquatic Life. Zinc is a commonly occurring nutrient element. Zinc occurs in many forms in natural waters and aquatic sediments. At pH 6.0 in fresh water, the dominant forms of dissolved zinc are the free ion (98%) and zinc sulfate (2%), whereas at pH 9.0, the dominant forms are the monohydroxide ion (78%), zinc carbonate (16%), and the free ion (6%) (EPA 1987-Zn). Zinc toxicity, which is relatively well defined, increases as either hardness decreases or temperature increases (EPA 1987-Zn). The aqueous toxicity of zinc is summarized in Table F1.9. Although freshwater plants are often more sensitive to zinc than freshwater animals, the range of toxicity values was much greater:

growth of the algae *Selenastrum capricornutum* was inhibited by 0.030 mg/L, whereas several other species of green algae had 96-hour EC_{50}s that exceeded 200.0 mg/L. Zinc bioaccumulated in freshwater animal tissue from 51 to 1130 times the water concentration. Toxicities of body burdens were not determined.

Toxicity of Zinc in Sediment to Benthic Organisms. A concentration of 127 mg/kg caused 34% mortality to *Hyalella azteca* in Waukegan Harbor, Illinois. A concentration of 320 mg/kg in Lake Union, Washington, caused 95% mortality to *H. azteca*. In Torch Lake, Michigan, there was significant mortality of *Daphnia magna* and *Hexagenia limbata* associated with concentrations of 310 mg/kg. At two rivers in Illinois, the highest number of benthic macroinvertebrate taxa was associated with concentrations of 96 and 182 mg/kg zinc, while the lowest number of taxa was associated with concentrations of 107 and 327 mg/kg, respectively (studies cited in Long and Morgan 1991).

Table F1.9. Aqueous concentrations of zinc causing effects on freshwater aquatic biota at hardness equivalent to Clinch River and Poplar Creek

Concentration (mg/L)[a]	Effect[b]
160	damselfly (*Argia sp.*) LC50
35.6	amphipod (*Crangonyx pseudogracilis*) LC50
33.8	pumpkinseed (*Lepomis gibbosus*) LC50
33.1	Worm (*Nals sp.*) LC50
31.9	banded killifish (*Fundulus diaphanus*) LC50
30.3	snail (*Amnicola sp.*) LC50
24.5	American eel (*Anquilla rostrata*) LC50
24.2	white perch (*Morone americana*) LC50
20.9	isopod (*Asellus communis*) LC50
18.9	guppy (*Poecilla reticulata*) LC50
18.4	goldfish (*Carassius auratus*) LC50
17.5	Worm (*Lumbriculus variegatus*) LC50
14.6	amphipod (*Gammarus sp.*) LC50
14.1	Caddisfly (*Clistoronia magnifica*) CV
13.0	common carp (*Cyprinus carpio*) LC50
11.8	northern squawfish (*Ptychochallus oregonensis*) LC50
10.8	golden shiner (*Notemigonus crysoleucas*) LC50
10.3	isopod (*Asellus bicrenata*) LC50
9.41	white sucker (*Catostomus commersoni*) LC50
8.82	Asiatic clam (*Corbicula fluminea?*) LC50

Table F1.9 (continued)

Concentration (mg/L)[a]	Effect[b]
8.75	bluegill (*Lepomis macrochirus*) LC50
7.81	southern platyfish (*Xiphophorus maculatus*) LC50
6.81	fathead minnow (*Pimephales promelas*) LC50
5.87	isopod (*Lirceus alabamae*) LC50
3.91	Atlantic salmon (*Salmo salar*) LC50
3.70	brook trout (*Salvelinus fontinalis*) LC50
3.07	bryozoan (*Lophopodella carteri*) LC50
3.01	flagfish (*Jordanella floridae*) LC50
2.93	coho salmon (*Oncorhynchus kisutch*) LC50
2.89	bryozoan (*Plumatella emarginata*) LC52
2.84	snail (*Hellsoma campanulatum*) LC 50
2.70	sockeye salmon (*Oncorhynchus nerka*) LC50
2.35	bryozoan (*Pectinatella magnifica*) LC50
2.27	Tublificid worm (*Limnodrilus hoffmeisteri*) LC50
2.08	snail (*Physa gyrina*) LC50
2.07	snail (*Physa heterostropha*) LC50
1.62	brook trout (*Salvelinus fontinalis*) CV
1.42	Mozambique tilapia (*Tilapia mossambica*) LC50
1.37	rainbow trout (*Oncorhynchus mykiss*) CV
1.26	rainbow trout (*Oncorhynchus mykiss*) LC50
1.25	guppy (*Poecilla reticulata*) CV
1.20	chinook salmon (*Oncorhynchus tshawytscha*) CV
0.848	cladoceran (*Daphnia magna*) EC50
0.803	chinook salmon (*Oncorhynchus tshawytsche*) LC50
0.598	Sockeye salmon (*Oncorhynchus nerka*) CV
0.455	cladoceran (*Daphnia pulex*) EC50
0.410	longfin dace (*Agosia chrysogaster*) LC50
0.313	cladoceran (*Ceriodaphnia dubia*) EC50
0.218	striped bass (*Morone saxatilis*) LC50
0.203	fathead minnow (*Pimephales promelas*) CV

Table F1.9 (continued)

Concentration (mg/L)[a]	Effect[b]
0.120	acute NAWQC
0.110	chronic NAWQC
0.0928	Cladoceran (*Daphnia magna*) CV
0.0912	cladoceran (*Ceriodaphnia reticulata*) EC50
0.0900	cutthroat trout (*Salmo clarki*) LC50[c]
0.0730	flagfish (*Jordanella floridae*) CV

[a] Effect levels were converted based on a 100 mg/L water hardness. Slopes used for the conversion were associated with individual species, where specified in the Criteria document. Otherwise, 0.8473 was the slope for both the acute and chronic test conversions.
[b] LC = Lethal Concentration; CV = Chronic Value; EC = Effects Concentration; NAWQC = National Ambient Water Quality Criteria.
[c] The cutthroat trout acute test did not specify the hardness of the water.

Zinc. Zinc makes up about 0.002% of the earth's crust (NAS 1980). Zinc is an essential trace element in all living organisms; it assures the stability of biological molecules and structures such as DNA, membranes, and ribosomes (Eisler 1993). It is used commercially primarily in galvanized metals and metal alloys, but zinc compounds also have wide applications as chemical intermediates, catalysts, pigments, vulcanization activators and accelerators in the rubber industry, UV stabilizers, and supplements in animal feeds and fertilizers. Zinc compounds are also used in rayon manufacture, smoke bombs, soldering fluxes, mordants for printing and dyeing, wood preservatives, mildew inhibitors, deodorants, antiseptics, and astringents (Lloyd 1984; ATSDR 1989). In addition, zinc phosphide is used as a rodenticide.

Zinc occurs in nature as a sulfide, oxide, or carbonate (Eisler 1993). It is divalent in solution. In freshwater with pH >4 and <7 it exists almost exclusively as the aquo ion $(Zn(H_2O)_6)^{2+}$ (Campbell and Stokes 1985). Zinc interacts with many chemicals, and it may diminish the toxic effects of cadmium and protects against lead toxicosis in terrestrial animals (Eisler 1993). Background concentrations seldom exceed 0.040 mg/L in water or 200 mg/kg in soil or sediment (Eisler 1993).

Although it is essential for normal growth and reproduction (Prasad 1979; Stahl et al. 1989) and important to central nervous system function (Eisler 1993), the primary toxic effect of zinc is on zinc-dependent enzymes that regulate RNA and DNA. It is most harmful to aquatic life in conditions of low pH, low alkalinity, low dissolved oxygen, and elevated temperature. Zinc is relatively nontoxic in mammals, but excessive intake can cause a variety of effects. It is not known to be carcinogenic by normal exposure routes (Eisler 1993).

Gastrointestinal absorption of zinc is variable (20–80%) and depends on the chemical compound as well as on zinc levels in the body and on dietary concentrations of other nutrients (EPA 1984). Information on pulmonary absorption is limited and complicated by the potential for gastrointestinal absorption due to mucociliary clearance from the respiratory tract and subsequent swallowing. Pulmonary inflammation and changes in lung function have been observed in inhalation studies on animals (Amur et al. 1982; Lam et al. 1985; Drinker and Drinker 1928). Zinc is present in all tissues with the highest concentrations in the prostate, kidney, liver, heart, and pancreas. Zinc is a vital

component of many metalloenzymes such as carbonic anhydrase, which regulates CO_2 exchange (Stokinger 1981).

In animals, gastrointestinal and hepatic lesions (Allen et al. 1983; Brink et al. 1959), pancreatic lesions (Maita et al. 1981; Drinker et al. 1927), anemia (ATSDR 1989; Fox and Jacobs 1986; Maita et al. 1981), and diffuse nephrosis (Maita et al. 1981; Allen et al. 1983) have been observed following subchronic oral exposures. Anemia and pancreatitis were the major adverse effects observed in chronic animal studies (Aughey et al. 1977; Drinker et al. 1927; Walters and Roe 1965; Sutton and Nelson 1937). Teratogenic effects have not been seen in animals exposed to zinc; however, high oral doses can affect reproduction and fetal growth (Ketcheson et al. 1969; Schlicker and Cox 1967, 1968; Sutton and Nelson 1937).

Livestock and small mammals are tolerant of extended dietary loadings >100 times the minimum recommended daily zinc requirement (Eisler 1993). No adverse effects on general health or reproduction were observed in dairy cows fed 1310 mg zinc/kg food (Miller et al. 1989). A diet of 4000–5000 mg zinc/kg food for 18 days resulted in fetotoxicity and poor reproduction in rats (NAS 1979). Acute oral LD_{50} doses of 350–800 mg zinc/kg bw have been reported for rats (Eisler 1993). Wlostowski et al. (1988) recommended 30 mg zinc/kg in the diet of bank voles.

Dogs on diets with up to 1000 mg zinc/kg of food for up to 1 year showed no measurable signs of damage (NAS 1979). Horses ingesting >90 mg zinc/kg bw daily in the vicinity of a lead-zinc smelter exhibited decreased growth and death (NAS 1979). No effects were observed in mice fed <682 mg zinc/kg food (<109 mg zinc/kg bw daily) for 13 weeks, but at 6820 mg zinc/kg food, adverse effects on growth and survival were documented (Maita et al. 1981). In a 37-day study involving rats, doses of 97 mg/kg-day administered as zinc carbonate in the diet had no adverse effects on the reproductivity of rats (Kinnamon 1963). European ferrets (*Mustela putorius furo*) fed up to 500 mg zinc/kg for up to 197 days all survived with no significant histopathologies, but those fed 1500 or 3000 mg/kg diet died within 21 days (Straube et al. 1980; Reece et al. 1986). Reproduction ceased entirely in female rats ingesting a diet with 500 mg zinc/kg/day (Sutton and Nelson 1937), possibly a result of zinc-induced anemia.

Mallards (*Anas platyrhynchos*) fed diets containing >3000 mg zinc/kg for 30 or 60 days suffered leg paralysis, decreased food consumption, and high mortality (Gasaway and Buss 1972; NAS 1979). Egg production in Japanese quail (*Coturnix coturnix japonica*) hens fed 15,000 mg zinc (as ZnO)/kg feed for 7 days decreased to near zero within 3 days (Hussein et al. 1988). Seven percent of 14-day old quail fed 600 mg zinc (as zinc phosphide)/kg feed over 5 days died, 53% of those fed 990 mg/kg died, and 93% of those fed 1634 mg/kg died (Hill and Camardese 1986). Domestic chicken pullets and hens on a diet with 20,000 mg zinc/kg feed for 5 days were lighter weight by day 5 and produced significantly fewer eggs for 4 weeks following treatment (Palafox and Ho-A 1980). Eggs collected 14–28 days post-treatment had reduced fertility and hatchability. However, normal growth, egg production, fertility, and hatchability were observed 4–12 weeks post-treatment. Acute oral LD_{50} values for zinc phosphide, a rodenticide, were between 16 and 47 mg/kg bw in ring-necked pheasants (*Phasianus colchicus*), golden eagles (*Aquila chrysaetos*), mallards, and horned larks (*Eremophila alpestris*) (Hudson et al. 1984), but much of the biocidal action is attributed to the phosphide rather than the zinc (Eisler 1993).

Diets containing 28, 48, 228, or 2028 mg zinc/kg for 12–44 weeks had no effect on overall egg production by domestic chickens although zinc levels were elevated in hens on the highest zinc diet (Stahl et al. 1990). All day-old chicks fed diets containing 16,000 mg zinc/kg feed for 5 weeks and 80% of those fed 8000 mg/kg died; those on a 4,000 mg zinc/kg diet showed no significant reductions in growth or survival (Oh et al. 1979). In a 60-day study, doses of 170 mg/kg-day administered as zinc

carbonate in the diet caused increased mortality and altered blood chemistry in mallards (Gasaway and Buss 1972).

In chickens, adverse effects associated with zinc deficiency have been observed at <38 mg zinc/kg dry weight feed (Blamberg et al. 1960; Westmoreland and Hoekstra 1969; Stahl et al. 1989), but concentrations of 93–120 mg/kg are suggested as adequate in the diet (Blamberg et al. 1960; Westmoreland and Hoekstra 1969). Greater than 178 mg/kg dry weight feed is considered excessive (Stahl et al. 1989), and dietary concentrations >2000 mg/kg dry weight feed are considered toxic (NAS 1979; Oh et al. 1979; Stahl et al. 1990). Turkey poults tolerated zinc levels up to 2000 ppm in starter diets for 21 days with no deleterious effects, but levels ≥4000 ppm resulted in marked growth depression (Vohra and Kratzer 1968). No mortality was observed in poults on a diet containing 10,000 ppm zinc (Vohra and Kratzer 1968), but increased mortality has been observed for chickens on diets with 3000 ppm zinc (Roberson and Schaible 1960).

Toxicity of Zinc in Soil to Plants. Zinc is an essential element for plant growth. It has a part in many enzymes, and is involved in disease protection and metabolism of carbohydrates and proteins. Zinc is actively taken up by roots in ionic form, and less so in organically chelated form (Collins 1981). It is fairly uniformly distributed between roots and shoots being transported in the xylem in ionic form (Wallace and Romney 1977a). Transport in the phloem appears to be as an anionic complex (van Goor and Wiersma 1976). Toxicity symptoms include chlorosis and depressed plant growth (Chapman 1966). It acts to inhibit CO_2 fixation, phloem transport of carbohydrates, and alter membrane permeability (Collins 1981). Muramoto et al. (1990) measured the effects of addition of Zn as ZnO to an alluvial soil (pH 6) on root and stem weights, stem length, and grain yield of wheat and rice grown from seed to maturity. Root weight of rice was reduced about 29% by 1000 ppm (lowest concentration tested). Wheat grain yield and plant weight were reduced 66 and 28% by 1000 ppm (lowest concentration tested).

The effect of Zn on soybean growth has been evaluated. Number of seeds produced per plant was decreased by 28% when plants were grown from seed to maturity in an average garden soil to which 25 ppm Zn was added as $ZnSO_4$ (Aery and Sakar 1991). Zn at 10 ppm had no effect. The work of White et al. (1979) shows the ameliorating effect on Zn toxicity of increased pH in a sandy loam soil. Soybean leaf weight was reduced 30% by 131 ppm Zn at pH 5.5, while 115 ppm had no effect. Lata and Veer (1990) measured 45 and 22% reductions in plant weights of spinach and coriander after 60 days in soil with 87 ppm Zn.

F1.2 ORGANIC CHEMICALS

F1.2.1 Acenaphthene

Toxicity of Acenaphthene in Sediment to Benthic Organisms. In the studies used to calculate the NOAA ER-L, effects were usually observed in association with concentrations of 0.15 mg/kg or greater (Long and Morgan 1991). The AET for Puget Sound sediments, derived from the Microtox© bioassay, the benthic community composition, oyster larvae bioassay, and *Rhepoxynius abronius* amphipod bioassay, were 0.5, 0.5, 0.5, and 0.63 mg/kg, respectively, in a 1986 study and 0.5, 0.73, 0.5, and 2.0 mg/kg, respectively, in a 1988 study (Long and Morgan 1991). Confidence in the ER-L is low (Long and Morgan 1991). The EPA sediment quality criterion assuming 1% organic carbon is 1.3 mg/kg (EPA, 1993-Acen).

F1.2.2 Anthracene

Toxicity of Anthracene in Sediment to Benthic Organisms. In the studies used to calculate the NOAA ER-L, effects are almost always observed with concentrations exceeding 0.3 mg/kg (Long and Morgan 1991). Confidence in the ER-L is low because there is no consistency in the effects observed at lower concentrations (Long and Morgan 1991).

F1.2.3 Benzo(a)anthracene

Toxicity of Benzo(a)anthracene in Sediment to Benthic Organisms. In bioassays of the lower Columbia River sediments, no toxicity to *Hyalella azteca* was observed at concentrations of 2.2 mg/kg. However, these data were not used in the calculation of the ER-L (Long and Morgan 1991). In the studies used to calculate the ER-L, no effects were observed at concentrations below 0.06 mg/kg. The overall AET from these data was 0.55 mg/kg, although AET values in the data base ranged from 1.3 to 5.1 mg/kg for Puget Sound to 0.06 to 1.1 mg/kg for San Francisco Bay. Confidence in the ER-L is low (studies cited in Long and Morgan 1991). The EPA (1988) interim freshwater criterion value assuming 1% organic carbon is 13.2 mg/kg.

F1.2.4 Benzo(a)pyrene

Toxicity of Benzo(a)pyrene in Sediment to Benthic Organisms. Only one study was found relating effects data in freshwater sediment to concentrations of benzo(a)pyrene: 220 mg/kg resulted in 95% mortality of *H. azteca*. In the studies documented in Long et al. (1995), 63% indicated biological effects at concentrations between the ER-L and ER-M, and 80% of the studies at concentrations above the ER-M indicated biological effects.

F1.2.5 Bis(2-ethylhexyl)phthalate

Toxicity of Bis(2-ethylhexyl)phthalate in Water to Aquatic Life. Chemicals used as plasticizers. As a group, the esters are colorless liquids, have low volatility, and are poorly soluble in water. Bis(2-ethylhexyl)phthalate, also known as di-2-ethylhexyl phthalate or DEHP, is the most widely used phthalate ester (EPA 1980-bis).

Of the available acute toxicity tests only a *Daphnia magna* test resulted in an LC50 (11.1 mg/L). Calculated LC_{50} values exceeded the highest test concentrations for the midge, scud, and bluegill and were >18.00 mg/L, >32.00 mg/L, and >770 mg/L, respectively. Data are available from two chronic studies of bis(2-ethylhexyl)phthalate: rainbow trout and *Daphnia magna* had chronic values of 0.0084 mg/L and < 0.003 mg/L, respectively.

Bioconcentration factors for bis(2-ethylhexyl)phthalate in fish and invertebrate species ranged from 14 to 2680. Toxicities of body burdens were not determined for phthalate esters. There are no NAWQC for phthalate esters.

Bis(2-ethylhexyl)phthalate. Bis(2-ethylhexyl)phthalate is the most abundant of the phthalate esters, a class of chemicals that are plasticizers and common laboratory contaminants. The LC50 and CV for *Daphnia magna* of are 11 mg/L and <0.003 mg/L, respectively (EPA 1980-phth). At 0.003 mg/L, reproduction was reduced 60% (Mayer and Sanders 1973). However, a subsequent study did not find significant effects on *Daphnia magna* survival or reproduction below 0.811 mg/L with a CV of 0.358 mg/L (Knowles et al. 1987). The CV for rainbow trout is 0.084 mg/L; at the LOEC of 0.014 mg/L 20%

of larvae died (Mehre and Mayer 1976). BCFs for fish and invertebrates range from 54 to 2,680 (EPA 1980-phth).

F1.2.6 Carbon disulfide

Toxicity of Carbon Disulfide in Water to Aquatic Life. The EC50 for *Daphnia magna* is 2.1 mg/L and the LC50 for mosquitofish is 135 mg/L (Van Leeuwen et al. 1985 AQUIRE). The secondary chronic value is derived from these values.

F1.2.7 Chrysene

Toxicity of Chrysene in Sediment to Benthic Organisms. In freshwater systems, a concentration of 4.1 mg/kg was not toxic to *Hyalella azteca* in the Columbia River but a concentration of 170 mg/kg in Lake Union, Washington, resulted in 95% mortality to *Hyalella azteca*. However, these data were not used to calculate the ER-L. In the studies used to calculate the ER-L, effects were almost always observed at concentrations exceeding 0.9 mg/kg, although the lowest Puget Sound and San Francisco Bay AET values were 1.4 and 1.7 mg/kg, respectively (studies cited in Long and Morgan 1991). Confidence in the ER-L is moderate.

F1.2.8 4,4'-DDD

Toxicity of 4,4'-DDD in Water to Aquatic Life. No data regarding effects of 4,4'-DDD on benthic invertebrates were found from freshwater systems. The NS&T Program marine data were from only two geographic regions and spiked sediment bioassays were not performed. Therefore, confidence in the NOAA ER-L and ER-M is low (Long and Morgan 1991).

Toxicity of 4,4'-DDD in Sediment to Benthic Organisms. No data regarding effects of 4,4'-DDT on benthic invertebrates were found from freshwater systems. Although marine data are available from all approaches, the degree of confidence in the ER-L and ER-M is low (Long and Morgan 1991). The data do not cluster about the ER-L and ER-M, especially at the upper end of the bioeffects range, and are not from a broad range of geographic areas.

F1.2.9 DDT-Total

Toxicity of Total DDT in Sediment to Benthic Organisms. Limited data were found regarding effects of total DDT (the summation of all quantified isomers) on freshwater benthic invertebrates. Confidence in the ER-L and ER-M is moderate because marine and/or freshwater data are available from all approaches (Long and Morgan 1991). In the Dupage River in Illinois, the highest number of benthic macroinvertebrate taxa were observed at concentrations averaging 0.020 mg/kg, whereas the least taxa were associated with 0.222 mg/kg total DDT. In sediments of Trinity River in Texas, *D. magna* survival was significantly affected at .031 mg/kg and low mortality occurred at .007 mg/kg. *H. azteca* LC50s in spiked sediment bioassays were 11.0, 19.6, and 49.7 mg/kg total DDT at organic carbon concentrations of 3%, 7.2%, and 10.5%, respectively (studies cited in Long and Morgan 1991).

F1.2.10 Dibenz(a,h)anthracene

Toxicity of Dibenz(a,h)anthracene in Sediment to Benthic Organisms. In studies used to calculate the ER-L, effects in sediments were observed at concentrations as low as 0.042 mg/kg in marine systems (Long and Morgan 1991). Confidence in the ER-L is moderate. The safe sediment level, based upon equilibrium partitioning and the acute NAWQC, is 240 mg/kg (Long and Morgan 1991).

F1.2.11 Fluoranthene

Toxicity of Fluoranthene in Sediment to Benthic Organisms. Lake Union, Washington, sediment with a concentration of 570 mg/kg caused 95% mortality to *Hyalella azteca*. Columbia River, Washington, sediment with 2.1 mg/kg fluoranthene was not toxic to *Hyalella azteca*. The lowest AET for Puget Sound and San Francisco Bay was 1.7 and 2.0, respectively. The confidence in the ER-L is high (Long and Morgan 1991). The EPA freshwater SQC assuming 1% organic carbon is 6.2 mg/kg (EPA 1993-Fluor).

A freshwater sediment with approximately 0.5% organic carbon was spiked with fluoranthene to generate an EC_{50} for *Hyalella azteca* and *Chironomus tentans*, using organism immobility as the endpoint (Suedel et al. 1993). The EC_{50} values were between 2.3 and 7.4 mg/kg for *H. azteca* and between 3.0 and 8.7 mg/kg for *C. tentans*.

F1.2.12 Fluorene

Toxicity of Fluorene in Sediment to Benthic Organisms. Lake Union, Washington, sediment with a concentration of 40 mg/kg fluorene caused 95% mortality in *Hyalella azteca*. A sediment quality criterion (SQC) calculated using equilibrium partitioning and the acute NAWQC and 1% organic carbon yields a value of 7.0 mg/kg. Confidence in the ER-L is low (Long and Morgan 1991).

F1.2.13 2-Methylnaphthalene

Toxicity of 2-Methylnaphthalene Sediment to Benthic Organisms. No data regarding effects of 2-methylnaphthalene on benthic invertebrates were found from freshwater systems, and the NS&T Program marine data were from only a few geographic regions. Therefore, the confidence in the NOAA ER-L is low (Long and Morgan 1991). The lowest AETs (concentrations at which adverse effects are always expected to occur) for Puget Sound and San Francisco Bay were 0.67 and 0.027 mg/kg, respectively.

F1.2.14 Naphthalene

Toxicity of Naphthalene in Sediment to Benthic Organisms. Lake Union, Washington, sediments with 40 mg/kg naphthalene caused 95% mortality in *Hyalella azteca*. Effects were almost always observed at concentrations greater than 0.50 mg/kg in marine systems (Long and Morgan 1991). The Puget Sound AET was 2.1 mg/kg. Confidence in the ER-L is moderate (Long and Morgan 1991).

F1.2.15 PCB-Total

Toxicity of Total PCB in Sediment to Benthic Organisms. ER-L and ER-M values are 0.0227 mg/kg and 0.180 mg/kg, respectively (Long et al. 1995). Freshwater data indicated little or no concordance between toxicity and PCB concentrations. Relatively poor relationships were observed between the incidence of effects and the concentrations of total PCBs in marine sediments. For example, there is a relatively low (51%) incidence of biological effects at concentrations greater than the ER-M ("probable-effects range") (Long et al. 1995). Co-occurrence analyses and apparent effects thresholds are highly variable and are predominantly for marine and estuarine systems. Co-occurrence analyses indicated that concentrations of PCBs ranging from 0.038 mg/kg to 0.276 mg/kg were highly toxic (43–79% mortality) to the amphipod *Rhepoxynius abronius*. Amphipod bioassays also resulted in LC_{50} and/or EC_{50} at PCB concentrations of 0.26 mg/kg (studies cited in Long and Morgan 1991). Apparent effects thresholds,

approximately 1 mg/kg, resulted in reduction of the benthic community composition in Puget Sound. However, some inconsistency in effects is expected given the variance in composition of PCB mixtures.

Toxicity of PCBs to Wildlife. Polychlorinated biphenyls (PCBs) are a family of man-made chemicals consisting of 209 individual compounds with varying toxicity (ATSDR 1989b). Aroclor is the trade name for PCBs made by Monsanto. Because of their insulating and nonflammable properties, PCBs were widely used in industrial applications such as coolants and lubricants in transformers, capacitors, and electrical equipment (ATSDR 1989b). The United States stopped manufacturing PCBs in 1977 due to evidence that they accumulate in the environment. PCBs have become widespread environmental contaminants.

Most exposures to PCBs are oral. Absorption of PCBs following oral exposure is often >90% (ATSDR 1989b). PCBs are preferentially stored in adipose tissues in animals. They may cross the placenta or be transferred to offspring through milk. PCBs with higher chlorine content (the last 2 digits of the Aroclor designation indicate the percent Cl content of the compound) tend to persist in the environment longer than those with lower Cl content, and PCBs are known to bioaccumulate and biomagnify to toxic concentrations in animals (Eisler 1986, ATSDR 1989b). Chronic exposures are of particular concern. PCBs with high K_{ow} values and high numbers of chlorines in adjacent positions are generally the most toxic. Although relatively insoluble in water, PCBs are generally freely soluble in nonpolar organic solvents and in biological lipids (EPA 1980b).

Sixty percent of mice fed diets containing 1,000 ppm Aroclor 1254 for 14 days died within 15 days, but none of the mice fed diets with only 250 ppm Aroclor for 14 days died (Sanders et al. 1974). These diets translate to doses of 130 and 32.5 mg/kg/day, respectively (ATSDR 1989b). White-footed mice fed 10 ppm Aroclor 1254 for 18 months had fewer offspring produced and a longer time between litters than control mice (Linzey 1987).

Feeding studies suggest a total intake of 500-2,000 mg/kg of Aroclor 1254 obtained through the diet over 1 to 7 weeks is lethal in rats (Hudson et al. 1984). Male rats consuming diets containing 0–100 ppm Aroclor 1254 for 104 weeks suffered dose-related reduced survival (NCI 1978); however, there was no effect on similarly treated female rats. Dietary concentrations of ≥20 ppm Aroclor 1254 reduced litter sizes in one- and two-generation reproduction studies with rats; concentrations <5 ppm had no effect (Linder et al. 1974).

Mink are one of the most susceptible mammals; dietary levels as low as 0.1 ppm fresh weight have caused death and reproductive toxicity (Eisler 1986b). Diets containing 20 ppm Aroclor 1242 were lethal to mink in a 247-day experiment. The LC_{50} for chronic exposures is 6.65 ppm Aroclor 1254 for mink over a 8 month period (Ringer et al. 1981). Diets containing 5 ppm Aroclor 1242 caused complete reproductive failure (Bleavins et al. 1980). Exposure for 160 days to 3.57 ppm Aroclor 1254 resulted in 100% mortality of adult mink (Platonow and Karstad 1973).

A chronic study was conducted over 4.5 months exposing mink to 1, 5 and 15 ppm Aroclor 1254 in the diet. There was a significant reduction in the number of offspring born alive at the 5 and 15 mg/kg exposures (Aulerich and Ringer 1977). Mink fed carp containing 1.5 ppm Aroclor 1254 for 6 months produced no offspring that survived to 24 hours (Hornshaw et al. 1983). No effects were observed in mink fed 0.64 ppm Aroclor 1254 for 160 days (Platonow and Karstad 1973). Exposure of mink for 6 months to 1 ppm Aroclor 1254 resulted in no significant difference from controls in number of offspring, or offspring mortality (Wren et al. 1987). Therefore, the 1 ppm dose was considered to be a chronic NOAEL.

A dietary dose of 25 ppm Aroclor 1254 fed for at lease a month before egg-laying in mallard ducks had no detrimental effect on reproductive success (Custer and Heinz 1980). Dietary exposure of 5 ppm Aroclor 1254 for 39 weeks to laying hens and roosters resulted in reduced egg production, although hatchability of fertile eggs was not affected (Platonow and Reinhart 1973). Screech owls fed 3 ppm Aroclor 1248 through two breeding seasons did not have significantly different reproductive success, relative to controls (McLane and Hughes 1980). Exposure of pheasants to 12.5 mg/bird/week (1.8 mg/kg/day) of Aroclor 1254 for 17 weeks resulted in significantly reduced egg hatchability (Dahlgren et al. 1972). Because this study considered exposure throughout a critical lifestage (reproduction), the 12.5 mg/bird/week dose was considered to be a chronic LOAEL.

F1.2.16 PCB-1248

Toxicity of PCB-1248 in Sediment to Benthic Organisms. The log K_{oc} for Aroclor 1248 is 7.02. The sediment quality benchmark (SQB) of 1.05 mg/kg is derived using the equilibrium partitioning approach based on 1% organic carbon. The secondary chronic value (Suter and Mabrey 1994) of 0.00001 mg/L is used as the water quality benchmark. The secondary chronic value implies a greater than 20% chance that the NAWQC, if its value were known, would be exceeded. For comparison, substitution of the lowest chronic value for daphnids results in a SQB of 450 mg/kg for Aroclor 1248.

F1.2.17 PCB-1254

Toxicity of PCB-1254 in Water to Aquatic Life. Polychlorinated biphenyls are highly persistent and widely distributed industrial chemicals. PCB 1254 is a mixture of isomers of biphenyl with approximately 54% chlorine substitution. Because few toxicity tests have been performed with that mixture, Table F1.10 summarizes aquatic toxicity for all mixtures. Bioconcentration factors for PCBs range from 3,000 to 274,000 in laboratory studies (EPA 1980b).

Toxicity of PCB-1254 in Sediment to Benthic Organisms. The log K_{oc} for Aroclor 1254 is 5.93. Using the secondary chronic value (Suter and Mabrey 1994) of 0.00002 mg/L as the water quality benchmark in the equilibrium partitioning equation results in a sediment benchmark of 0.17 mg/kg based on 1% organic carbon. For comparison, substitution of the lowest chronic value for daphnids results in a SQB of 17.9 mg/kg for Aroclor 1254.

F1.2.18 PCB-1260

Toxicity of PCB-1260 in Sediment to Benthic Organisms. The log K_{oc} for Aroclor 1260 is 7.02. The sediment quality benchmark (SQB) of 1099 mg/kg is derived using the equilibrium partitioning approach based on 1% organic carbon. The secondary chronic value (Suter and Mabrey 1994) of 0.0105 mg/L is used as the water quality benchmark. For comparison, substitution of the lowest chronic value for daphnids results in a SQB of 220 mg/kg for Aroclor 1260.

F1.2.19 Phenanthrene

Toxicity of Phenanthrene in Sediment to Benthic Organisms. Lake Union, Washington, sediments with 410 mg/kg phenanthrene caused 95% mortality among *Hyalella azteca*. Columbia River, Washington, sediments with 0.58 mg/kg phenanthrene were not toxic to the same species (studies cited in Long and Morgan 1991). Confidence in the ER-L is moderate. The EPA sediment quality criterion is 1.8 mg/kg, assuming 1% organic carbon (EPA 1993-Phen).

Table F1.10. Aqueous concentrations of PCBs causing effects on freshwater aquatic biota

Concentration (mg/L)	Effect[a]
0.283	damselfly (*Ischnura verticalis*) LC50
0.046	Scud (*Gammarus pseudolimnaeus*) LC50
0.033	fathead minnow (*Pimephales promelas*) LC50
0.019	redear sunfish (*Lepomis microlophus*) LC50
0.010	Scud (*Gammarus fasciatus*) LC50
0.00514	cladoceran (*Daphnia magna*) CV
0.00402	Scud (*Gammarus pseudolimnaeus*) CV
0.0023	largemouth bass (*Micropterus salmoides*) LC50
0.0020	rainbow trout (*Oncorhynchus mykiss*) LC50
0.00186	fathead minnow (*Pimephales promelas*) CV
0.0010	brook trout (*Salvelinus fontinalis*) CV
0.00080	Midge (*Tanytarsus dissimilis*) CV

[a] LC = Lethal Concentration; CV = Chronic Value.

F1.2.20 Pyrene

Toxicity of Pyrene in Sediment to Benthic Organisms. Lake Union, Washington, sediments with 750 mg/kg pyrene caused 95% mortality among *Hyalella azteca*. A concentration of 2.5 mg/kg in Columbia River, Washington, sediments was not toxic to the same species (studies cited in Long and Morgan 1991). The EPA interim sediment quality criterion, based on equilibrium partitioning and 1% organic carbon, is 13.1 mg/kg (Long and Morgan 1991). Confidence in the ER-L is moderate.

Table F1.11. Concentrations of PCB causing toxic effects in lipids and whole bodies of fish. Concentrations are the geometric means of body burdens at the LOEC[a] and NOEC[b].

Species	PCB Form	mg/kg lipid wet weight	mg/kg wet weight	LOEC Effect	Source
Channel catfish	1242	<213[c]	<14.3 <11.9[k]	growth	Hansen et al. 1976
Fathead minnow	1242	NE[d]	>390[e]	100% mortality	Nebeker et al. 1974
Fathead minnow	1248	370[f]	ca 26[f]	growth (F2)	DeFoe et al. 1978
Lake trout	1254	22[g]	0.7	survival	Berlin et al. 1981
Coho salmon	1254	NE[d]	<645	100% mortality	Mayer et al. 1977
Fathead minnow	1254	NE[d]	126[h]	repro	Nebeker et al. 1974
Brook trout	1254	NE[d]	94[i]	mortality	Mauck et al. 1978
Fathead minnow	1260	NE[d]	<350[j]	weight	DeFoe et al. 1978

[a] LOEC = Lowest Observed Effect Concentration.
[b] NOEC = No Observed Effect Concentration.
[c] The < sign signifies that the value corresponds to a LOEC, not a CV.
[d] Not estimated due to lack of lipid content data.
[e] 390mg/kg is the residue that was associated with no mortality and extremely variable spawning. Mortality occurred at higher exposures, but residues were not measured.
[f] These values are approximate due to extraction of the LOEC, NOEC, and lipid content from figures.
[g] The residue is normalized for lipid content based on an estimate of R. Hesselberg, one of the authors of the paper. His estimate of 3 % lipid is from another study, but is from fish of the same species and about the same age.
[h] Value for males; the female value is higher.
[i] The residue for effects on weight was not presented in the paper but is probably < 71 mg/kg.
[j] 350 mg/kg was the body residue at 250 days exposure. The 66 days exposure was associated with an 8% decrease in weight.
[k] Concentration in edible carcass; all others are whole fish.

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Appendix F2

FISH COMMUNITY

Table F2.1 Mean and upper confidence bound (UCB) aqueous chemical concentrations in filtered (FLTR) and unfiltered (WHOL) samples, aqueous ecotoxicological benchmarks and their values for each chemical, and the quotients of UCBs/benchmark values. All units are mg/L. Only the chemicals for which at least one quotient equaled or exceeded 1 are included. If only one observation (Obs.) resulted in detection of the the chemical, the UCB was set to that observed value.

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
1,1-Dichloroethane	75-34-3	O	WHOL	21	18	2	0.00120	0.00120	0.00008	14.6800	LCV_ALLO
1,1-Dichloroethane	75-34-3	O	WHOL	21	18	2	0.00120	0.00120	0.00008	14.6800	LCV_FISH
1,1-Dichloroethane	75-34-3	O	WHOL	21	18	2	0.00120	0.00120	0.00015	8.2190	LTV_FISH
1,1-Dichloroethane	75-34-3	O	WHOL	21	18	2	0.00120	0.00120	0.00144	0.8340	S_ACU_V
1,1-Dichloroethane	75-34-3	O	WHOL	21	18	2	0.00120	0.00120	0.02575	0.0466	S_CHR_V
1,2-Dichloroethene	540-59-0	O	WHOL	21	18	8	0.01461	0.02002	0.00210	9.5380	LCV_ALLO
1,2-Dichloroethene	540-59-0	O	WHOL	21	18	8	0.01461	0.02002	0.00210	9.5380	LCV_FISH
1,2-Dichloroethene	540-59-0	O	WHOL	21	18	8	0.01461	0.02002	0.00350	5.7190	LTV_FISH
1,2-Dichloroethene	540-59-0	O	WHOL	21	18	8	0.01461	0.02002	0.03587	0.5580	S_ACU_V
1,2-Dichloroethene	540-59-0	O	WHOL	21	18	8	0.01461	0.02002	0.64153	0.0312	S_CHR_V
2-Butanone	78-93-3	O	WHOL	00	10	2	0.00705	0.00840	0.00003	282.1700	LCV_ALLO
2-Butanone	78-93-3	O	WHOL	01	28	4	0.00335	0.00588	0.00002	282.1700	LCV_ALLO
2-Butanone	78-93-3	O	WHOL	02.02	9	1	0.00200	0.00200	0.00001	282.1700	LCV_ALLO
2-Butanone	78-93-3	O	WHOL	03.03	9	1	0.00200	0.00200	0.00001	282.1700	LCV_ALLO
2-Butanone	78-93-3	O	WHOL	04.01	9	1	0.00300	0.00300	0.00001	282.1700	LCV_ALLO
2-Butanone	78-93-3	O	WHOL	18	9	1	0.00200	0.00200	0.00001	282.1700	LCV_ALLO
2-Butanone	78-93-3	O	WHOL	20.01	9	1	0.00200	0.00200	0.00001	282.1700	LCV_ALLO
2-Butanone	78-93-3	O	WHOL	20.02	10	2	0.00630	0.01235	0.00004	282.1700	LCV_ALLO
2-Butanone	78-93-3	O	WHOL	21	18	1	0.00100	0.00100	0.00000	282.1700	LCV_ALLO
2-Butanone	78-93-3	O	WHOL	00	10	2	0.00705	0.00840	0.00001	1394.9270	LCV_DAPH
2-Butanone	78-93-3	O	WHOL	01	28	4	0.00335	0.00588	0.00000	1394.9270	LCV_DAPH
2-Butanone	78-93-3	O	WHOL	02.02	9	1	0.00200	0.00200	0.00000	1394.9270	LCV_DAPH
2-Butanone	78-93-3	O	WHOL	03.03	9	1	0.00200	0.00200	0.00000	1394.9270	LCV_DAPH
2-Butanone	78-93-3	O	WHOL	04.01	9	1	0.00300	0.00300	0.00000	1394.9270	LCV_DAPH
2-Butanone	78-93-3	O	WHOL	18	9	1	0.00200	0.00200	0.00000	1394.9270	LCV_DAPH
2-Butanone	78-93-3	O	WHOL	20.01	9	1	0.00200	0.00200	0.00000	1394.9270	LCV_DAPH
2-Butanone	78-93-3	O	WHOL	20.02	10	2	0.00630	0.01235	0.00001	1394.9270	LCV_DAPH
2-Butanone	78-93-3	O	WHOL	21	18	1	0.00100	0.00100	0.00000	1394.9270	LCV_DAPH
2-Butanone	78-93-3	O	WHOL	00	10	2	0.00705	0.00840	0.00003	282.1700	LCV_FISH
2-Butanone	78-93-3	O	WHOL	01	28	4	0.00335	0.00588	0.00002	282.1700	LCV_FISH
2-Butanone	78-93-3	O	WHOL	02.02	9	1	0.00200	0.00200	0.00001	282.1700	LCV_FISH
2-Butanone	78-93-3	O	WHOL	03.03	9	1	0.00200	0.00200	0.00001	282.1700	LCV_FISH
2-Butanone	78-93-3	O	WHOL	04.01	9	1	0.00300	0.00300	0.00001	282.1700	LCV_FISH
2-Butanone	78-93-3	O	WHOL	18	9	1	0.00200	0.00200	0.00001	282.1700	LCV_FISH
2-Butanone	78-93-3	O	WHOL	20.01	9	1	0.00200	0.00200	0.00001	282.1700	LCV_FISH
2-Butanone	78-93-3	O	WHOL	20.02	10	2	0.00630	0.01235	0.00004	282.1700	LCV_FISH
2-Butanone	78-93-3	O	WHOL	21	18	1	0.00100	0.00100	0.00000	282.1700	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
2-Butanone	78-93-3	O	WHOL	00	10	2	0.00705	0.00840	0.00009	98.7720	LTV_FISH
2-Butanone	78-93-3	O	WHOL	01	28	4	0.00335	0.00588	0.00006	98.7720	LTV_FISH
2-Butanone	78-93-3	O	WHOL	02.02	9	1	0.00200	0.00200	0.00002	98.7720	LTV_FISH
2-Butanone	78-93-3	O	WHOL	03.03	9	1	0.00200	0.00200	0.00002	98.7720	LTV_FISH
2-Butanone	78-93-3	O	WHOL	04.01	9	1	0.00300	0.00300	0.00003	98.7720	LTV_FISH
2-Butanone	78-93-3	O	WHOL	18	9	1	0.00200	0.00200	0.00002	98.7720	LTV_FISH
2-Butanone	78-93-3	O	WHOL	20.01	9	1	0.00200	0.00200	0.00002	98.7720	LTV_FISH
2-Butanone	78-93-3	O	WHOL	20.02	10	2	0.00630	0.01235	0.00013	98.7720	LTV_FISH
2-Butanone	78-93-3	O	WHOL	21	18	1	0.00100	0.00100	0.00001	98.7720	LTV_FISH
2-Butanone	78-93-3	O	WHOL	00	10	2	0.00705	0.00840	0.00002	372.0000	S_ACU_V
2-Butanone	78-93-3	O	WHOL	01	28	4	0.00335	0.00588	0.00002	372.0000	S_ACU_V
2-Butanone	78-93-3	O	WHOL	02.02	9	1	0.00200	0.00200	0.00001	372.0000	S_ACU_V
2-Butanone	78-93-3	O	WHOL	03.03	9	1	0.00200	0.00200	0.00001	372.0000	S_ACU_V
2-Butanone	78-93-3	O	WHOL	04.01	9	1	0.00300	0.00300	0.00001	372.0000	S_ACU_V
2-Butanone	78-93-3	O	WHOL	18	9	1	0.00200	0.00200	0.00001	372.0000	S_ACU_V
2-Butanone	78-93-3	O	WHOL	20.01	9	1	0.00200	0.00200	0.00001	372.0000	S_ACU_V
2-Butanone	78-93-3	O	WHOL	20.02	10	2	0.00630	0.01235	0.00003	372.0000	S_ACU_V
2-Butanone	78-93-3	O	WHOL	21	18	1	0.00100	0.00100	0.00000	372.0000	S_ACU_V
2-Butanone	78-93-3	O	WHOL	00	10	2	0.00705	0.00840	0.00040	20.8000	S_CHR_V
2-Butanone	78-93-3	O	WHOL	01	28	4	0.00335	0.00588	0.00028	20.8000	S_CHR_V
2-Butanone	78-93-3	O	WHOL	02.02	9	1	0.00200	0.00200	0.00010	20.8000	S_CHR_V
2-Butanone	78-93-3	O	WHOL	03.03	9	1	0.00200	0.00200	0.00010	20.8000	S_CHR_V
2-Butanone	78-93-3	O	WHOL	04.01	9	1	0.00300	0.00300	0.00014	20.8000	S_CHR_V
2-Butanone	78-93-3	O	WHOL	18	9	1	0.00200	0.00200	0.00010	20.8000	S_CHR_V
2-Butanone	78-93-3	O	WHOL	20.01	9	1	0.00200	0.00200	0.00010	20.8000	S_CHR_V
2-Butanone	78-93-3	O	WHOL	20.02	10	2	0.00630	0.01235	0.00059	20.8000	S_CHR_V
2-Butanone	78-93-3	O	WHOL	21	18	1	0.00100	0.00100	0.00005	20.8000	S_CHR_V
Acetone	67-64-1	O	WHOL	00	10	1	0.00970	0.00970	0.00002	507.6400	LCV_ALLO
Acetone	67-64-1	O	WHOL	01	28	1	0.00700	0.00700	0.00001	507.6400	LCV_ALLO
Acetone	67-64-1	O	WHOL	02.02	9	1	0.01400	0.01400	0.00003	507.6400	LCV_ALLO
Acetone	67-64-1	O	WHOL	03.03	9	1	0.01300	0.01300	0.00003	507.6400	LCV_ALLO
Acetone	67-64-1	O	WHOL	13	9	1	0.04500	0.04500	0.00009	507.6400	LCV_ALLO
Acetone	67-64-1	O	WHOL	18	9	1	0.00300	0.00300	0.00001	507.6400	LCV_ALLO
Acetone	67-64-1	O	WHOL	20.02	10	1	0.00300	0.00300	0.00001	507.6400	LCV_ALLO
Acetone	67-64-1	O	WHOL	22	10	1	0.00780	0.00780	0.00002	507.6400	LCV_ALLO
Acetone	67-64-1	O	WHOL	00	10	1	0.00970	0.00970	0.00000	3114.1820	LCV_DAPH
Acetone	67-64-1	O	WHOL	01	28	1	0.00700	0.00700	0.00000	3114.1820	LCV_DAPH
Acetone	67-64-1	O	WHOL	02.02	9	1	0.01400	0.01400	0.00000	3114.1820	LCV_DAPH
Acetone	67-64-1	O	WHOL	03.03	9	1	0.01300	0.01300	0.00000	3114.1820	LCV_DAPH
Acetone	67-64-1	O	WHOL	13	9	1	0.04500	0.04500	0.00001	3114.1820	LCV_DAPH
Acetone	67-64-1	O	WHOL	18	9	1	0.00300	0.00300	0.00000	3114.1820	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Acetone	67-64-1	O	WHOL	20.02	10	1	0.00300	0.00300	0.00000	3114.1820	LCV_DAPH
Acetone	67-64-1	O	WHOL	22	10	1	0.00780	0.00780	0.00000	3114.1820	LCV_DAPH
Acetone	67-64-1	O	WHOL	00	10	1	0.00970	0.00970	0.00002	507.6400	LCV_FISH
Acetone	67-64-1	O	WHOL	01	28	1	0.00700	0.00700	0.00001	507.6400	LCV_FISH
Acetone	67-64-1	O	WHOL	02.02	9	1	0.01400	0.01400	0.00003	507.6400	LCV_FISH
Acetone	67-64-1	O	WHOL	03.03	9	1	0.01300	0.01300	0.00003	507.6400	LCV_FISH
Acetone	67-64-1	O	WHOL	13	9	1	0.04500	0.04500	0.00009	507.6400	LCV_FISH
Acetone	67-64-1	O	WHOL	18	9	1	0.00300	0.00300	0.00001	507.6400	LCV_FISH
Acetone	67-64-1	O	WHOL	20.02	10	1	0.00300	0.00300	0.00001	507.6400	LCV_FISH
Acetone	67-64-1	O	WHOL	22	10	1	0.00780	0.00780	0.00002	507.6400	LCV_FISH
Acetone	67-64-1	O	WHOL	00	10	1	0.00970	0.00970	0.00006	161.8670	LTV_FISH
Acetone	67-64-1	O	WHOL	01	28	1	0.00700	0.00700	0.00004	161.8670	LTV_FISH
Acetone	67-64-1	O	WHOL	02.02	9	1	0.01400	0.01400	0.00009	161.8670	LTV_FISH
Acetone	67-64-1	O	WHOL	03.03	9	1	0.01300	0.01300	0.00008	161.8670	LTV_FISH
Acetone	67-64-1	O	WHOL	13	9	1	0.04500	0.04500	0.00028	161.8670	LTV_FISH
Acetone	67-64-1	O	WHOL	18	9	1	0.00300	0.00300	0.00002	161.8670	LTV_FISH
Acetone	67-64-1	O	WHOL	20.02	10	1	0.00300	0.00300	0.00002	161.8670	LTV_FISH
Acetone	67-64-1	O	WHOL	22	10	1	0.00780	0.00780	0.00005	161.8670	LTV_FISH
Acetone	67-64-1	O	WHOL	00	10	1	0.00970	0.00970	0.00005	200.0000	S_ACU_V
Acetone	67-64-1	O	WHOL	01	28	1	0.00700	0.00700	0.00004	200.0000	S_ACU_V
Acetone	67-64-1	O	WHOL	02.02	9	1	0.01400	0.01400	0.00007	200.0000	S_ACU_V
Acetone	67-64-1	O	WHOL	03.03	9	1	0.01300	0.01300	0.00007	200.0000	S_ACU_V
Acetone	67-64-1	O	WHOL	13	9	1	0.04500	0.04500	0.00023	200.0000	S_ACU_V
Acetone	67-64-1	O	WHOL	18	9	1	0.00300	0.00300	0.00002	200.0000	S_ACU_V
Acetone	67-64-1	O	WHOL	20.02	10	1	0.00300	0.00300	0.00002	200.0000	S_ACU_V
Acetone	67-64-1	O	WHOL	22	10	1	0.00780	0.00780	0.00004	200.0000	S_ACU_V
Acetone	67-64-1	O	WHOL	00	10	1	0.00970	0.00970	0.00087	11.2000	S_CHR_V
Acetone	67-64-1	O	WHOL	01	28	1	0.00700	0.00700	0.00063	11.2000	S_CHR_V
Acetone	67-64-1	O	WHOL	02.02	9	1	0.01400	0.01400	0.00125	11.2000	S_CHR_V
Acetone	67-64-1	O	WHOL	03.03	9	1	0.01300	0.01300	0.00116	11.2000	S_CHR_V
Acetone	67-64-1	O	WHOL	13	9	1	0.04500	0.04500	0.00402	11.2000	S_CHR_V
Acetone	67-64-1	O	WHOL	18	9	1	0.00300	0.00300	0.00027	11.2000	S_CHR_V
Acetone	67-64-1	O	WHOL	20.02	10	1	0.00300	0.00300	0.00027	11.2000	S_CHR_V
Acetone	67-64-1	O	WHOL	22	10	1	0.00780	0.00780	0.00070	11.2000	S_CHR_V
Aluminum	7429-90-5	I	FLTR	00	1	1	0.02390	0.02390	0.05196	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	01	17	15	0.02036	0.02484	0.05401	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	02.01	3	3	0.02194	0.04470	0.09716	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	02.02	12	4	0.00953	0.01209	0.02629	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	02.03	6	2	0.00736	0.01008	0.02192	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	03.01	13	13	0.03552	0.05835	0.12685	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	03.02	13	12	0.01970	0.02515	0.05466	0.4600	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Aluminum	7429-90-5	I	FLTR	03.03	13	11	0.01752	0.02113	0.04593	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	03.04	15	14	0.01851	0.02193	0.04768	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	04.01	15	14	0.01909	0.02325	0.05055	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	04.02	6	4	0.01183	0.01479	0.03216	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	04.04	9	7	0.01789	0.02410	0.05239	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	07.01	5	1	0.01140	0.01140	0.02478	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	07.02	17	10	0.01104	0.01213	0.02636	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	08	2	1	0.02220	0.02220	0.04826	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	13	46	36	0.02520	0.04014	0.08726	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	00	11	11	0.35118	0.50129	1.08976	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	01	48	47	0.24938	0.33308	0.72408	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	02.01	3	3	0.12123	0.29901	0.65003	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	02.02	21	21	0.24075	0.34387	0.74754	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	02.03	6	6	0.17027	0.32668	0.71017	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	02.04	10	10	0.23938	0.30979	0.67345	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	03.01	33	33	0.45244	0.54178	1.17778	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	03.02	13	13	0.34300	0.47787	1.03885	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	03.03	22	22	0.51559	0.65273	1.41898	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	03.04	15	15	0.40367	0.55036	1.19643	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	04.01	24	24	0.31790	0.42974	0.93423	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	04.02	6	6	0.14820	0.26664	0.57966	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	04.04	9	9	0.19457	0.29582	0.64308	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	07.01	5	5	0.14764	0.23407	0.50884	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	07.02	17	16	0.13956	0.19715	0.42859	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	08	2	2	0.06340	0.25849	0.56195	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	13	57	56	0.42175	0.48568	1.05583	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	18	9	9	0.53000	0.93591	2.03458	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	20.01	9	7	0.21256	0.34700	0.75434	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	20.02	10	10	0.21613	0.30419	0.66129	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	21	18	17	1.05449	2.10690	4.58023	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	WHOL	22	10	10	1.02250	1.41099	3.06737	0.4600	LCV_ALLO
Aluminum	7429-90-5	I	FLTR	00	1	1	0.02390	0.02390	0.05196	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	01	17	15	0.02036	0.02484	0.05401	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	02.01	3	3	0.02194	0.04470	0.09716	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	02.02	12	4	0.00953	0.01209	0.02629	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	02.03	6	2	0.00736	0.01008	0.02192	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	03.01	13	13	0.03552	0.05835	0.12685	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	03.02	13	12	0.01970	0.02515	0.05466	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	03.03	13	11	0.01752	0.02113	0.04593	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	03.04	15	14	0.01851	0.02193	0.04768	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	04.01	15	14	0.01909	0.02325	0.05055	0.4600	LCV_AQPL

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Aluminum	7429-90-5	I	FLTR	04.02	6	4	0.01183	0.01479	0.03216	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	04.04	9	7	0.01789	0.02410	0.05239	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	07.01	5	1	0.01140	0.01140	0.02478	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	07.02	17	10	0.01104	0.01213	0.02636	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	08	2	1	0.02220	0.02220	0.04826	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	13	46	36	0.02520	0.04014	0.08726	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	00	11	11	0.35118	0.50129	1.08976	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	01	48	47	0.24938	0.33308	0.72408	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	02.01	3	3	0.12123	0.29901	0.65003	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	02.02	21	21	0.24075	0.34387	0.74754	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	02.03	6	6	0.17027	0.32668	0.71017	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	02.04	10	10	0.23938	0.30979	0.67345	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	03.01	33	33	0.45244	0.54178	1.17778	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	03.02	13	13	0.34300	0.47787	1.03885	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	03.03	22	22	0.51559	0.65273	1.41898	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	03.04	15	15	0.40367	0.55036	1.19643	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	04.01	24	24	0.31790	0.42974	0.93423	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	04.02	6	6	0.14820	0.26664	0.57966	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	04.04	9	9	0.19457	0.29582	0.64308	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	07.01	5	5	0.14764	0.23407	0.50884	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	07.02	17	16	0.13956	0.19715	0.42859	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	08	2	2	0.06340	0.25849	0.56195	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	13	57	56	0.42175	0.48568	1.05583	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	18	9	9	0.53000	0.93591	2.03458	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	20.01	9	7	0.21256	0.34700	0.75434	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	20.02	10	10	0.21613	0.30419	0.66129	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	21	18	17	1.05449	2.10690	4.58023	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	WHOL	22	10	10	1.02250	1.41099	3.06737	0.4600	LCV_AQPL
Aluminum	7429-90-5	I	FLTR	00	1	1	0.02390	0.02390	0.01258	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	01	17	15	0.02036	0.02484	0.01308	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	02.01	3	3	0.02194	0.04470	0.02352	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	02.02	12	4	0.00953	0.01209	0.00637	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	02.03	6	2	0.00736	0.01008	0.00531	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	03.01	13	13	0.03552	0.05835	0.03071	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	03.02	13	12	0.01970	0.02515	0.01323	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	03.03	13	11	0.01752	0.02113	0.01112	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	03.04	15	14	0.01851	0.02193	0.01154	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	04.01	15	14	0.01909	0.02325	0.01224	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	04.02	6	4	0.01183	0.01479	0.00779	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	04.04	9	7	0.01789	0.02410	0.01269	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	07.01	5	1	0.01140	0.01140	0.00600	1.9000	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Aluminum	7429-90-5	I	FLTR	07.02	17	10	0.01104	0.01213	0.00638	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	08	2	1	0.02220	0.02220	0.01168	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	13	46	36	0.02520	0.04014	0.02113	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	00	11	11	0.35118	0.50129	0.26384	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	01	48	47	0.24938	0.33308	0.17530	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	02.01	3	3	0.12123	0.29901	0.15737	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	02.02	21	21	0.24075	0.34387	0.18098	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	02.03	6	6	0.17027	0.32668	0.17194	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	02.04	10	10	0.23938	0.30979	0.16305	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	03.01	33	33	0.45244	0.54178	0.28515	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	03.02	13	13	0.34300	0.47787	0.25151	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	03.03	22	22	0.51559	0.65273	0.34354	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	03.04	15	15	0.40367	0.55036	0.28966	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	04.01	24	24	0.31790	0.42974	0.22618	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	04.02	6	6	0.14820	0.26664	0.14034	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	04.04	9	9	0.19457	0.29582	0.15569	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	07.01	5	5	0.14764	0.23407	0.12319	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	07.02	17	16	0.13956	0.19715	0.10376	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	08	2	2	0.06340	0.25849	0.13605	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	13	57	56	0.42175	0.48568	0.25562	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	18	9	9	0.53000	0.93591	0.49258	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	20.01	9	7	0.21256	0.34700	0.18263	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	20.02	10	10	0.21613	0.30419	0.16010	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	21	18	17	1.05449	2.10690	1.10890	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	WHOL	22	10	10	1.02250	1.41099	0.74263	1.9000	LCV_DAPH
Aluminum	7429-90-5	I	FLTR	00	1	1	0.02390	0.02390	0.00727	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	01	17	15	0.02036	0.02484	0.00756	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	02.01	3	3	0.02194	0.04470	0.01359	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	02.02	12	4	0.00953	0.01209	0.00368	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	02.03	6	2	0.00736	0.01008	0.00307	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	03.01	13	13	0.03552	0.05835	0.01775	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	03.02	13	12	0.01970	0.02515	0.00765	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	03.03	13	11	0.01752	0.02113	0.00643	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	03.04	15	14	0.01851	0.02193	0.00667	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	04.01	15	14	0.01909	0.02325	0.00707	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	04.02	6	4	0.01183	0.01479	0.00450	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	04.04	9	7	0.01789	0.02410	0.00733	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	07.01	5	1	0.01140	0.01140	0.00347	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	07.02	17	10	0.01104	0.01213	0.00369	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	08	2	1	0.02220	0.02220	0.00675	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	13	46	36	0.02520	0.04014	0.01221	3.2880	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Aluminum	7429-90-5	I	WHOL	00	11	11	0.35118	0.50129	0.15246	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	01	48	47	0.24938	0.33308	0.10130	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	02.01	3	3	0.12123	0.29901	0.09094	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	02.02	21	21	0.24075	0.34387	0.10458	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	02.03	6	6	0.17027	0.32668	0.09935	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	02.04	10	10	0.23938	0.30979	0.09422	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	03.01	33	33	0.45244	0.54178	0.16478	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	03.02	13	13	0.34300	0.47787	0.14534	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	03.03	22	22	0.51559	0.65273	0.19852	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	03.04	15	15	0.40367	0.55036	0.16738	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	04.01	24	24	0.31790	0.42974	0.13070	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	04.02	6	6	0.14820	0.26664	0.08110	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	04.04	9	9	0.19457	0.29582	0.08997	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	07.01	5	5	0.14764	0.23407	0.07119	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	07.02	17	16	0.13956	0.19715	0.05996	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	08	2	2	0.06340	0.25849	0.07862	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	13	57	56	0.42175	0.48568	0.14771	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	18	9	9	0.53000	0.93591	0.28464	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	20.01	9	7	0.21256	0.34700	0.10553	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	20.02	10	10	0.21613	0.30419	0.09252	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	21	18	17	1.05449	2.10690	0.64079	3.2880	LCV_FISH
Aluminum	7429-90-5	I	WHOL	22	10	10	1.02250	1.41099	0.42913	3.2880	LCV_FISH
Aluminum	7429-90-5	I	FLTR	00	1	1	0.02390	0.02390	0.04426	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	01	17	15	0.02036	0.02484	0.04601	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	02.01	3	3	0.02194	0.04470	0.08277	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	02.02	12	4	0.00953	0.01209	0.02240	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	02.03	6	2	0.00736	0.01008	0.01867	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	03.01	13	13	0.03552	0.05835	0.10806	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	03.02	13	12	0.01970	0.02515	0.04657	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	03.03	13	11	0.01752	0.02113	0.03912	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	03.04	15	14	0.01851	0.02193	0.04062	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	04.01	15	14	0.01909	0.02325	0.04306	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	04.02	6	4	0.01183	0.01479	0.02739	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	04.04	9	7	0.01789	0.02410	0.04463	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	07.01	5	1	0.01140	0.01140	0.02111	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	07.02	17	10	0.01104	0.01213	0.02246	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	08	2	1	0.02220	0.02220	0.04111	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	13	46	36	0.02520	0.04014	0.07434	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	00	11	11	0.35118	0.50129	0.92832	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	01	48	47	0.24938	0.33308	0.61681	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	02.01	3	3	0.12123	0.29901	0.55373	0.5400	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Aluminum	7429-90-5	I	WHOL	02.02	21	21	0.24075	0.34387	0.63679	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	02.03	6	6	0.17027	0.32668	0.60496	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	02.04	10	10	0.23938	0.30979	0.57368	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	03.01	33	33	0.45244	0.54178	1.00330	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	03.02	13	13	0.34300	0.47787	0.88495	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	03.03	22	22	0.51559	0.65273	1.20876	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	03.04	15	15	0.40367	0.55036	1.01918	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	04.01	24	24	0.31790	0.42974	0.79582	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	04.02	6	6	0.14820	0.26664	0.49378	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	04.04	9	9	0.19457	0.29582	0.54781	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	07.01	5	5	0.14764	0.23407	0.43346	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	07.02	17	16	0.13956	0.19715	0.36509	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	08	2	2	0.06340	0.25849	0.47869	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	13	57	56	0.42175	0.48568	0.89941	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	18	9	9	0.53000	0.93591	1.73316	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	20.01	9	7	0.21256	0.34700	0.64259	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	20.02	10	10	0.21613	0.30419	0.56332	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	21	18	17	1.05449	2.10690	3.90167	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	WHOL	22	10	10	1.02250	1.41099	2.61294	0.5400	LTV_DAPH
Aluminum	7429-90-5	I	FLTR	00	1	1	0.02390	0.02390	0.00509	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	01	17	15	0.02036	0.02484	0.00529	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	02.01	3	3	0.02194	0.04470	0.00951	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	02.02	12	4	0.00953	0.01209	0.00257	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	02.03	6	2	0.00736	0.01008	0.00215	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	03.01	13	13	0.03552	0.05835	0.01241	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	03.02	13	12	0.01970	0.02515	0.00535	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	03.03	13	11	0.01752	0.02113	0.00450	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	03.04	15	14	0.01851	0.02193	0.00467	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	04.01	15	14	0.01909	0.02325	0.00495	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	04.02	6	4	0.01183	0.01479	0.00315	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	04.04	9	7	0.01789	0.02410	0.00513	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	07.01	5	1	0.01140	0.01140	0.00243	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	07.02	17	10	0.01104	0.01213	0.00258	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	08	2	1	0.02220	0.02220	0.00472	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	13	46	36	0.02520	0.04014	0.00854	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	00	11	11	0.35118	0.50129	0.10666	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	01	48	47	0.24938	0.33308	0.07087	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	02.01	3	3	0.12123	0.29901	0.06362	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	02.02	21	21	0.24075	0.34387	0.07316	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	02.03	6	6	0.17027	0.32668	0.06951	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	02.04	10	10	0.23938	0.30979	0.06591	4.7000	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Aluminum	7429-90-5	I	WHOL	03.01	33	33	0.45244	0.54178	0.11527	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	03.02	13	13	0.34300	0.47787	0.10168	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	03.03	22	22	0.51559	0.65273	0.13888	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	03.04	15	15	0.40367	0.55036	0.11710	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	04.01	24	24	0.31790	0.42974	0.09143	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	04.02	6	6	0.14820	0.26664	0.05673	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	04.04	9	9	0.19457	0.29582	0.06294	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	07.01	5	5	0.14764	0.23407	0.04980	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	07.02	17	16	0.13956	0.19715	0.04195	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	08	2	2	0.06340	0.25849	0.05500	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	13	57	56	0.42175	0.48568	0.10334	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	18	9	9	0.53000	0.93591	0.19913	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	20.01	9	7	0.21256	0.34700	0.07383	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	20.02	10	10	0.21613	0.30419	0.06472	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	21	18	17	1.05449	2.10690	0.44828	4.7000	LTV_FISH
Aluminum	7429-90-5	I	WHOL	22	10	10	1.02250	1.41099	0.30021	4.7000	LTV_FISH
Aluminum	7429-90-5	I	FLTR	00	1	1	0.02390	0.02390	0.03187	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	01	17	15	0.02036	0.02484	0.03313	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	02.01	3	3	0.02194	0.04470	0.05959	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	02.02	12	4	0.00953	0.01209	0.01613	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	02.03	6	2	0.00736	0.01008	0.01344	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	03.01	13	13	0.03552	0.05835	0.07780	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	03.02	13	12	0.01970	0.02515	0.03353	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	03.03	13	11	0.01752	0.02113	0.02817	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	03.04	15	14	0.01851	0.02193	0.02924	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	04.01	15	14	0.01909	0.02325	0.03101	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	04.02	6	4	0.01183	0.01479	0.01972	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	04.04	9	7	0.01789	0.02410	0.03214	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	07.01	5	1	0.01140	0.01140	0.01520	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	07.02	17	10	0.01104	0.01213	0.01617	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	08	2	1	0.02220	0.02220	0.02960	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	13	46	36	0.02520	0.04014	0.05352	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	00	11	11	0.35118	0.50129	0.66839	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	01	48	47	0.24938	0.33308	0.44411	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	02.01	3	3	0.12123	0.29901	0.39868	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	02.02	21	21	0.24075	0.34387	0.45849	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	02.03	6	6	0.17027	0.32668	0.43557	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	02.04	10	10	0.23938	0.30979	0.41305	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	03.01	33	33	0.45244	0.54178	0.72237	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	03.02	13	13	0.34300	0.47787	0.63716	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	03.03	22	22	0.51559	0.65273	0.87031	0.7500	NAWQ_ACU

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Aluminum	7429-90-5	I	WHOL	03.04	15	15	0.40367	0.55036	0.73381	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	04.01	24	24	0.31790	0.42974	0.57299	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	04.02	6	6	0.14820	0.26664	0.35552	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	04.04	9	9	0.19457	0.29582	0.39442	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	07.01	5	5	0.14764	0.23407	0.31209	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	07.02	17	16	0.13956	0.19715	0.26287	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	08	2	2	0.06340	0.25849	0.34466	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	13	57	56	0.42175	0.48568	0.64758	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	18	9	9	0.53000	0.93591	1.24787	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	20.01	9	7	0.21256	0.34700	0.46266	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	20.02	10	10	0.21613	0.30419	0.40559	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	21	18	17	1.05449	2.10690	2.80920	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	WHOL	22	10	10	1.02250	1.41099	1.88132	0.7500	NAWQ_ACU
Aluminum	7429-90-5	I	FLTR	00	1	1	0.02390	0.02390	0.27471	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	01	17	15	0.02036	0.02484	0.28557	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	02.01	3	3	0.02194	0.04470	0.51374	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	02.02	12	4	0.00953	0.01209	0.13902	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	02.03	6	2	0.00736	0.01008	0.11589	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	03.01	13	13	0.03552	0.05835	0.67069	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	03.02	13	12	0.01970	0.02515	0.28903	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	03.03	13	11	0.01752	0.02113	0.24284	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	03.04	15	14	0.01851	0.02193	0.25211	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	04.01	15	14	0.01909	0.02325	0.26729	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	04.02	6	4	0.01183	0.01479	0.17004	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	04.04	9	7	0.01789	0.02410	0.27703	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	07.01	5	1	0.01140	0.01140	0.13103	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	07.02	17	10	0.01104	0.01213	0.13940	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	08	2	1	0.02220	0.02220	0.25517	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	FLTR	13	46	36	0.02520	0.04014	0.46140	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	00	11	11	0.35118	0.50129	5.76196	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	01	48	47	0.24938	0.33308	3.82849	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	02.01	3	3	0.12123	0.29901	3.43692	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	02.02	21	21	0.24075	0.34387	3.95251	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	02.03	6	6	0.17027	0.32668	3.75491	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	02.04	10	10	0.23938	0.30979	3.56077	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	03.01	33	33	0.45244	0.54178	6.22737	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	03.02	13	13	0.34300	0.47787	5.49279	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	03.03	22	22	0.51559	0.65273	7.50266	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	03.04	15	15	0.40367	0.55036	6.32597	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	04.01	24	24	0.31790	0.42974	4.93958	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	04.02	6	6	0.14820	0.26664	3.06487	0.0870	NAWQ_CHR

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Aluminum	7429-90-5	I	WHOL	04.04	9	9	0.19457	0.29582	3.40020	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	07.01	5	5	0.14764	0.23407	2.69042	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	07.02	17	16	0.13956	0.19715	2.26610	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	08	2	2	0.06340	0.25849	2.97121	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	13	57	56	0.42175	0.48568	5.58255	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	18	9	9	0.53000	0.93591	10.75754	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	20.01	9	7	0.21256	0.34700	3.98848	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	20.02	10	10	0.21613	0.30419	3.49648	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	21	18	17	1.05449	2.10690	24.21728	0.0870	NAWQ_CHR
Aluminum	7429-90-5	I	WHOL	22	10	10	1.02250	1.41099	16.21827	0.0870	NAWQ_CHR
Antimony	7440-36-0	I	FLTR	00	1	1	0.00470	0.00470	0.00770	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	01	20	13	0.00407	0.00536	0.00879	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	02.01	3	2	0.00323	0.00436	0.00714	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	02.02	13	12	0.00640	0.00770	0.01263	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	02.03	6	6	0.00633	0.00837	0.01372	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	03.01	14	8	0.00398	0.00502	0.00823	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	03.02	14	10	0.00621	0.00692	0.01135	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	03.03	14	12	0.00546	0.00652	0.01069	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	03.04	16	14	0.00483	0.00615	0.01007	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	04.01	16	11	0.00422	0.00508	0.00832	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	04.02	6	6	0.00572	0.00759	0.01244	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	04.04	11	8	0.00351	0.00474	0.00778	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	07.01	5	5	0.00520	0.00648	0.01062	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	07.02	17	12	0.00333	0.00447	0.00733	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	08	2	1	0.00340	0.00340	0.00557	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	13	47	42	0.00495	0.00563	0.00923	0.6100	LCV_ALLO
Antimony	7440-36-0	I	WHOL	01	51	1	0.00110	0.00110	0.00180	0.6100	LCV_ALLO
Antimony	7440-36-0	I	WHOL	02.01	3	1	0.00130	0.00130	0.00213	0.6100	LCV_ALLO
Antimony	7440-36-0	I	WHOL	03.01	34	2	0.00141	0.00142	0.00233	0.6100	LCV_ALLO
Antimony	7440-36-0	I	WHOL	03.02	14	1	0.00120	0.00120	0.00197	0.6100	LCV_ALLO
Antimony	7440-36-0	I	WHOL	03.04	16	3	0.00172	0.00175	0.00287	0.6100	LCV_ALLO
Antimony	7440-36-0	I	WHOL	04.01	25	2	0.00172	0.00176	0.00289	0.6100	LCV_ALLO
Antimony	7440-36-0	I	WHOL	04.02	6	2	0.00162	0.00166	0.00272	0.6100	LCV_ALLO
Antimony	7440-36-0	I	WHOL	07.02	17	1	0.00120	0.00120	0.00197	0.6100	LCV_ALLO
Antimony	7440-36-0	I	WHOL	13	58	2	0.00112	0.00118	0.00194	0.6100	LCV_ALLO
Antimony	7440-36-0	I	FLTR	00	1	1	0.00470	0.00470	0.00770	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	01	20	13	0.00407	0.00536	0.00879	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	02.01	3	2	0.00323	0.00436	0.00714	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	02.02	13	12	0.00640	0.00770	0.01263	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	02.03	6	6	0.00633	0.00837	0.01372	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	03.01	14	8	0.00398	0.00502	0.00823	0.6100	LCV_AQPL

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Antimony	7440-36-0	I	FLTR	03.02	14	10	0.00621	0.00692	0.01135	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	03.03	14	12	0.00546	0.00652	0.01069	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	03.04	16	14	0.00483	0.00615	0.01007	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	04.01	16	11	0.00422	0.00508	0.00832	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	04.02	6	6	0.00572	0.00759	0.01244	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	04.04	11	8	0.00351	0.00474	0.00778	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	07.01	5	5	0.00520	0.00648	0.01062	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	07.02	17	12	0.00333	0.00447	0.00733	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	08	2	1	0.00340	0.00340	0.00557	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	13	47	42	0.00495	0.00563	0.00923	0.6100	LCV_AQPL
Antimony	7440-36-0	I	WHOL	01	51	1	0.00110	0.00110	0.00180	0.6100	LCV_AQPL
Antimony	7440-36-0	I	WHOL	02.01	3	1	0.00130	0.00130	0.00213	0.6100	LCV_AQPL
Antimony	7440-36-0	I	WHOL	03.01	34	2	0.00141	0.00142	0.00233	0.6100	LCV_AQPL
Antimony	7440-36-0	I	WHOL	03.02	14	1	0.00120	0.00120	0.00197	0.6100	LCV_AQPL
Antimony	7440-36-0	I	WHOL	03.04	16	3	0.00172	0.00175	0.00287	0.6100	LCV_AQPL
Antimony	7440-36-0	I	WHOL	04.01	25	2	0.00172	0.00176	0.00289	0.6100	LCV_AQPL
Antimony	7440-36-0	I	WHOL	04.02	6	2	0.00162	0.00166	0.00272	0.6100	LCV_AQPL
Antimony	7440-36-0	I	WHOL	07.02	17	1	0.00120	0.00120	0.00197	0.6100	LCV_AQPL
Antimony	7440-36-0	I	WHOL	13	58	2	0.00112	0.00118	0.00194	0.6100	LCV_AQPL
Antimony	7440-36-0	I	FLTR	00	1	1	0.00470	0.00470	0.00087	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	01	20	13	0.00407	0.00536	0.00099	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	02.01	3	2	0.00323	0.00436	0.00081	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	02.02	13	12	0.00640	0.00770	0.00143	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	02.03	6	6	0.00633	0.00837	0.00155	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	03.01	14	8	0.00398	0.00502	0.00093	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	03.02	14	10	0.00621	0.00692	0.00128	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	03.03	14	12	0.00546	0.00652	0.00121	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	03.04	16	14	0.00483	0.00615	0.00114	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	04.01	16	11	0.00422	0.00508	0.00094	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	04.02	6	6	0.00572	0.00759	0.00141	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	04.04	11	8	0.00351	0.00474	0.00088	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	07.01	5	5	0.00520	0.00648	0.00120	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	07.02	17	12	0.00333	0.00447	0.00083	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	08	2	1	0.00340	0.00340	0.00063	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	13	47	42	0.00495	0.00563	0.00104	5.4000	LCV_DAPH
Antimony	7440-36-0	I	WHOL	01	51	1	0.00110	0.00110	0.00020	5.4000	LCV_DAPH
Antimony	7440-36-0	I	WHOL	02.01	3	1	0.00130	0.00130	0.00024	5.4000	LCV_DAPH
Antimony	7440-36-0	I	WHOL	03.01	34	2	0.00141	0.00142	0.00026	5.4000	LCV_DAPH
Antimony	7440-36-0	I	WHOL	03.02	14	1	0.00120	0.00120	0.00022	5.4000	LCV_DAPH
Antimony	7440-36-0	I	WHOL	03.04	16	3	0.00172	0.00175	0.00032	5.4000	LCV_DAPH
Antimony	7440-36-0	I	WHOL	04.01	25	2	0.00172	0.00176	0.00033	5.4000	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Antimony	7440-36-0	I	WHOL	04.02	6	2	0.00162	0.00166	0.00031	5.4000	LCV_DAPH
Antimony	7440-36-0	I	WHOL	07.02	17	1	0.00120	0.00120	0.00022	5.4000	LCV_DAPH
Antimony	7440-36-0	I	WHOL	13	58	2	0.00112	0.00118	0.00022	5.4000	LCV_DAPH
Antimony	7440-36-0	I	FLTR	00	1	1	0.00470	0.00470	0.00294	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	01	20	13	0.00407	0.00536	0.00335	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	02.01	3	2	0.00323	0.00436	0.00272	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	02.02	13	12	0.00640	0.00770	0.00481	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	02.03	6	6	0.00633	0.00837	0.00523	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	03.01	14	8	0.00398	0.00502	0.00314	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	03.02	14	10	0.00621	0.00692	0.00433	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	03.03	14	12	0.00546	0.00652	0.00408	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	03.04	16	14	0.00483	0.00615	0.00384	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	04.01	16	11	0.00422	0.00508	0.00317	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	04.02	6	6	0.00572	0.00759	0.00474	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	04.04	11	8	0.00351	0.00474	0.00296	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	07.01	5	5	0.00520	0.00648	0.00405	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	07.02	17	12	0.00333	0.00447	0.00279	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	08	2	1	0.00340	0.00340	0.00212	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	13	47	42	0.00495	0.00563	0.00352	1.6000	LCV_FISH
Antimony	7440-36-0	I	WHOL	01	51	1	0.00110	0.00110	0.00069	1.6000	LCV_FISH
Antimony	7440-36-0	I	WHOL	02.01	3	1	0.00130	0.00130	0.00081	1.6000	LCV_FISH
Antimony	7440-36-0	I	WHOL	03.01	34	2	0.00141	0.00142	0.00089	1.6000	LCV_FISH
Antimony	7440-36-0	I	WHOL	03.02	14	1	0.00120	0.00120	0.00075	1.6000	LCV_FISH
Antimony	7440-36-0	I	WHOL	03.04	16	3	0.00172	0.00175	0.00109	1.6000	LCV_FISH
Antimony	7440-36-0	I	WHOL	04.01	25	2	0.00172	0.00176	0.00110	1.6000	LCV_FISH
Antimony	7440-36-0	I	WHOL	04.02	6	2	0.00162	0.00166	0.00104	1.6000	LCV_FISH
Antimony	7440-36-0	I	WHOL	07.02	17	1	0.00120	0.00120	0.00075	1.6000	LCV_FISH
Antimony	7440-36-0	I	WHOL	13	58	2	0.00112	0.00118	0.00074	1.6000	LCV_FISH
Antimony	7440-36-0	I	FLTR	00	1	1	0.00470	0.00470	0.00247	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	01	20	13	0.00407	0.00536	0.00282	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	02.01	3	2	0.00323	0.00436	0.00229	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	02.02	13	12	0.00640	0.00770	0.00405	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	02.03	6	6	0.00633	0.00837	0.00440	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	03.01	14	8	0.00398	0.00502	0.00264	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	03.02	14	10	0.00621	0.00692	0.00364	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	03.03	14	12	0.00546	0.00652	0.00343	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	03.04	16	14	0.00483	0.00615	0.00323	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	04.01	16	11	0.00422	0.00508	0.00267	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	04.02	6	6	0.00572	0.00759	0.00399	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	04.04	11	8	0.00351	0.00474	0.00250	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	07.01	5	5	0.00520	0.00648	0.00341	1.9000	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Antimony	7440-36-0	I	FLTR	07.02	17	12	0.00333	0.00447	0.00235	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	08	2	1	0.00340	0.00340	0.00179	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	13	47	42	0.00495	0.00563	0.00296	1.9000	LTV_DAPH
Antimony	7440-36-0	I	WHOL	01	51	1	0.00110	0.00110	0.00058	1.9000	LTV_DAPH
Antimony	7440-36-0	I	WHOL	02.01	3	1	0.00130	0.00130	0.00068	1.9000	LTV_DAPH
Antimony	7440-36-0	I	WHOL	03.01	34	2	0.00141	0.00142	0.00075	1.9000	LTV_DAPH
Antimony	7440-36-0	I	WHOL	03.02	14	1	0.00120	0.00120	0.00063	1.9000	LTV_DAPH
Antimony	7440-36-0	I	WHOL	03.04	16	3	0.00172	0.00175	0.00092	1.9000	LTV_DAPH
Antimony	7440-36-0	I	WHOL	04.01	25	2	0.00172	0.00176	0.00093	1.9000	LTV_DAPH
Antimony	7440-36-0	I	WHOL	04.02	6	2	0.00162	0.00166	0.00087	1.9000	LTV_DAPH
Antimony	7440-36-0	I	WHOL	07.02	17	1	0.00120	0.00120	0.00063	1.9000	LTV_DAPH
Antimony	7440-36-0	I	WHOL	13	58	2	0.00112	0.00118	0.00062	1.9000	LTV_DAPH
Antimony	7440-36-0	I	FLTR	00	1	1	0.00470	0.00470	0.00203	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	01	20	13	0.00407	0.00536	0.00232	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	02.01	3	2	0.00323	0.00436	0.00189	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	02.02	13	12	0.00640	0.00770	0.00333	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	02.03	6	6	0.00633	0.00837	0.00362	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	03.01	14	8	0.00398	0.00502	0.00217	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	03.02	14	10	0.00621	0.00692	0.00300	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	03.03	14	12	0.00546	0.00652	0.00282	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	03.04	16	14	0.00483	0.00615	0.00266	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	04.01	16	11	0.00422	0.00508	0.00220	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	04.02	6	6	0.00572	0.00759	0.00328	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	04.04	11	8	0.00351	0.00474	0.00205	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	07.01	5	5	0.00520	0.00648	0.00280	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	07.02	17	12	0.00333	0.00447	0.00194	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	08	2	1	0.00340	0.00340	0.00147	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	13	47	42	0.00495	0.00563	0.00244	2.3100	LTV_FISH
Antimony	7440-36-0	I	WHOL	01	51	1	0.00110	0.00110	0.00048	2.3100	LTV_FISH
Antimony	7440-36-0	I	WHOL	02.01	3	1	0.00130	0.00130	0.00056	2.3100	LTV_FISH
Antimony	7440-36-0	I	WHOL	03.01	34	2	0.00141	0.00142	0.00061	2.3100	LTV_FISH
Antimony	7440-36-0	I	WHOL	03.02	14	1	0.00120	0.00120	0.00052	2.3100	LTV_FISH
Antimony	7440-36-0	I	WHOL	03.04	16	3	0.00172	0.00175	0.00076	2.3100	LTV_FISH
Antimony	7440-36-0	I	WHOL	04.01	25	2	0.00172	0.00176	0.00076	2.3100	LTV_FISH
Antimony	7440-36-0	I	WHOL	04.02	6	2	0.00162	0.00166	0.00072	2.3100	LTV_FISH
Antimony	7440-36-0	I	WHOL	07.02	17	1	0.00120	0.00120	0.00052	2.3100	LTV_FISH
Antimony	7440-36-0	I	WHOL	13	58	2	0.00112	0.00118	0.00051	2.3100	LTV_FISH
Antimony	7440-36-0	I	FLTR	00	1	1	0.00470	0.00470	0.00477	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	01	20	13	0.00407	0.00536	0.00545	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	02.01	3	2	0.00323	0.00436	0.00442	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	02.02	13	12	0.00640	0.00770	0.00782	0.9850	S_ACU_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Antimony	7440-36-0	I	FLTR	02.03	6	6	0.00633	0.00837	0.00850	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	03.01	14	8	0.00398	0.00502	0.00509	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	03.02	14	10	0.00621	0.00692	0.00703	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	03.03	14	12	0.00546	0.00652	0.00662	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	03.04	16	14	0.00483	0.00615	0.00624	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	04.01	16	11	0.00422	0.00508	0.00515	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	04.02	6	6	0.00572	0.00759	0.00770	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	04.04	11	8	0.00351	0.00474	0.00482	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	07.01	5	5	0.00520	0.00648	0.00658	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	07.02	17	12	0.00333	0.00447	0.00454	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	08	2	1	0.00340	0.00340	0.00345	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	13	47	42	0.00495	0.00563	0.00572	0.9850	S_ACU_V
Antimony	7440-36-0	I	WHOL	01	51	1	0.00110	0.00110	0.00112	0.9850	S_ACU_V
Antimony	7440-36-0	I	WHOL	02.01	3	1	0.00130	0.00130	0.00132	0.9850	S_ACU_V
Antimony	7440-36-0	I	WHOL	03.01	34	2	0.00141	0.00142	0.00144	0.9850	S_ACU_V
Antimony	7440-36-0	I	WHOL	03.02	14	1	0.00120	0.00120	0.00122	0.9850	S_ACU_V
Antimony	7440-36-0	I	WHOL	03.04	16	3	0.00172	0.00175	0.00177	0.9850	S_ACU_V
Antimony	7440-36-0	I	WHOL	04.01	25	2	0.00172	0.00176	0.00179	0.9850	S_ACU_V
Antimony	7440-36-0	I	WHOL	04.02	6	2	0.00162	0.00166	0.00169	0.9850	S_ACU_V
Antimony	7440-36-0	I	WHOL	07.02	17	1	0.00120	0.00120	0.00122	0.9850	S_ACU_V
Antimony	7440-36-0	I	WHOL	13	58	2	0.00112	0.00118	0.00120	0.9850	S_ACU_V
Antimony	7440-36-0	I	FLTR	00	1	1	0.00470	0.00470	0.04519	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	01	20	13	0.00407	0.00536	0.05157	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	02.01	3	2	0.00323	0.00436	0.04190	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	02.02	13	12	0.00640	0.00770	0.07407	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	02.03	6	6	0.00633	0.00837	0.08046	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	03.01	14	8	0.00398	0.00502	0.04825	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	03.02	14	10	0.00621	0.00692	0.06656	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	03.03	14	12	0.00546	0.00652	0.06269	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	03.04	16	14	0.00483	0.00615	0.05909	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	04.01	16	11	0.00422	0.00508	0.04882	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	04.02	6	6	0.00572	0.00759	0.07296	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	04.04	11	8	0.00351	0.00474	0.04561	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	07.01	5	5	0.00520	0.00648	0.06228	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	07.02	17	12	0.00333	0.00447	0.04299	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	08	2	1	0.00340	0.00340	0.03269	0.1040	S_CHR_V
Antimony	7440-36-0	I	FLTR	13	47	42	0.00495	0.00563	0.05415	0.1040	S_CHR_V
Antimony	7440-36-0	I	WHOL	01	51	1	0.00110	0.00110	0.01058	0.1040	S_CHR_V
Antimony	7440-36-0	I	WHOL	02.01	3	1	0.00130	0.00130	0.01250	0.1040	S_CHR_V
Antimony	7440-36-0	I	WHOL	03.01	34	2	0.00141	0.00142	0.01366	0.1040	S_CHR_V
Antimony	7440-36-0	I	WHOL	03.02	14	1	0.00120	0.00120	0.01154	0.1040	S_CHR_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Antimony	7440-36-0	I	WHOL	03.04	16	3	0.00172	0.00175	0.01681	0.1040	S_CHR_V
Antimony	7440-36-0	I	WHOL	04.01	25	2	0.00172	0.00176	0.01695	0.1040	S_CHR_V
Antimony	7440-36-0	I	WHOL	04.02	6	2	0.00162	0.00166	0.01596	0.1040	S_CHR_V
Antimony	7440-36-0	I	WHOL	07.02	17	1	0.00120	0.00120	0.01154	0.1040	S_CHR_V
Antimony	7440-36-0	I	WHOL	13	58	2	0.00112	0.00118	0.01136	0.1040	S_CHR_V
Arsenic	7440-38-2	I	FLTR	01	20	3	0.00123	0.00128	0.00140	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	02.02	13	1	0.00110	0.00110	0.00120	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	02.04	2	1	0.00129	0.00129	0.00141	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	03.01	14	2	0.00112	0.00116	0.00127	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	03.02	14	2	0.00134	0.00135	0.00148	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	03.03	14	3	0.00118	0.00130	0.00142	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	03.04	16	4	0.00115	0.00123	0.00134	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	04.01	16	4	0.00112	0.00114	0.00125	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	04.02	6	1	0.00170	0.00170	0.00186	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	04.04	11	3	0.00181	0.00196	0.00214	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	07.01	5	5	0.00394	0.00534	0.00584	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	07.02	17	5	0.00115	0.00132	0.00144	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	13	47	6	0.00106	0.00111	0.00121	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	00	11	1	0.05000	0.05000	0.05470	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	01	51	4	0.00114	0.00120	0.00131	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	02.02	22	1	0.00110	0.00110	0.00120	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	02.04	11	1	0.00110	0.00110	0.00120	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	03.02	14	1	0.00140	0.00140	0.00153	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	03.03	23	3	0.00129	0.00145	0.00159	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	03.04	16	4	0.00109	0.00120	0.00131	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	04.01	25	3	0.00103	0.00107	0.00117	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	04.02	6	1	0.00130	0.00130	0.00142	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	04.04	11	4	0.00129	0.00169	0.00184	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	07.01	5	5	0.00408	0.00523	0.00572	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	07.02	17	3	0.00111	0.00129	0.00141	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	13	58	10	0.00213	0.00370	0.00404	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	WHOL	20.01	9	1	0.05450	0.05450	0.05963	0.9140	LCV_DAPH
Arsenic	7440-38-2	I	FLTR	01	20	3	0.00123	0.00128	0.00043	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	02.02	13	1	0.00110	0.00110	0.00037	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	02.04	2	1	0.00129	0.00129	0.00043	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	03.01	14	2	0.00112	0.00116	0.00039	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	03.02	14	2	0.00134	0.00135	0.00046	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	03.03	14	3	0.00118	0.00130	0.00044	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	03.04	16	4	0.00115	0.00123	0.00041	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	04.01	16	4	0.00112	0.00114	0.00039	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	04.02	6	1	0.00170	0.00170	0.00057	2.9620	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Arsenic	7440-38-2	I	FLTR	04.04	11	3	0.00181	0.00196	0.00066	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	07.01	5	5	0.00394	0.00534	0.00180	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	07.02	17	5	0.00115	0.00132	0.00045	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	13	47	6	0.00106	0.00111	0.00037	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	00	11	1	0.05000	0.05000	0.01688	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	01	51	4	0.00114	0.00120	0.00040	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	02.02	22	1	0.00110	0.00110	0.00037	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	02.04	11	1	0.00110	0.00110	0.00037	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	03.02	14	1	0.00140	0.00140	0.00047	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	03.03	23	3	0.00129	0.00145	0.00049	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	03.04	16	4	0.00109	0.00120	0.00041	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	04.01	25	3	0.00103	0.00107	0.00036	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	04.02	6	1	0.00130	0.00130	0.00044	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	04.04	11	4	0.00129	0.00169	0.00057	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	07.01	5	5	0.00408	0.00523	0.00177	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	07.02	17	3	0.00111	0.00129	0.00043	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	13	58	10	0.00213	0.00370	0.00125	2.9620	LCV_FISH
Arsenic	7440-38-2	I	WHOL	20.01	9	1	0.05450	0.05450	0.01840	2.9620	LCV_FISH
Arsenic	7440-38-2	I	FLTR	01	20	3	0.00123	0.00128	0.00203	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	02.02	13	1	0.00110	0.00110	0.00174	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	02.04	2	1	0.00129	0.00129	0.00203	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	03.01	14	2	0.00112	0.00116	0.00184	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	03.02	14	2	0.00134	0.00135	0.00214	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	03.03	14	3	0.00118	0.00130	0.00205	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	03.04	16	4	0.00115	0.00123	0.00194	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	04.01	16	4	0.00112	0.00114	0.00181	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	04.02	6	1	0.00170	0.00170	0.00269	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	04.04	11	3	0.00181	0.00196	0.00309	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	07.01	5	5	0.00394	0.00534	0.00843	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	07.02	17	5	0.00115	0.00132	0.00208	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	13	47	6	0.00106	0.00111	0.00175	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	00	11	1	0.05000	0.05000	0.07899	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	01	51	4	0.00114	0.00120	0.00189	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	02.02	22	1	0.00110	0.00110	0.00174	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	02.04	11	1	0.00110	0.00110	0.00174	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	03.02	14	1	0.00140	0.00140	0.00221	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	03.03	23	3	0.00129	0.00145	0.00230	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	03.04	16	4	0.00109	0.00120	0.00190	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	04.01	25	3	0.00103	0.00107	0.00169	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	04.02	6	1	0.00130	0.00130	0.00205	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	04.04	11	4	0.00129	0.00169	0.00266	0.6330	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Arsenic	7440-38-2	I	WHOL	07.01	5	5	0.00408	0.00523	0.00826	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	07.02	17	3	0.00111	0.00129	0.00203	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	13	58	10	0.00213	0.00370	0.00584	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	WHOL	20.01	9	1	0.05450	0.05450	0.08610	0.6330	LTV_DAPH
Arsenic	7440-38-2	I	FLTR	01	20	3	0.00123	0.00128	0.00060	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	02.02	13	1	0.00110	0.00110	0.00052	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	02.04	2	1	0.00129	0.00129	0.00060	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	03.01	14	2	0.00112	0.00116	0.00055	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	03.02	14	2	0.00134	0.00135	0.00064	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	03.03	14	3	0.00118	0.00130	0.00061	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	03.04	16	4	0.00115	0.00123	0.00058	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	04.01	16	4	0.00112	0.00114	0.00054	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	04.02	6	1	0.00170	0.00170	0.00080	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	04.04	11	3	0.00181	0.00196	0.00092	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	07.01	5	5	0.00394	0.00534	0.00251	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	07.02	17	5	0.00115	0.00132	0.00062	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	13	47	6	0.00106	0.00111	0.00052	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	00	11	1	0.05000	0.05000	0.02347	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	01	51	4	0.00114	0.00120	0.00056	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	02.02	22	1	0.00110	0.00110	0.00052	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	02.04	11	1	0.00110	0.00110	0.00052	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	03.02	14	1	0.00140	0.00140	0.00066	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	03.03	23	3	0.00129	0.00145	0.00068	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	03.04	16	4	0.00109	0.00120	0.00056	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	04.01	25	3	0.00103	0.00107	0.00050	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	04.02	6	1	0.00130	0.00130	0.00061	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	04.04	11	4	0.00129	0.00169	0.00079	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	07.01	5	5	0.00408	0.00523	0.00246	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	07.02	17	3	0.00111	0.00129	0.00060	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	13	58	10	0.00213	0.00370	0.00174	2.1300	LTV_FISH
Arsenic	7440-38-2	I	WHOL	20.01	9	1	0.05450	0.05450	0.02559	2.1300	LTV_FISH
Arsenic	7440-38-2	I	FLTR	01	20	3	0.00123	0.00128	0.00356	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	02.02	13	1	0.00110	0.00110	0.00306	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	02.04	2	1	0.00129	0.00129	0.00357	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	03.01	14	2	0.00112	0.00116	0.00323	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	03.02	14	2	0.00134	0.00135	0.00376	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	03.03	14	3	0.00118	0.00130	0.00360	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	03.04	16	4	0.00115	0.00123	0.00341	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	04.01	16	4	0.00112	0.00114	0.00318	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	04.02	6	1	0.00170	0.00170	0.00472	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	04.04	11	3	0.00181	0.00196	0.00544	0.3600	NAWQ_ACU

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Arsenic	7440-38-2	I	FLTR	07.01	5	5	0.00394	0.00534	0.01482	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	07.02	17	5	0.00115	0.00132	0.00366	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	13	47	6	0.00106	0.00111	0.00308	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	00	11	1	0.05000	0.05000	0.13889	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	01	51	4	0.00114	0.00120	0.00333	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	02.02	22	1	0.00110	0.00110	0.00306	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	02.04	11	1	0.00110	0.00110	0.00306	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	03.02	14	1	0.00140	0.00140	0.00389	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	03.03	23	3	0.00129	0.00145	0.00404	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	03.04	16	4	0.00109	0.00120	0.00333	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	04.01	25	3	0.00103	0.00107	0.00297	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	04.02	6	1	0.00130	0.00130	0.00361	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	04.04	11	4	0.00129	0.00169	0.00468	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	07.01	5	5	0.00408	0.00523	0.01453	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	07.02	17	3	0.00111	0.00129	0.00357	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	13	58	10	0.00213	0.00370	0.01027	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	WHOL	20.01	9	1	0.05450	0.05450	0.15139	0.3600	NAWQ_ACU
Arsenic	7440-38-2	I	FLTR	01	20	3	0.00123	0.00128	0.00675	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	02.02	13	1	0.00110	0.00110	0.00579	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	02.04	2	1	0.00129	0.00129	0.00676	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	03.01	14	2	0.00112	0.00116	0.00612	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	03.02	14	2	0.00134	0.00135	0.00712	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	03.03	14	3	0.00118	0.00130	0.00682	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	03.04	16	4	0.00115	0.00123	0.00646	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	04.01	16	4	0.00112	0.00114	0.00602	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	04.02	6	1	0.00170	0.00170	0.00895	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	04.04	11	3	0.00181	0.00196	0.01031	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	07.01	5	5	0.00394	0.00534	0.02808	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	07.02	17	5	0.00115	0.00132	0.00694	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	FLTR	13	47	6	0.00106	0.00111	0.00583	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	00	11	1	0.05000	0.05000	0.26316	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	01	51	4	0.00114	0.00120	0.00631	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	02.02	22	1	0.00110	0.00110	0.00579	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	02.04	11	1	0.00110	0.00110	0.00579	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	03.02	14	1	0.00140	0.00140	0.00737	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	03.03	23	3	0.00129	0.00145	0.00765	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	03.04	16	4	0.00109	0.00120	0.00632	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	04.01	25	3	0.00103	0.00107	0.00563	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	04.02	6	1	0.00130	0.00130	0.00684	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	04.04	11	4	0.00129	0.00169	0.00887	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	07.01	5	5	0.00408	0.00523	0.02753	0.1900	NAWQ_CHR

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Arsenic	7440-38-2	I	WHOL	07.02	17	3	0.00111	0.00129	0.00677	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	13	58	10	0.00213	0.00370	0.01945	0.1900	NAWQ_CHR
Arsenic	7440-38-2	I	WHOL	20.01	9	1	0.05450	0.05450	0.28684	0.1900	NAWQ_CHR
Barium	7440-39-3	I	FLTR	00	1	1	0.02960	0.02960	0.00510	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	01	17	17	0.02340	0.02424	0.00418	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	02.01	3	3	0.02442	0.03179	0.00548	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	02.02	12	12	0.02406	0.02552	0.00440	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	02.03	6	6	0.02392	0.02622	0.00452	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	02.04	1	1	0.03217	0.03217	0.00555	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	03.01	13	13	0.03304	0.03667	0.00632	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	03.02	13	13	0.03367	0.03675	0.00634	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	03.03	13	13	0.02961	0.03215	0.00554	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	03.04	15	15	0.02902	0.03132	0.00540	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	04.01	15	15	0.02431	0.02557	0.00441	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	04.02	6	6	0.02405	0.02551	0.00440	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	04.04	9	9	0.02458	0.02601	0.00449	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	07.01	5	5	0.02982	0.03518	0.00607	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	07.02	17	16	0.02459	0.02593	0.00447	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	08	2	2	0.02440	0.03766	0.00649	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	13	46	46	0.03749	0.03974	0.00685	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	00	11	11	0.04841	0.07445	0.01284	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	01	48	48	0.03195	0.03459	0.00596	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	02.01	3	3	0.02860	0.03561	0.00614	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	02.02	21	21	0.02996	0.03178	0.00548	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	02.03	6	6	0.02873	0.03045	0.00525	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	02.04	10	9	0.03012	0.03289	0.00567	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	03.01	33	33	0.03491	0.03638	0.00627	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	03.02	13	13	0.03765	0.04029	0.00695	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	03.03	22	21	0.03539	0.03723	0.00642	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	03.04	15	15	0.03452	0.03658	0.00631	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	04.01	24	23	0.02938	0.03122	0.00538	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	04.02	6	6	0.02763	0.02890	0.00498	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	04.04	9	9	0.02763	0.02878	0.00496	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	07.01	5	5	0.03362	0.03722	0.00642	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	07.02	17	17	0.02765	0.02862	0.00493	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	08	2	2	0.02590	0.02906	0.00501	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	13	57	57	0.04303	0.04509	0.00777	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	18	9	9	0.02602	0.03057	0.00527	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	20.01	9	8	0.03159	0.03438	0.00593	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	20.02	10	10	0.07413	0.09024	0.01556	5.8000	LCV_ALLO
Barium	7440-39-3	I	WHOL	21	18	16	0.04774	0.06138	0.01058	5.8000	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Barium	7440-39-3	I	WHOL	22	10	10	0.05437	0.07905	0.01363	5.8000	LCV_ALLO
Barium	7440-39-3	I	FLTR	00	1	1	0.02960	0.02960	0.00510	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	01	17	17	0.02340	0.02424	0.00418	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	02.01	3	3	0.02442	0.03179	0.00548	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	02.02	12	12	0.02406	0.02552	0.00440	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	02.03	6	6	0.02392	0.02622	0.00452	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	02.04	1	1	0.03217	0.03217	0.00555	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	03.01	13	13	0.03304	0.03667	0.00632	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	03.02	13	13	0.03367	0.03675	0.00634	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	03.03	13	13	0.02961	0.03215	0.00554	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	03.04	15	15	0.02902	0.03132	0.00540	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	04.01	15	15	0.02431	0.02557	0.00441	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	04.02	6	6	0.02405	0.02551	0.00440	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	04.04	9	9	0.02458	0.02601	0.00449	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	07.01	5	5	0.02982	0.03518	0.00607	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	07.02	17	16	0.02459	0.02593	0.00447	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	08	2	2	0.02440	0.03766	0.00649	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	13	46	46	0.03749	0.03974	0.00685	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	00	11	11	0.04841	0.07445	0.01284	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	01	48	48	0.03195	0.03459	0.00596	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	02.01	3	3	0.02860	0.03561	0.00614	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	02.02	21	21	0.02996	0.03178	0.00548	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	02.03	6	6	0.02873	0.03045	0.00525	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	02.04	10	9	0.03012	0.03289	0.00567	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	03.01	33	33	0.03491	0.03638	0.00627	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	03.02	13	13	0.03765	0.04029	0.00695	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	03.03	22	21	0.03539	0.03723	0.00642	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	03.04	15	15	0.03452	0.03658	0.00631	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	04.01	24	23	0.02938	0.03122	0.00538	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	04.02	6	6	0.02763	0.02890	0.00498	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	04.04	9	9	0.02763	0.02878	0.00496	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	07.01	5	5	0.03362	0.03722	0.00642	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	07.02	17	17	0.02765	0.02862	0.00493	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	08	2	2	0.02590	0.02906	0.00501	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	13	57	57	0.04303	0.04509	0.00777	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	18	9	9	0.02602	0.03057	0.00527	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	20.01	9	8	0.03159	0.03438	0.00593	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	20.02	10	10	0.07413	0.09024	0.01556	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	21	18	16	0.04774	0.06138	0.01058	5.8000	LCV_DAPH
Barium	7440-39-3	I	WHOL	22	10	10	0.05437	0.07905	0.01363	5.8000	LCV_DAPH
Barium	7440-39-3	I	FLTR	00	1	1	0.02960	0.02960	0.42836	0.0691	S_ACU_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Barium	7440-39-3	I	FLTR	01	17	17	0.02340	0.02424	0.35079	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	02.01	3	3	0.02442	0.03179	0.46012	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	02.02	12	12	0.02406	0.02552	0.36930	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	02.03	6	6	0.02392	0.02622	0.37944	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	02.04	1	1	0.03217	0.03217	0.46548	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	03.01	13	13	0.03304	0.03667	0.53065	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	03.02	13	13	0.03367	0.03675	0.53188	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	03.03	13	13	0.02961	0.03215	0.46533	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	03.04	15	15	0.02902	0.03132	0.45325	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	04.01	15	15	0.02431	0.02557	0.37007	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	04.02	6	6	0.02405	0.02551	0.36915	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	04.04	9	9	0.02458	0.02601	0.37648	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	07.01	5	5	0.02982	0.03518	0.50917	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	07.02	17	16	0.02459	0.02593	0.37526	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	08	2	2	0.02440	0.03766	0.54499	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	13	46	46	0.03749	0.03974	0.57514	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	00	11	11	0.04841	0.07445	1.07735	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	01	48	48	0.03195	0.03459	0.50061	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	02.01	3	3	0.02860	0.03561	0.51540	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	02.02	21	21	0.02996	0.03178	0.45987	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	02.03	6	6	0.02873	0.03045	0.44073	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	02.04	10	9	0.03012	0.03289	0.47601	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	03.01	33	33	0.03491	0.03638	0.52655	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	03.02	13	13	0.03765	0.04029	0.58305	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	03.03	22	21	0.03539	0.03723	0.53880	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	03.04	15	15	0.03452	0.03658	0.52937	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	04.01	24	23	0.02938	0.03122	0.45188	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	04.02	6	6	0.02763	0.02890	0.41826	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	04.04	9	9	0.02763	0.02878	0.41650	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	07.01	5	5	0.03362	0.03722	0.53863	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	07.02	17	17	0.02765	0.02862	0.41420	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	08	2	2	0.02590	0.02906	0.42050	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	13	57	57	0.04303	0.04509	0.65256	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	18	9	9	0.02602	0.03057	0.44239	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	20.01	9	8	0.03159	0.03438	0.49758	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	20.02	10	10	0.07413	0.09024	1.30590	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	21	18	16	0.04774	0.06138	0.88830	0.0691	S_ACU_V
Barium	7440-39-3	I	WHOL	22	10	10	0.05437	0.07905	1.14403	0.0691	S_ACU_V
Barium	7440-39-3	I	FLTR	00	1	1	0.02960	0.02960	7.78947	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	01	17	17	0.02340	0.02424	6.37887	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	02.01	3	3	0.02442	0.03179	8.36688	0.0038	S_CHR_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Barium	7440-39-3	I	FLTR	02.02	12	12	0.02406	0.02552	6.71541	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	02.03	6	6	0.02392	0.02622	6.89983	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	02.04	1	1	0.03217	0.03217	8.46447	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	03.01	13	13	0.03304	0.03667	9.64937	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	03.02	13	13	0.03367	0.03675	9.67173	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	03.03	13	13	0.02961	0.03215	8.46169	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	03.04	15	15	0.02902	0.03132	8.24197	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	04.01	15	15	0.02431	0.02557	6.72937	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	04.02	6	6	0.02405	0.02551	6.71276	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	04.04	9	9	0.02458	0.02601	6.84599	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	07.01	5	5	0.02982	0.03518	9.25889	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	07.02	17	16	0.02459	0.02593	6.82376	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	08	2	2	0.02440	0.03766	9.91023	0.0038	S_CHR_V
Barium	7440-39-3	I	FLTR	13	46	46	0.03749	0.03974	10.45841	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	00	11	11	0.04841	0.07445	19.59084	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	01	48	48	0.03195	0.03459	9.10328	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	02.01	3	3	0.02860	0.03561	9.37212	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	02.02	21	21	0.02996	0.03178	8.36243	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	02.03	6	6	0.02873	0.03045	8.01440	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	02.04	10	9	0.03012	0.03289	8.65582	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	03.01	33	33	0.03491	0.03638	9.57486	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	03.02	13	13	0.03765	0.04029	10.60239	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	03.03	22	21	0.03539	0.03723	9.79762	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	03.04	15	15	0.03452	0.03658	9.62609	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	04.01	24	23	0.02938	0.03122	8.21705	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	04.02	6	6	0.02763	0.02890	7.60581	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	04.04	9	9	0.02763	0.02878	7.57370	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	07.01	5	5	0.03362	0.03722	9.79453	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	07.02	17	17	0.02765	0.02862	7.53187	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	08	2	2	0.02590	0.02906	7.64655	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	13	57	57	0.04303	0.04509	11.86628	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	18	9	9	0.02602	0.03057	8.04459	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	20.01	9	8	0.03159	0.03438	9.04809	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	20.02	10	10	0.07413	0.09024	23.74678	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	21	18	16	0.04774	0.06138	16.15308	0.0038	S_CHR_V
Barium	7440-39-3	I	WHOL	22	10	10	0.05437	0.07905	20.80334	0.0038	S_CHR_V
Benzoic acid	65-85-0	O	FLTR	00	1	1	0.00100	0.00100	0.00008	12.9760	LCV_ALLO
Benzoic acid	65-85-0	O	FLTR	13	46	2	0.00150	0.00234	0.00018	12.9760	LCV_ALLO
Benzoic acid	65-85-0	O	FLTR	00	1	1	0.00100	0.00100	0.00008	12.9760	LCV_FISH
Benzoic acid	65-85-0	O	FLTR	13	46	2	0.00150	0.00234	0.00018	12.9760	LCV_FISH
Benzoic acid	65-85-0	O	FLTR	00	1	1	0.00100	0.00100	0.00013	7.4090	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Benzoic acid	65-85-0	O	FLTR	13	46	2	0.00150	0.00234	0.00032	7.4090	LTV_FISH
Benzoic acid	65-85-0	O	FLTR	00	1	1	0.00100	0.00100	0.00135	0.7430	S_ACU_V
Benzoic acid	65-85-0	O	FLTR	13	46	2	0.00150	0.00234	0.00315	0.7430	S_ACU_V
Benzoic acid	65-85-0	O	FLTR	00	1	1	0.00100	0.00100	0.02404	0.0416	S_CHR_V
Benzoic acid	65-85-0	O	FLTR	13	46	2	0.00150	0.00234	0.05624	0.0416	S_CHR_V
Beryllium	7440-41-7	I	WHOL	00	11	1	0.00120	0.00120	0.22642	0.0053	LCV_ALLO
Beryllium	7440-41-7	I	WHOL	01	51	1	0.00140	0.00140	0.26415	0.0053	LCV_ALLO
Beryllium	7440-41-7	I	WHOL	20.02	10	1	0.00100	0.00100	0.18868	0.0053	LCV_ALLO
Beryllium	7440-41-7	I	WHOL	00	11	1	0.00120	0.00120	0.00001	100.0000	LCV_AQPL
Beryllium	7440-41-7	I	WHOL	01	51	1	0.00140	0.00140	0.00001	100.0000	LCV_AQPL
Beryllium	7440-41-7	I	WHOL	20.02	10	1	0.00100	0.00100	0.00001	100.0000	LCV_AQPL
Beryllium	7440-41-7	I	WHOL	00	11	1	0.00120	0.00120	0.22642	0.0053	LCV_DAPH
Beryllium	7440-41-7	I	WHOL	01	51	1	0.00140	0.00140	0.26415	0.0053	LCV_DAPH
Beryllium	7440-41-7	I	WHOL	20.02	10	1	0.00100	0.00100	0.18868	0.0053	LCV_DAPH
Beryllium	7440-41-7	I	WHOL	00	11	1	0.00120	0.00120	0.02105	0.0570	LCV_FISH
Beryllium	7440-41-7	I	WHOL	01	51	1	0.00140	0.00140	0.02456	0.0570	LCV_FISH
Beryllium	7440-41-7	I	WHOL	20.02	10	1	0.00100	0.00100	0.01754	0.0570	LCV_FISH
Beryllium	7440-41-7	I	WHOL	00	11	1	0.00120	0.00120	0.31579	0.0038	LTV_DAPH
Beryllium	7440-41-7	I	WHOL	01	51	1	0.00140	0.00140	0.36842	0.0038	LTV_DAPH
Beryllium	7440-41-7	I	WHOL	20.02	10	1	0.00100	0.00100	0.26316	0.0038	LTV_DAPH
Beryllium	7440-41-7	I	WHOL	00	11	1	0.00120	0.00120	0.00811	0.1480	LTV_FISH
Beryllium	7440-41-7	I	WHOL	01	51	1	0.00140	0.00140	0.00946	0.1480	LTV_FISH
Beryllium	7440-41-7	I	WHOL	20.02	10	1	0.00100	0.00100	0.00676	0.1480	LTV_FISH
Beryllium	7440-41-7	I	WHOL	00	11	1	0.00120	0.00120	0.00443	0.2710	S_ACU_V
Beryllium	7440-41-7	I	WHOL	01	51	1	0.00140	0.00140	0.00517	0.2710	S_ACU_V
Beryllium	7440-41-7	I	WHOL	20.02	10	1	0.00100	0.00100	0.00369	0.2710	S_ACU_V
Beryllium	7440-41-7	I	WHOL	00	11	1	0.00120	0.00120	0.23576	0.0051	S_CHR_V
Beryllium	7440-41-7	I	WHOL	01	51	1	0.00140	0.00140	0.27505	0.0051	S_CHR_V
Beryllium	7440-41-7	I	WHOL	20.02	10	1	0.00100	0.00100	0.19646	0.0051	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	01	20	2	0.00230	0.00540	1.79949	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.01	2	1	0.00100	0.00100	0.33333	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.02	12	1	0.00400	0.00400	1.33333	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.03	5	1	0.00200	0.00200	0.66667	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.04	1	1	0.00350	0.00350	1.16667	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	03.01	12	1	0.00400	0.00400	1.33333	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.01	14	4	0.00150	0.00239	0.79516	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.02	6	1	0.00100	0.00100	0.33333	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.04	9	1	0.03000	0.03000	10.00000	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	13	46	4	0.00771	0.01738	5.79308	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	01	23	1	0.00200	0.00200	0.66667	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	02.04	2	1	0.03750	0.03750	12.50000	0.0030	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.02	12	2	0.00245	0.00356	1.18509	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.03	13	1	0.00100	0.00100	0.33333	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.01	5	1	0.00100	0.00100	0.33333	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.02	17	1	0.00600	0.00600	2.00000	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	10	2	1	0.00500	0.00500	1.66667	0.0030	LCV_ALLO
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	01	20	2	0.00230	0.00540	1.79949	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.01	2	1	0.00100	0.00100	0.33333	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.02	12	1	0.00400	0.00400	1.33333	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.03	5	1	0.00200	0.00200	0.66667	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.04	1	1	0.00350	0.00350	1.16667	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	03.01	12	1	0.00400	0.00400	1.33333	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.01	14	4	0.00150	0.00239	0.79516	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.02	6	1	0.00100	0.00100	0.33333	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.04	9	1	0.03000	0.03000	10.00000	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	13	46	4	0.00771	0.01738	5.79308	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	01	23	1	0.00200	0.00200	0.66667	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	02.04	2	1	0.03750	0.03750	12.50000	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.02	12	2	0.00245	0.00356	1.18509	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.03	13	1	0.00100	0.00100	0.33333	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.01	5	1	0.00100	0.00100	0.33333	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.02	17	1	0.00600	0.00600	2.00000	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	10	2	1	0.00500	0.00500	1.66667	0.0030	LCV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	01	20	2	0.00230	0.00540	0.64268	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.01	2	1	0.00100	0.00100	0.11905	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.02	12	1	0.00400	0.00400	0.47619	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.03	5	1	0.00200	0.00200	0.23810	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.04	1	1	0.00350	0.00350	0.41667	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	03.01	12	1	0.00400	0.00400	0.47619	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.01	14	4	0.00150	0.00239	0.28398	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.02	6	1	0.00100	0.00100	0.11905	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.04	9	1	0.03000	0.03000	3.57143	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	13	46	4	0.00771	0.01738	2.06896	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	01	23	1	0.00200	0.00200	0.23810	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	02.04	2	1	0.03750	0.03750	4.46429	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.02	12	2	0.00245	0.00356	0.42325	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.03	13	1	0.00100	0.00100	0.11905	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.01	5	1	0.00100	0.00100	0.11905	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.02	17	1	0.00600	0.00600	0.71429	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	10	2	1	0.00500	0.00500	0.59524	0.0084	LCV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	01	20	2	0.00230	0.00540	1.79949	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.01	2	1	0.00100	0.00100	0.33333	0.0030	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.02	12	1	0.00400	0.00400	1.33333	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.03	5	1	0.00200	0.00200	0.66667	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.04	1	1	0.00350	0.00350	1.16667	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	03.01	12	1	0.00400	0.00400	1.33333	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.01	14	4	0.00150	0.00239	0.79516	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.02	6	1	0.00100	0.00100	0.33333	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.04	9	1	0.03000	0.03000	10.00000	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	13	46	4	0.00771	0.01738	5.79308	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	01	23	1	0.00200	0.00200	0.66667	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	02.04	2	1	0.03750	0.03750	12.50000	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.02	12	2	0.00245	0.00356	1.18509	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.03	13	1	0.00100	0.00100	0.33333	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.01	5	1	0.00100	0.00100	0.33333	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.02	17	1	0.00600	0.00600	2.00000	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	10	2	1	0.00500	0.00500	1.66667	0.0030	LTV_DAPH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	01	20	2	0.00230	0.00540	0.09997	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.01	2	1	0.00100	0.00100	0.01852	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.02	12	1	0.00400	0.00400	0.07407	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.03	5	1	0.00200	0.00200	0.03704	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.04	1	1	0.00350	0.00350	0.06481	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	03.01	12	1	0.00400	0.00400	0.07407	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.01	14	4	0.00150	0.00239	0.04418	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.02	6	1	0.00100	0.00100	0.01852	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.04	9	1	0.03000	0.03000	0.55556	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	13	46	4	0.00771	0.01738	0.32184	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	01	23	1	0.00200	0.00200	0.03704	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	02.04	2	1	0.03750	0.03750	0.69444	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.02	12	2	0.00245	0.00356	0.06584	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.03	13	1	0.00100	0.00100	0.01852	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.01	5	1	0.00100	0.00100	0.01852	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.02	17	1	0.00600	0.00600	0.11111	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	10	2	1	0.00500	0.00500	0.09259	0.0540	LTV_FISH
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	01	20	2	0.00230	0.00540	0.01888	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.01	2	1	0.00100	0.00100	0.00350	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.02	12	1	0.00400	0.00400	0.01399	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.03	5	1	0.00200	0.00200	0.00699	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.04	1	1	0.00350	0.00350	0.01224	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	03.01	12	1	0.00400	0.00400	0.01399	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.01	14	4	0.00150	0.00239	0.00834	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.02	6	1	0.00100	0.00100	0.00350	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.04	9	1	0.03000	0.03000	0.10490	0.2860	S_ACU_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	13	46	4	0.00771	0.01738	0.06077	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	01	23	1	0.00200	0.00200	0.00699	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	02.04	2	1	0.03750	0.03750	0.13112	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.02	12	2	0.00245	0.00356	0.01243	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.03	13	1	0.00100	0.00100	0.00350	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.01	5	1	0.00100	0.00100	0.00350	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.02	17	1	0.00600	0.00600	0.02098	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	10	2	1	0.00500	0.00500	0.01748	0.2860	S_ACU_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	01	20	2	0.00230	0.00540	0.16765	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.01	2	1	0.00100	0.00100	0.03106	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.02	12	1	0.00400	0.00400	0.12422	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.03	5	1	0.00200	0.00200	0.06211	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	02.04	1	1	0.00350	0.00350	0.10870	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	03.01	12	1	0.00400	0.00400	0.12422	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.01	14	4	0.00150	0.00239	0.07408	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.02	6	1	0.00100	0.00100	0.03106	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	04.04	9	1	0.03000	0.03000	0.93168	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	FLTR	13	46	4	0.00771	0.01738	0.53973	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	01	23	1	0.00200	0.00200	0.06211	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	02.04	2	1	0.03750	0.03750	1.16460	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.02	12	2	0.00245	0.00356	0.11041	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	03.03	13	1	0.00100	0.00100	0.03106	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.01	5	1	0.00100	0.00100	0.03106	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	07.02	17	1	0.00600	0.00600	0.18634	0.0322	S_CHR_V
Bis(2-ethylhexyl)phthalate	117-81-7	O	WHOL	10	2	1	0.00500	0.00500	0.15528	0.0322	S_CHR_V
Boron	7440-42-8	I	FLTR	00	1	1	0.01730	0.01730	0.00196	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	01	17	13	0.04409	0.05372	0.00608	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	02.01	3	2	0.04849	0.13701	0.01552	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	02.02	12	8	0.04383	0.06298	0.00713	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	02.03	6	3	0.03622	0.05458	0.00618	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	02.04	1	1	0.03358	0.03358	0.00380	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	03.01	13	12	0.05282	0.07547	0.00855	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	03.02	13	12	0.04983	0.06423	0.00727	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	03.03	13	10	0.04094	0.05290	0.00599	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	03.04	15	14	0.03896	0.05111	0.00579	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	04.01	15	10	0.04030	0.05182	0.00587	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	04.02	6	5	0.02926	0.04244	0.00481	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	04.04	9	7	0.04937	0.06064	0.00687	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	07.01	5	3	0.03543	0.04793	0.00543	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	07.02	17	9	0.05170	0.06463	0.00732	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	08	2	1	0.01170	0.01170	0.00133	8.8300	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Boron	7440-42-8	I	FLTR	13	46	38	0.04165	0.04697	0.00532	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	00	1	1	0.02640	0.02640	0.00299	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	01	20	16	0.05201	0.06507	0.00737	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	02.01	3	1	0.09020	0.09020	0.01022	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	02.02	12	7	0.04421	0.04792	0.00543	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	02.03	6	3	0.04377	0.05784	0.00655	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	02.04	1	1	0.04290	0.04290	0.00486	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	03.01	33	22	0.02717	0.03714	0.00421	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	03.02	13	12	0.05020	0.06789	0.00769	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	03.03	13	10	0.03399	0.04700	0.00532	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	03.04	15	13	0.04760	0.06455	0.00731	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	04.01	15	10	0.04757	0.06308	0.00714	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	04.02	6	4	0.03413	0.04086	0.00463	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	04.04	9	6	0.04023	0.05978	0.00677	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	07.01	5	2	0.03783	0.05826	0.00660	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	07.02	17	10	0.04345	0.05779	0.00654	8.8300	LCV_ALLO
Boron	7440-42-8	I	WHOL	13	48	43	0.04747	0.05448	0.00617	8.8300	LCV_ALLO
Boron	7440-42-8	I	FLTR	00	1	1	0.01730	0.01730	0.00196	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	01	17	13	0.04409	0.05372	0.00608	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	02.01	3	2	0.04849	0.13701	0.01552	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	02.02	12	8	0.04383	0.06298	0.00713	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	02.03	6	3	0.03622	0.05458	0.00618	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	02.04	1	1	0.03358	0.03358	0.00380	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	03.01	13	12	0.05282	0.07547	0.00855	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	03.02	13	12	0.04983	0.06423	0.00727	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	03.03	13	10	0.04094	0.05290	0.00599	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	03.04	15	14	0.03896	0.05111	0.00579	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	04.01	15	10	0.04030	0.05182	0.00587	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	04.02	6	5	0.02926	0.04244	0.00481	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	04.04	9	7	0.04937	0.06064	0.00687	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	07.01	5	3	0.03543	0.04793	0.00543	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	07.02	17	9	0.05170	0.06463	0.00732	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	08	2	1	0.01170	0.01170	0.00133	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	13	46	38	0.04165	0.04697	0.00532	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	00	1	1	0.02640	0.02640	0.00299	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	01	20	16	0.05201	0.06507	0.00737	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	02.01	3	1	0.09020	0.09020	0.01022	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	02.02	12	7	0.04421	0.04792	0.00543	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	02.03	6	3	0.04377	0.05784	0.00655	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	02.04	1	1	0.04290	0.04290	0.00486	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	03.01	33	22	0.02717	0.03714	0.00421	8.8300	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Boron	7440-42-8	I	WHOL	03.02	13	12	0.05020	0.06789	0.00769	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	03.03	13	10	0.03399	0.04700	0.00532	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	03.04	15	13	0.04760	0.06455	0.00731	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	04.01	15	10	0.04757	0.06308	0.00714	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	04.02	6	4	0.03413	0.04086	0.00463	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	04.04	9	6	0.04023	0.05978	0.00677	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	07.01	5	2	0.03783	0.05826	0.00660	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	07.02	17	10	0.04345	0.05779	0.00654	8.8300	LCV_DAPH
Boron	7440-42-8	I	WHOL	13	48	43	0.04747	0.05448	0.00617	8.8300	LCV_DAPH
Boron	7440-42-8	I	FLTR	00	1	1	0.01730	0.01730	2.47143	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	01	17	13	0.04409	0.05372	7.67495	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	02.01	3	2	0.04849	0.13701	19.57313	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	02.02	12	8	0.04383	0.06298	8.99677	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	02.03	6	3	0.03622	0.05458	7.79762	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	02.04	1	1	0.03358	0.03358	4.79643	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	03.01	13	12	0.05282	0.07547	10.78198	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	03.02	13	12	0.04983	0.06423	9.17642	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	03.03	13	10	0.04094	0.05290	7.55659	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	03.04	15	14	0.03896	0.05111	7.30111	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	04.01	15	10	0.04030	0.05182	7.40336	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	04.02	6	5	0.02926	0.04244	6.06357	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	04.04	9	7	0.04937	0.06064	8.66286	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	07.01	5	3	0.03543	0.04793	6.84678	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	07.02	17	9	0.05170	0.06463	9.23322	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	08	2	1	0.01170	0.01170	1.67143	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	13	46	38	0.04165	0.04697	6.70946	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	00	1	1	0.02640	0.02640	3.77143	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	01	20	16	0.05201	0.06507	9.29598	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	02.01	3	1	0.09020	0.09020	12.88571	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	02.02	12	7	0.04421	0.04792	6.84538	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	02.03	6	3	0.04377	0.05784	8.26277	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	02.04	1	1	0.04290	0.04290	6.12857	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	03.01	33	22	0.02717	0.03714	5.30578	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	03.02	13	12	0.05020	0.06789	9.69795	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	03.03	13	10	0.03399	0.04700	6.71419	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	03.04	15	13	0.04760	0.06455	9.22192	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	04.01	15	10	0.04757	0.06308	9.01173	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	04.02	6	4	0.03413	0.04086	5.83643	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	04.04	9	6	0.04023	0.05978	8.54057	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	07.01	5	2	0.03783	0.05826	8.32226	0.0070	LTV_DAPH
Boron	7440-42-8	I	WHOL	07.02	17	10	0.04345	0.05779	8.25564	0.0070	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Boron	7440-42-8	I	WHOL	13	48	43	0.04747	0.05448	7.78321	0.0070	LTV_DAPH
Boron	7440-42-8	I	FLTR	00	1	1	0.01730	0.01730	0.00157	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	01	17	13	0.04409	0.05372	0.00488	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	02.01	3	2	0.04849	0.13701	0.01246	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	02.02	12	8	0.04383	0.06298	0.00573	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	02.03	6	3	0.03622	0.05458	0.00496	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	02.04	1	1	0.03358	0.03358	0.00305	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	03.01	13	12	0.05282	0.07547	0.00686	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	03.02	13	12	0.04983	0.06423	0.00584	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	03.03	13	10	0.04094	0.05290	0.00481	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	03.04	15	14	0.03896	0.05111	0.00465	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	04.01	15	10	0.04030	0.05182	0.00471	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	04.02	6	5	0.02926	0.04244	0.00386	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	04.04	9	7	0.04937	0.06064	0.00551	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	07.01	5	3	0.03543	0.04793	0.00436	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	07.02	17	9	0.05170	0.06463	0.00588	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	08	2	1	0.01170	0.01170	0.00106	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	13	46	38	0.04165	0.04697	0.00427	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	00	1	1	0.02640	0.02640	0.00240	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	01	20	16	0.05201	0.06507	0.00592	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	02.01	3	1	0.09020	0.09020	0.00820	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	02.02	12	7	0.04421	0.04792	0.00436	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	02.03	6	3	0.04377	0.05784	0.00526	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	02.04	1	1	0.04290	0.04290	0.00390	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	03.01	33	22	0.02717	0.03714	0.00338	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	03.02	13	12	0.05020	0.06789	0.00617	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	03.03	13	10	0.03399	0.04700	0.00427	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	03.04	15	13	0.04760	0.06455	0.00587	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	04.01	15	10	0.04757	0.06308	0.00573	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	04.02	6	4	0.03413	0.04086	0.00371	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	04.04	9	6	0.04023	0.05978	0.00543	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	07.01	5	2	0.03783	0.05826	0.00530	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	07.02	17	10	0.04345	0.05779	0.00525	11.0000	S_ACU_V
Boron	7440-42-8	I	WHOL	13	48	43	0.04747	0.05448	0.00495	11.0000	S_ACU_V
Boron	7440-42-8	I	FLTR	00	1	1	0.01730	0.01730	0.03163	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	01	17	13	0.04409	0.05372	0.09822	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	02.01	3	2	0.04849	0.13701	0.25048	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	02.02	12	8	0.04383	0.06298	0.11513	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	02.03	6	3	0.03622	0.05458	0.09979	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	02.04	1	1	0.03358	0.03358	0.06138	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	03.01	13	12	0.05282	0.07547	0.13798	0.5470	S_CHR_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Boron	7440-42-8	I	FLTR	03.02	13	12	0.04983	0.06423	0.11743	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	03.03	13	10	0.04094	0.05290	0.09670	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	03.04	15	14	0.03896	0.05111	0.09343	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	04.01	15	10	0.04030	0.05182	0.09474	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	04.02	6	5	0.02926	0.04244	0.07760	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	04.04	9	7	0.04937	0.06064	0.11086	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	07.01	5	3	0.03543	0.04793	0.08762	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	07.02	17	9	0.05170	0.06463	0.11816	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	08	2	1	0.01170	0.01170	0.02139	0.5470	S_CHR_V
Boron	7440-42-8	I	FLTR	13	46	38	0.04165	0.04697	0.08586	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	00	1	1	0.02640	0.02640	0.04826	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	01	20	16	0.05201	0.06507	0.11896	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	02.01	3	1	0.09020	0.09020	0.16490	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	02.02	12	7	0.04421	0.04792	0.08760	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	02.03	6	3	0.04377	0.05784	0.10574	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	02.04	1	1	0.04290	0.04290	0.07843	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	03.01	33	22	0.02717	0.03714	0.06790	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	03.02	13	12	0.05020	0.06789	0.12411	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	03.03	13	10	0.03399	0.04700	0.08592	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	03.04	15	13	0.04760	0.06455	0.11801	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	04.01	15	10	0.04757	0.06308	0.11532	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	04.02	6	4	0.03413	0.04086	0.07469	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	04.04	9	6	0.04023	0.05978	0.10929	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	07.01	5	2	0.03783	0.05826	0.10650	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	07.02	17	10	0.04345	0.05779	0.10565	0.5470	S_CHR_V
Boron	7440-42-8	I	WHOL	13	48	43	0.04747	0.05448	0.09960	0.5470	S_CHR_V
Cadmium	7440-43-9	I	FLTR	01	20	1	0.00039	0.00039	2.60000	0.0002	LCV_ALLO
Cadmium	7440-43-9	I	FLTR	04.04	11	1	0.00031	0.00031	2.06667	0.0002	LCV_ALLO
Cadmium	7440-43-9	I	FLTR	13	47	1	0.00240	0.00240	16.00000	0.0002	LCV_ALLO
Cadmium	7440-43-9	I	FLTR	22	1	1	0.00240	0.00240	16.00000	0.0002	LCV_ALLO
Cadmium	7440-43-9	I	WHOL	22	11	1	0.00036	0.00036	2.40000	0.0002	LCV_ALLO
Cadmium	7440-43-9	I	FLTR	01	20	1	0.00039	0.00039	0.19500	0.0020	LCV_AQPL
Cadmium	7440-43-9	I	FLTR	04.04	11	1	0.00031	0.00031	0.15500	0.0020	LCV_AQPL
Cadmium	7440-43-9	I	FLTR	13	47	1	0.00240	0.00240	1.20000	0.0020	LCV_AQPL
Cadmium	7440-43-9	I	FLTR	22	1	1	0.00240	0.00240	1.20000	0.0020	LCV_AQPL
Cadmium	7440-43-9	I	WHOL	22	11	1	0.00036	0.00036	0.18000	0.0020	LCV_AQPL
Cadmium	7440-43-9	I	FLTR	01	20	1	0.00039	0.00039	2.60000	0.0002	LCV_DAPH
Cadmium	7440-43-9	I	FLTR	04.04	11	1	0.00031	0.00031	2.06667	0.0002	LCV_DAPH
Cadmium	7440-43-9	I	FLTR	13	47	1	0.00240	0.00240	16.00000	0.0002	LCV_DAPH
Cadmium	7440-43-9	I	FLTR	22	1	1	0.00240	0.00240	16.00000	0.0002	LCV_DAPH
Cadmium	7440-43-9	I	WHOL	22	11	1	0.00036	0.00036	2.40000	0.0002	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Cadmium	7440-43-9	I	FLTR	01	20	1	0.00039	0.00039	0.22941	0.0017	LCV_FISH
Cadmium	7440-43-9	I	FLTR	04.04	11	1	0.00031	0.00031	0.18235	0.0017	LCV_FISH
Cadmium	7440-43-9	I	FLTR	13	47	1	0.00240	0.00240	1.41176	0.0017	LCV_FISH
Cadmium	7440-43-9	I	FLTR	22	1	1	0.00240	0.00240	1.41176	0.0017	LCV_FISH
Cadmium	7440-43-9	I	WHOL	22	11	1	0.00036	0.00036	0.21176	0.0017	LCV_FISH
Cadmium	7440-43-9	I	FLTR	01	20	1	0.00039	0.00039	0.52000	0.0008	LTV_DAPH
Cadmium	7440-43-9	I	FLTR	04.04	11	1	0.00031	0.00031	0.41333	0.0008	LTV_DAPH
Cadmium	7440-43-9	I	FLTR	13	47	1	0.00240	0.00240	3.20000	0.0008	LTV_DAPH
Cadmium	7440-43-9	I	FLTR	22	1	1	0.00240	0.00240	3.20000	0.0008	LTV_DAPH
Cadmium	7440-43-9	I	WHOL	22	11	1	0.00036	0.00036	0.48000	0.0008	LTV_DAPH
Cadmium	7440-43-9	I	FLTR	01	20	1	0.00039	0.00039	0.21667	0.0018	LTV_FISH
Cadmium	7440-43-9	I	FLTR	04.04	11	1	0.00031	0.00031	0.17222	0.0018	LTV_FISH
Cadmium	7440-43-9	I	FLTR	13	47	1	0.00240	0.00240	1.33333	0.0018	LTV_FISH
Cadmium	7440-43-9	I	FLTR	22	1	1	0.00240	0.00240	1.33333	0.0018	LTV_FISH
Cadmium	7440-43-9	I	WHOL	22	11	1	0.00036	0.00036	0.20000	0.0018	LTV_FISH
Cadmium	7440-43-9	I	FLTR	01	20	1	0.00039	0.00039	0.10000	0.0039	NAWQ_ACU
Cadmium	7440-43-9	I	FLTR	04.04	11	1	0.00031	0.00031	0.07949	0.0039	NAWQ_ACU
Cadmium	7440-43-9	I	FLTR	13	47	1	0.00240	0.00240	0.61538	0.0039	NAWQ_ACU
Cadmium	7440-43-9	I	FLTR	22	1	1	0.00240	0.00240	0.61538	0.0039	NAWQ_ACU
Cadmium	7440-43-9	I	WHOL	22	11	1	0.00036	0.00036	0.09231	0.0039	NAWQ_ACU
Cadmium	7440-43-9	I	FLTR	01	20	1	0.00039	0.00039	0.35455	0.0011	NAWQ_CHR
Cadmium	7440-43-9	I	FLTR	04.04	11	1	0.00031	0.00031	0.28182	0.0011	NAWQ_CHR
Cadmium	7440-43-9	I	FLTR	13	47	1	0.00240	0.00240	2.18182	0.0011	NAWQ_CHR
Cadmium	7440-43-9	I	FLTR	22	1	1	0.00240	0.00240	2.18182	0.0011	NAWQ_CHR
Cadmium	7440-43-9	I	WHOL	22	11	1	0.00036	0.00036	0.32727	0.0011	NAWQ_CHR
Calcium	7440-70-2	I	FLTR	00	1	1	32.20000	32.20000	0.27759	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	01	20	20	28.30754	29.55724	0.25480	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	02.01	3	3	28.18855	37.02582	0.31919	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	02.02	13	13	27.07692	28.79939	0.24827	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	02.03	6	6	27.16000	29.97594	0.25841	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	02.04	2	2	35.11474	38.99606	0.33617	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	03.01	14	14	25.82495	29.65099	0.25561	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	03.02	14	14	28.42394	31.96497	0.27556	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	03.03	14	14	24.95233	28.14448	0.24262	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	03.04	16	15	24.93004	27.48386	0.23693	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	04.01	16	16	27.38070	28.83334	0.24856	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	04.02	6	6	27.31167	28.39043	0.24475	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	04.04	10	10	23.75063	25.91987	0.22345	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	05	4	4	21.97500	30.62735	0.26403	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	07.01	5	5	31.02000	32.09737	0.27670	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	07.02	17	16	27.55882	28.68024	0.24724	116.0000	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Calcium	7440-70-2	I	FLTR	08	2	2	28.30000	47.24125	0.40725	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	10	2	2	34.30000	37.45688	0.32290	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	13	47	47	24.90395	26.65514	0.22979	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	22	1	1	35.30000	35.30000	0.30431	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	00	11	11	31.70000	33.54447	0.28918	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	01	51	51	30.78637	31.71534	0.27341	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	02.01	3	3	30.60000	38.09210	0.32838	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	02.02	22	22	29.31364	30.85958	0.26603	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	02.03	6	6	28.53333	31.72181	0.27346	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	02.04	11	11	31.74545	33.62352	0.28986	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	03.01	34	33	23.66201	26.12697	0.22523	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	03.02	14	14	28.70714	32.02776	0.27610	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	03.03	23	23	26.76522	29.44923	0.25387	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	03.04	16	15	25.36250	27.78153	0.23950	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	04.01	25	25	28.30200	29.59237	0.25511	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	04.02	6	6	27.96667	29.59513	0.25513	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	04.04	10	10	23.75500	25.84438	0.22280	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	05	4	4	21.92500	30.69812	0.26464	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	07.01	5	5	31.74000	32.95646	0.28411	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	07.02	17	17	28.83779	29.97667	0.25842	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	08	2	2	27.90000	31.05688	0.26773	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	10	2	2	34.55000	36.12844	0.31145	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	13	58	58	25.65626	27.29581	0.23531	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	18	9	9	18.66667	20.44137	0.17622	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	20.01	9	9	44.20000	46.40657	0.40006	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	20.02	10	10	42.69000	48.18448	0.41538	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	21	18	18	32.93333	38.91140	0.33544	116.0000	LCV_ALLO
Calcium	7440-70-2	I	WHOL	22	11	11	39.12727	42.80439	0.36900	116.0000	LCV_ALLO
Calcium	7440-70-2	I	FLTR	00	1	1	32.20000	32.20000	0.27759	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	01	20	20	28.30754	29.55724	0.25480	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	02.01	3	3	28.18855	37.02582	0.31919	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	02.02	13	13	27.07692	28.79939	0.24827	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	02.03	6	6	27.16000	29.97594	0.25841	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	02.04	2	2	35.11474	38.99606	0.33617	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	03.01	14	14	25.82495	29.65099	0.25561	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	03.02	14	14	28.42394	31.96497	0.27556	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	03.03	14	14	24.95233	28.14448	0.24262	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	03.04	16	15	24.93004	27.48386	0.23693	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	04.01	16	16	27.38070	28.83334	0.24856	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	04.02	6	6	27.31167	28.39043	0.24475	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	04.04	10	10	23.75063	25.91987	0.22345	116.0000	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Calcium	7440-70-2	I	FLTR	05	4	4	21.97500	30.62735	0.26403	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	07.01	5	5	31.02000	32.09737	0.27670	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	07.02	17	16	27.55882	28.68024	0.24724	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	08	2	2	28.30000	47.24125	0.40725	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	10	2	2	34.30000	37.45688	0.32290	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	13	47	47	24.90395	26.65514	0.22979	116.0000	LCV_DAPH
Calcium	7440-70-2	I	FLTR	22	1	1	35.30000	35.30000	0.30431	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	00	11	11	31.70000	33.54447	0.28918	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	01	51	51	30.78637	31.71534	0.27341	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	02.01	3	3	30.60000	38.09210	0.32838	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	02.02	22	22	29.31364	30.85958	0.26603	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	02.03	6	6	28.53333	31.72181	0.27346	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	02.04	11	11	31.74545	33.62352	0.28986	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	03.01	34	33	23.66201	26.12697	0.22523	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	03.02	14	14	28.70714	32.02776	0.27610	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	03.03	23	23	26.76522	29.44923	0.25387	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	03.04	16	15	25.36250	27.78153	0.23950	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	04.01	25	25	28.30200	29.59237	0.25511	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	04.02	6	6	27.96667	29.59513	0.25513	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	04.04	10	10	23.75500	25.84438	0.22280	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	05	4	4	21.92500	30.69812	0.26464	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	07.01	5	5	31.74000	32.95646	0.28411	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	07.02	17	17	28.83779	29.97667	0.25842	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	08	2	2	27.90000	31.05688	0.26773	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	10	2	2	34.55000	36.12844	0.31145	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	13	58	58	25.65626	27.29581	0.23531	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	18	9	9	18.66667	20.44137	0.17622	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	20.01	9	9	44.20000	46.40657	0.40006	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	20.02	10	10	42.69000	48.18448	0.41538	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	21	18	18	32.93333	38.91140	0.33544	116.0000	LCV_DAPH
Calcium	7440-70-2	I	WHOL	22	11	11	39.12727	42.80439	0.36900	116.0000	LCV_DAPH
Carbon disulfide	75-15-0	O	WHOL	02.04	9	1	0.01000	0.01000	0.04098	0.2440	LCV_ALLO
Carbon disulfide	75-15-0	O	WHOL	03.03	9	2	0.00578	0.01019	0.04174	0.2440	LCV_ALLO
Carbon disulfide	75-15-0	O	WHOL	13	9	1	0.02400	0.02400	0.09836	0.2440	LCV_ALLO
Carbon disulfide	75-15-0	O	WHOL	02.04	9	1	0.01000	0.01000	0.04098	0.2440	LCV_DAPH
Carbon disulfide	75-15-0	O	WHOL	03.03	9	2	0.00578	0.01019	0.04174	0.2440	LCV_DAPH
Carbon disulfide	75-15-0	O	WHOL	13	9	1	0.02400	0.02400	0.09836	0.2440	LCV_DAPH
Carbon disulfide	75-15-0	O	WHOL	02.04	9	1	0.01000	0.01000	0.00105	9.5380	LCV_FISH
Carbon disulfide	75-15-0	O	WHOL	03.03	9	2	0.00578	0.01019	0.00107	9.5380	LCV_FISH
Carbon disulfide	75-15-0	O	WHOL	13	9	1	0.02400	0.02400	0.00252	9.5380	LCV_FISH
Carbon disulfide	75-15-0	O	WHOL	02.04	9	1	0.01000	0.01000	0.00175	5.7190	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Carbon disulfide	75-15-0	O	WHOL	03.03	9	2	0.00578	0.01019	0.00178	5.7190	LTV_FISH
Carbon disulfide	75-15-0	O	WHOL	13	9	1	0.02400	0.02400	0.00420	5.7190	LTV_FISH
Carbon disulfide	75-15-0	O	WHOL	02.04	9	1	0.01000	0.01000	0.06289	0.1590	S_ACU_V
Carbon disulfide	75-15-0	O	WHOL	03.03	9	2	0.00578	0.01019	0.06406	0.1590	S_ACU_V
Carbon disulfide	75-15-0	O	WHOL	13	9	1	0.02400	0.02400	0.15094	0.1590	S_ACU_V
Carbon disulfide	75-15-0	O	WHOL	02.04	9	1	0.01000	0.01000	1.12486	0.0089	S_CHR_V
Carbon disulfide	75-15-0	O	WHOL	03.03	9	2	0.00578	0.01019	1.14574	0.0089	S_CHR_V
Carbon disulfide	75-15-0	O	WHOL	13	9	1	0.02400	0.02400	2.69966	0.0089	S_CHR_V
Chloroform	67-66-3	O	WHOL	03.03	9	1	0.00400	0.00400	0.00323	1.2400	LCV_ALLO
Chloroform	67-66-3	O	WHOL	21	18	6	0.00217	0.00286	0.00231	1.2400	LCV_ALLO
Chloroform	67-66-3	O	WHOL	03.03	9	1	0.00400	0.00400	0.00089	4.4830	LCV_DAPH
Chloroform	67-66-3	O	WHOL	21	18	6	0.00217	0.00286	0.00064	4.4830	LCV_DAPH
Chloroform	67-66-3	O	WHOL	03.03	9	1	0.00400	0.00400	0.00323	1.2400	LCV_FISH
Chloroform	67-66-3	O	WHOL	21	18	6	0.00217	0.00286	0.00231	1.2400	LCV_FISH
Chloroform	67-66-3	O	WHOL	03.03	9	1	0.00400	0.00400	0.00048	8.4000	LTV_FISH
Chloroform	67-66-3	O	WHOL	21	18	6	0.00217	0.00286	0.00034	8.4000	LTV_FISH
Chloroform	67-66-3	O	WHOL	03.03	9	1	0.00400	0.00400	0.00119	3.3600	S_ACU_V
Chloroform	67-66-3	O	WHOL	21	18	6	0.00217	0.00286	0.00085	3.3600	S_ACU_V
Chloroform	67-66-3	O	WHOL	03.03	9	1	0.00400	0.00400	0.02128	0.1880	S_CHR_V
Chloroform	67-66-3	O	WHOL	21	18	6	0.00217	0.00286	0.01523	0.1880	S_CHR_V
Chromium	7440-47-3	I	FLTR	00	1	1	0.00150	0.00150	0.03409	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	01	20	12	0.00198	0.00250	0.05682	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	02.01	3	3	0.00186	0.00377	0.08578	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	02.02	13	5	0.00141	0.00171	0.03890	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	02.03	6	5	0.00169	0.00217	0.04926	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	02.04	2	1	0.00167	0.00167	0.03795	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	03.01	14	8	0.00171	0.00205	0.04669	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	03.02	14	9	0.00137	0.00165	0.03740	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	03.03	14	10	0.00149	0.00172	0.03914	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	03.04	16	9	0.00167	0.00210	0.04763	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	04.01	16	8	0.00158	0.00208	0.04717	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	04.02	6	3	0.00138	0.00193	0.04377	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	04.04	10	6	0.00250	0.00338	0.07681	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	07.01	5	1	0.00140	0.00140	0.03182	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	07.02	17	6	0.00200	0.00271	0.06160	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	13	47	34	0.00159	0.00174	0.03964	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	00	11	4	0.00389	0.00622	0.14130	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	01	51	20	0.00258	0.00314	0.07127	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	02.01	3	3	0.00230	0.00393	0.08922	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	02.02	22	7	0.00290	0.00543	0.12333	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	02.03	6	4	0.00193	0.00262	0.05959	0.0440	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Chromium	7440-47-3	I	WHOL	02.04	11	1	0.00155	0.00155	0.03523	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	03.01	34	32	0.00194	0.00208	0.04726	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	03.02	14	11	0.00160	0.00185	0.04206	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	03.03	23	13	0.00223	0.00260	0.05910	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	03.04	16	12	0.00200	0.00234	0.05326	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	04.01	25	10	0.00170	0.00184	0.04192	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	04.02	6	4	0.00150	0.00190	0.04308	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	04.04	10	6	0.00241	0.00382	0.08671	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	07.01	5	2	0.00123	0.00181	0.04119	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	07.02	17	8	0.00159	0.00177	0.04017	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	08	2	1	0.00100	0.00100	0.02273	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	13	58	43	0.00219	0.00251	0.05706	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	18	9	2	0.00536	0.00549	0.12485	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	20.02	10	3	0.01054	0.01160	0.26370	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	21	18	9	0.00654	0.00819	0.18612	0.0440	LCV_ALLO
Chromium	7440-47-3	I	WHOL	22	11	11	0.01379	0.01696	0.38548	0.0440	LCV_ALLO
Chromium	7440-47-3	I	FLTR	00	1	1	0.00150	0.00150	0.00378	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	01	20	12	0.00198	0.00250	0.00630	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	02.01	3	3	0.00186	0.00377	0.00951	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	02.02	13	5	0.00141	0.00171	0.00431	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	02.03	6	5	0.00169	0.00217	0.00546	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	02.04	2	1	0.00167	0.00167	0.00421	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	03.01	14	8	0.00171	0.00205	0.00518	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	03.02	14	9	0.00137	0.00165	0.00415	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	03.03	14	10	0.00149	0.00172	0.00434	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	03.04	16	9	0.00167	0.00210	0.00528	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	04.01	16	8	0.00158	0.00208	0.00523	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	04.02	6	3	0.00138	0.00193	0.00485	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	04.04	10	6	0.00250	0.00338	0.00851	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	07.01	5	1	0.00140	0.00140	0.00353	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	07.02	17	6	0.00200	0.00271	0.00683	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	13	47	34	0.00159	0.00174	0.00439	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	00	11	4	0.00389	0.00622	0.01566	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	01	51	20	0.00258	0.00314	0.00790	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	02.01	3	3	0.00230	0.00393	0.00989	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	02.02	22	7	0.00290	0.00543	0.01367	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	02.03	6	4	0.00193	0.00262	0.00660	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	02.04	11	1	0.00155	0.00155	0.00390	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	03.01	34	32	0.00194	0.00208	0.00524	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	03.02	14	11	0.00160	0.00185	0.00466	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	03.03	23	13	0.00223	0.00260	0.00655	0.3970	LCV_AQPL

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Chromium	7440-47-3	I	WHOL	03.04	16	12	0.00200	0.00234	0.00590	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	04.01	25	10	0.00170	0.00184	0.00465	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	04.02	6	4	0.00150	0.00190	0.00477	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	04.04	10	6	0.00241	0.00382	0.00961	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	07.01	5	2	0.00123	0.00181	0.00457	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	07.02	17	8	0.00159	0.00177	0.00445	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	08	2	1	0.00100	0.00100	0.00252	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	13	58	43	0.00219	0.00251	0.00632	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	18	9	2	0.00536	0.00549	0.01384	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	20.02	10	3	0.01054	0.01160	0.02923	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	21	18	9	0.00654	0.00819	0.02063	0.3970	LCV_AQPL
Chromium	7440-47-3	I	WHOL	22	11	11	0.01379	0.01696	0.04272	0.3970	LCV_AQPL
Chromium	7440-47-3	I	FLTR	00	1	1	0.00150	0.00150	0.03409	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	01	20	12	0.00198	0.00250	0.05682	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	02.01	3	3	0.00186	0.00377	0.08578	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	02.02	13	5	0.00141	0.00171	0.03890	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	02.03	6	5	0.00169	0.00217	0.04926	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	02.04	2	1	0.00167	0.00167	0.03795	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	03.01	14	8	0.00171	0.00205	0.04669	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	03.02	14	9	0.00137	0.00165	0.03740	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	03.03	14	10	0.00149	0.00172	0.03914	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	03.04	16	9	0.00167	0.00210	0.04763	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	04.01	16	8	0.00158	0.00208	0.04717	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	04.02	6	3	0.00138	0.00193	0.04377	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	04.04	10	6	0.00250	0.00338	0.07681	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	07.01	5	1	0.00140	0.00140	0.03182	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	07.02	17	6	0.00200	0.00271	0.06160	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	13	47	34	0.00159	0.00174	0.03964	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	00	11	4	0.00389	0.00622	0.14130	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	01	51	20	0.00258	0.00314	0.07127	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	02.01	3	3	0.00230	0.00393	0.08922	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	02.02	22	7	0.00290	0.00543	0.12333	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	02.03	6	4	0.00193	0.00262	0.05959	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	02.04	11	1	0.00155	0.00155	0.03523	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	03.01	34	32	0.00194	0.00208	0.04726	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	03.02	14	11	0.00160	0.00185	0.04206	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	03.03	23	13	0.00223	0.00260	0.05910	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	03.04	16	12	0.00200	0.00234	0.05326	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	04.01	25	10	0.00170	0.00184	0.04192	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	04.02	6	4	0.00150	0.00190	0.04308	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	04.04	10	6	0.00241	0.00382	0.08671	0.0440	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Chromium	7440-47-3	I	WHOL	07.01	5	2	0.00123	0.00181	0.04119	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	07.02	17	8	0.00159	0.00177	0.04017	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	08	2	1	0.00100	0.00100	0.02273	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	13	58	43	0.00219	0.00251	0.05706	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	18	9	2	0.00536	0.00549	0.12485	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	20.02	10	3	0.01054	0.01160	0.26370	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	21	18	9	0.00654	0.00819	0.18612	0.0440	LCV_DAPH
Chromium	7440-47-3	I	WHOL	22	11	11	0.01379	0.01696	0.38548	0.0440	LCV_DAPH
Chromium	7440-47-3	I	FLTR	00	1	1	0.00150	0.00150	0.02179	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	01	20	12	0.00198	0.00250	0.03632	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	02.01	3	3	0.00186	0.00377	0.05483	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	02.02	13	5	0.00141	0.00171	0.02487	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	02.03	6	5	0.00169	0.00217	0.03149	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	02.04	2	1	0.00167	0.00167	0.02426	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	03.01	14	8	0.00171	0.00205	0.02985	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	03.02	14	9	0.00137	0.00165	0.02391	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	03.03	14	10	0.00149	0.00172	0.02502	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	03.04	16	9	0.00167	0.00210	0.03045	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	04.01	16	8	0.00158	0.00208	0.03015	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	04.02	6	3	0.00138	0.00193	0.02798	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	04.04	10	6	0.00250	0.00338	0.04910	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	07.01	5	1	0.00140	0.00140	0.02034	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	07.02	17	6	0.00200	0.00271	0.03938	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	13	47	34	0.00159	0.00174	0.02534	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	00	11	4	0.00389	0.00622	0.09033	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	01	51	20	0.00258	0.00314	0.04556	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	02.01	3	3	0.00230	0.00393	0.05704	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	02.02	22	7	0.00290	0.00543	0.07884	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	02.03	6	4	0.00193	0.00262	0.03809	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	02.04	11	1	0.00155	0.00155	0.02252	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	03.01	34	32	0.00194	0.00208	0.03021	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	03.02	14	11	0.00160	0.00185	0.02689	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	03.03	23	13	0.00223	0.00260	0.03778	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	03.04	16	12	0.00200	0.00234	0.03405	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	04.01	25	10	0.00170	0.00184	0.02680	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	04.02	6	4	0.00150	0.00190	0.02754	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	04.04	10	6	0.00241	0.00382	0.05543	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	07.01	5	2	0.00123	0.00181	0.02633	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	07.02	17	8	0.00159	0.00177	0.02568	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	08	2	1	0.00100	0.00100	0.01453	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	13	58	43	0.00219	0.00251	0.03648	0.0688	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Chromium	7440-47-3	I	WHOL	18	9	2	0.00536	0.00549	0.07981	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	20.02	10	3	0.01054	0.01160	0.16857	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	21	18	9	0.00654	0.00819	0.11898	0.0688	LCV_FISH
Chromium	7440-47-3	I	WHOL	22	11	11	0.01379	0.01696	0.24642	0.0688	LCV_FISH
Chromium	7440-47-3	I	FLTR	00	1	1	0.00150	0.00150	0.01685	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	01	20	12	0.00198	0.00250	0.02809	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	02.01	3	3	0.00186	0.00377	0.04241	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	02.02	13	5	0.00141	0.00171	0.01923	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	02.03	6	5	0.00169	0.00217	0.02435	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	02.04	2	1	0.00167	0.00167	0.01876	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	03.01	14	8	0.00171	0.00205	0.02308	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	03.02	14	9	0.00137	0.00165	0.01849	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	03.03	14	10	0.00149	0.00172	0.01935	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	03.04	16	9	0.00167	0.00210	0.02355	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	04.01	16	8	0.00158	0.00208	0.02332	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	04.02	6	3	0.00138	0.00193	0.02164	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	04.04	10	6	0.00250	0.00338	0.03797	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	07.01	5	1	0.00140	0.00140	0.01573	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	07.02	17	6	0.00200	0.00271	0.03046	0.0890	LTV_FISH
Chromium	7440-47-3	I	FLTR	13	47	34	0.00159	0.00174	0.01960	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	00	11	4	0.00389	0.00622	0.06986	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	01	51	20	0.00258	0.00314	0.03523	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	02.01	3	3	0.00230	0.00393	0.04411	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	02.02	22	7	0.00290	0.00543	0.06097	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	02.03	6	4	0.00193	0.00262	0.02946	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	02.04	11	1	0.00155	0.00155	0.01742	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	03.01	34	32	0.00194	0.00208	0.02337	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	03.02	14	11	0.00160	0.00185	0.02079	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	03.03	23	13	0.00223	0.00260	0.02922	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	03.04	16	12	0.00200	0.00234	0.02633	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	04.01	25	10	0.00170	0.00184	0.02072	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	04.02	6	4	0.00150	0.00190	0.02130	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	04.04	10	6	0.00241	0.00382	0.04287	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	07.01	5	2	0.00123	0.00181	0.02036	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	07.02	17	8	0.00159	0.00177	0.01986	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	08	2	1	0.00100	0.00100	0.01124	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	13	58	43	0.00219	0.00251	0.02821	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	18	9	2	0.00536	0.00549	0.06172	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	20.02	10	3	0.01054	0.01160	0.13037	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	21	18	9	0.00654	0.00819	0.09202	0.0890	LTV_FISH
Chromium	7440-47-3	I	WHOL	22	11	11	0.01379	0.01696	0.19058	0.0890	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Chromium	7440-47-3	I	FLTR	00	1	1	0.00150	0.00150	0.00088	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	01	20	12	0.00198	0.00250	0.00147	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	02.01	3	3	0.00186	0.00377	0.00222	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	02.02	13	5	0.00141	0.00171	0.00101	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	02.03	6	5	0.00169	0.00217	0.00127	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	02.04	2	1	0.00167	0.00167	0.00098	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	03.01	14	8	0.00171	0.00205	0.00121	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	03.02	14	9	0.00137	0.00165	0.00097	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	03.03	14	10	0.00149	0.00172	0.00101	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	03.04	16	9	0.00167	0.00210	0.00123	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	04.01	16	8	0.00158	0.00208	0.00122	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	04.02	6	3	0.00138	0.00193	0.00113	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	04.04	10	6	0.00250	0.00338	0.00199	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	07.01	5	1	0.00140	0.00140	0.00082	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	07.02	17	6	0.00200	0.00271	0.00159	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	13	47	34	0.00159	0.00174	0.00103	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	00	11	4	0.00389	0.00622	0.00366	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	01	51	20	0.00258	0.00314	0.00184	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	02.01	3	3	0.00230	0.00393	0.00231	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	02.02	22	7	0.00290	0.00543	0.00319	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	02.03	6	4	0.00193	0.00262	0.00154	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	02.04	11	1	0.00155	0.00155	0.00091	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	03.01	34	32	0.00194	0.00208	0.00122	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	03.02	14	11	0.00160	0.00185	0.00109	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	03.03	23	13	0.00223	0.00260	0.00153	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	03.04	16	12	0.00200	0.00234	0.00138	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	04.01	25	10	0.00170	0.00184	0.00108	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	04.02	6	4	0.00150	0.00190	0.00111	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	04.04	10	6	0.00241	0.00382	0.00224	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	07.01	5	2	0.00123	0.00181	0.00107	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	07.02	17	8	0.00159	0.00177	0.00104	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	08	2	1	0.00100	0.00100	0.00059	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	13	58	43	0.00219	0.00251	0.00148	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	18	9	2	0.00536	0.00549	0.00323	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	20.02	10	3	0.01054	0.01160	0.00683	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	21	18	9	0.00654	0.00819	0.00482	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	WHOL	22	11	11	0.01379	0.01696	0.00998	1.7000	NAWQ_ACU
Chromium	7440-47-3	I	FLTR	00	1	1	0.00150	0.00150	0.00714	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	01	20	12	0.00198	0.00250	0.01191	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	02.01	3	3	0.00186	0.00377	0.01797	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	02.02	13	5	0.00141	0.00171	0.00815	0.2100	NAWQ_CHR

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Chromium	7440-47-3	I	FLTR	02.03	6	5	0.00169	0.00217	0.01032	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	02.04	2	1	0.00167	0.00167	0.00795	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	03.01	14	8	0.00171	0.00205	0.00978	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	03.02	14	9	0.00137	0.00165	0.00784	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	03.03	14	10	0.00149	0.00172	0.00820	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	03.04	16	9	0.00167	0.00210	0.00998	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	04.01	16	8	0.00158	0.00208	0.00988	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	04.02	6	3	0.00138	0.00193	0.00917	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	04.04	10	6	0.00250	0.00338	0.01609	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	07.01	5	1	0.00140	0.00140	0.00667	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	07.02	17	6	0.00200	0.00271	0.01291	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	FLTR	13	47	34	0.00159	0.00174	0.00831	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	00	11	4	0.00389	0.00622	0.02961	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	01	51	20	0.00258	0.00314	0.01493	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	02.01	3	3	0.00230	0.00393	0.01869	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	02.02	22	7	0.00290	0.00543	0.02584	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	02.03	6	4	0.00193	0.00262	0.01249	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	02.04	11	1	0.00155	0.00155	0.00738	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	03.01	34	32	0.00194	0.00208	0.00990	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	03.02	14	11	0.00160	0.00185	0.00881	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	03.03	23	13	0.00223	0.00260	0.01238	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	03.04	16	12	0.00200	0.00234	0.01116	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	04.01	25	10	0.00170	0.00184	0.00878	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	04.02	6	4	0.00150	0.00190	0.00903	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	04.04	10	6	0.00241	0.00382	0.01817	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	07.01	5	2	0.00123	0.00181	0.00863	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	07.02	17	8	0.00159	0.00177	0.00842	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	08	2	1	0.00100	0.00100	0.00476	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	13	58	43	0.00219	0.00251	0.01196	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	18	9	2	0.00536	0.00549	0.02616	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	20.02	10	3	0.01054	0.01160	0.05525	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	21	18	9	0.00654	0.00819	0.03900	0.2100	NAWQ_CHR
Chromium	7440-47-3	I	WHOL	22	11	11	0.01379	0.01696	0.08077	0.2100	NAWQ_CHR
Cobalt	7440-48-4	I	WHOL	01	48	1	0.00450	0.00450	0.88235	0.0051	LCV_ALLO
Cobalt	7440-48-4	I	WHOL	02.02	21	1	0.00450	0.00450	0.88235	0.0051	LCV_ALLO
Cobalt	7440-48-4	I	WHOL	03.01	33	10	0.00108	0.00114	0.22312	0.0051	LCV_ALLO
Cobalt	7440-48-4	I	WHOL	03.03	22	2	0.00148	0.00190	0.37230	0.0051	LCV_ALLO
Cobalt	7440-48-4	I	WHOL	03.04	15	2	0.00113	0.00119	0.23350	0.0051	LCV_ALLO
Cobalt	7440-48-4	I	WHOL	13	57	7	0.00117	0.00123	0.24057	0.0051	LCV_ALLO
Cobalt	7440-48-4	I	WHOL	18	9	1	0.00520	0.00520	1.01961	0.0051	LCV_ALLO
Cobalt	7440-48-4	I	WHOL	21	18	2	0.00482	0.00629	1.23354	0.0051	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Cobalt	7440-48-4	I	WHOL	22	10	1	0.00770	0.00770	1.50980	0.0051	LCV_ALLO
Cobalt	7440-48-4	I	WHOL	01	48	1	0.00450	0.00450	0.88235	0.0051	LCV_DAPH
Cobalt	7440-48-4	I	WHOL	02.02	21	1	0.00450	0.00450	0.88235	0.0051	LCV_DAPH
Cobalt	7440-48-4	I	WHOL	03.01	33	10	0.00108	0.00114	0.22312	0.0051	LCV_DAPH
Cobalt	7440-48-4	I	WHOL	03.03	22	2	0.00148	0.00190	0.37230	0.0051	LCV_DAPH
Cobalt	7440-48-4	I	WHOL	03.04	15	2	0.00113	0.00119	0.23350	0.0051	LCV_DAPH
Cobalt	7440-48-4	I	WHOL	13	57	7	0.00117	0.00123	0.24057	0.0051	LCV_DAPH
Cobalt	7440-48-4	I	WHOL	18	9	1	0.00520	0.00520	1.01961	0.0051	LCV_DAPH
Cobalt	7440-48-4	I	WHOL	21	18	2	0.00482	0.00629	1.23354	0.0051	LCV_DAPH
Cobalt	7440-48-4	I	WHOL	22	10	1	0.00770	0.00770	1.50980	0.0051	LCV_DAPH
Cobalt	7440-48-4	I	WHOL	01	48	1	0.00450	0.00450	0.01552	0.2900	LCV_FISH
Cobalt	7440-48-4	I	WHOL	02.02	21	1	0.00450	0.00450	0.01552	0.2900	LCV_FISH
Cobalt	7440-48-4	I	WHOL	03.01	33	10	0.00108	0.00114	0.00392	0.2900	LCV_FISH
Cobalt	7440-48-4	I	WHOL	03.03	22	2	0.00148	0.00190	0.00655	0.2900	LCV_FISH
Cobalt	7440-48-4	I	WHOL	03.04	15	2	0.00113	0.00119	0.00411	0.2900	LCV_FISH
Cobalt	7440-48-4	I	WHOL	13	57	7	0.00117	0.00123	0.00423	0.2900	LCV_FISH
Cobalt	7440-48-4	I	WHOL	18	9	1	0.00520	0.00520	0.01793	0.2900	LCV_FISH
Cobalt	7440-48-4	I	WHOL	21	18	2	0.00482	0.00629	0.02169	0.2900	LCV_FISH
Cobalt	7440-48-4	I	WHOL	22	10	1	0.00770	0.00770	0.02655	0.2900	LCV_FISH
Cobalt	7440-48-4	I	WHOL	01	48	1	0.00450	0.00450	1.02273	0.0044	LTV_DAPH
Cobalt	7440-48-4	I	WHOL	02.02	21	1	0.00450	0.00450	1.02273	0.0044	LTV_DAPH
Cobalt	7440-48-4	I	WHOL	03.01	33	10	0.00108	0.00114	0.25862	0.0044	LTV_DAPH
Cobalt	7440-48-4	I	WHOL	03.03	22	2	0.00148	0.00190	0.43153	0.0044	LTV_DAPH
Cobalt	7440-48-4	I	WHOL	03.04	15	2	0.00113	0.00119	0.27064	0.0044	LTV_DAPH
Cobalt	7440-48-4	I	WHOL	13	57	7	0.00117	0.00123	0.27884	0.0044	LTV_DAPH
Cobalt	7440-48-4	I	WHOL	18	9	1	0.00520	0.00520	1.18182	0.0044	LTV_DAPH
Cobalt	7440-48-4	I	WHOL	21	18	2	0.00482	0.00629	1.42978	0.0044	LTV_DAPH
Cobalt	7440-48-4	I	WHOL	22	10	1	0.00770	0.00770	1.75000	0.0044	LTV_DAPH
Cobalt	7440-48-4	I	WHOL	01	48	1	0.00450	0.00450	0.00556	0.8100	LTV_FISH
Cobalt	7440-48-4	I	WHOL	02.02	21	1	0.00450	0.00450	0.00556	0.8100	LTV_FISH
Cobalt	7440-48-4	I	WHOL	03.01	33	10	0.00108	0.00114	0.00140	0.8100	LTV_FISH
Cobalt	7440-48-4	I	WHOL	03.03	22	2	0.00148	0.00190	0.00234	0.8100	LTV_FISH
Cobalt	7440-48-4	I	WHOL	03.04	15	2	0.00113	0.00119	0.00147	0.8100	LTV_FISH
Cobalt	7440-48-4	I	WHOL	13	57	7	0.00117	0.00123	0.00151	0.8100	LTV_FISH
Cobalt	7440-48-4	I	WHOL	18	9	1	0.00520	0.00520	0.00642	0.8100	LTV_FISH
Cobalt	7440-48-4	I	WHOL	21	18	2	0.00482	0.00629	0.00777	0.8100	LTV_FISH
Cobalt	7440-48-4	I	WHOL	22	10	1	0.00770	0.00770	0.00951	0.8100	LTV_FISH
Cobalt	7440-48-4	I	WHOL	01	48	1	0.00450	0.00450	0.02308	0.1950	S_ACU_V
Cobalt	7440-48-4	I	WHOL	02.02	21	1	0.00450	0.00450	0.02308	0.1950	S_ACU_V
Cobalt	7440-48-4	I	WHOL	03.01	33	10	0.00108	0.00114	0.00584	0.1950	S_ACU_V
Cobalt	7440-48-4	I	WHOL	03.03	22	2	0.00148	0.00190	0.00974	0.1950	S_ACU_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Cobalt	7440-48-4	I	WHOL	03.04	15	2	0.00113	0.00119	0.00611	0.1950	S_ACU_V
Cobalt	7440-48-4	I	WHOL	13	57	7	0.00117	0.00123	0.00629	0.1950	S_ACU_V
Cobalt	7440-48-4	I	WHOL	18	9	1	0.00520	0.00520	0.02667	0.1950	S_ACU_V
Cobalt	7440-48-4	I	WHOL	21	18	2	0.00482	0.00629	0.03226	0.1950	S_ACU_V
Cobalt	7440-48-4	I	WHOL	22	10	1	0.00770	0.00770	0.03949	0.1950	S_ACU_V
Cobalt	7440-48-4	I	WHOL	01	48	1	0.00450	0.00450	1.47059	0.0031	S_CHR_V
Cobalt	7440-48-4	I	WHOL	02.02	21	1	0.00450	0.00450	1.47059	0.0031	S_CHR_V
Cobalt	7440-48-4	I	WHOL	03.01	33	10	0.00108	0.00114	0.37187	0.0031	S_CHR_V
Cobalt	7440-48-4	I	WHOL	03.03	22	2	0.00148	0.00190	0.62051	0.0031	S_CHR_V
Cobalt	7440-48-4	I	WHOL	03.04	15	2	0.00113	0.00119	0.38916	0.0031	S_CHR_V
Cobalt	7440-48-4	I	WHOL	13	57	7	0.00117	0.00123	0.40095	0.0031	S_CHR_V
Cobalt	7440-48-4	I	WHOL	18	9	1	0.00520	0.00520	1.69935	0.0031	S_CHR_V
Cobalt	7440-48-4	I	WHOL	21	18	2	0.00482	0.00629	2.05589	0.0031	S_CHR_V
Cobalt	7440-48-4	I	WHOL	22	10	1	0.00770	0.00770	2.51634	0.0031	S_CHR_V
Copper	7440-50-8	I	FLTR	00	1	1	0.00140	0.00140	6.08696	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	01	20	15	0.00459	0.00625	27.18758	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	02.01	3	3	0.00265	0.00467	20.29853	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	02.02	13	12	0.00311	0.00378	16.41716	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	02.03	6	6	0.00328	0.00457	19.86234	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	03.01	14	13	0.00301	0.00376	16.33048	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	03.02	14	13	0.00317	0.00383	16.63936	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	03.03	14	11	0.00317	0.00380	16.54216	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	03.04	16	14	0.00705	0.01346	58.50694	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	04.01	16	14	0.01076	0.01949	84.74953	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	04.02	6	6	0.00244	0.00325	14.11042	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	04.04	10	9	0.00369	0.00530	23.03597	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	07.01	5	5	0.00400	0.00614	26.68335	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	07.02	17	14	0.00348	0.00437	18.98262	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	08	2	1	0.00430	0.00430	18.69565	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	13	47	46	0.00344	0.00421	18.29638	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	00	11	1	0.00230	0.00230	10.00000	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	01	51	19	0.00513	0.00789	34.32088	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	02.01	3	3	0.00413	0.00741	32.20921	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	02.02	22	12	0.00494	0.00650	28.24685	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	02.03	6	6	0.00703	0.01329	57.78487	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	02.04	11	2	0.00375	0.00873	37.97508	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	03.01	34	33	0.00367	0.00429	18.64917	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	03.02	14	13	0.00277	0.00336	14.60363	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	03.03	23	12	0.00383	0.00474	20.60131	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	03.04	16	14	0.00370	0.00471	20.48783	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	04.01	25	14	0.00977	0.01760	76.52451	0.0002	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Copper	7440-50-8	I	WHOL	04.02	6	6	0.00238	0.00366	15.90985	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	04.04	10	9	0.00418	0.00602	26.15775	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	07.01	5	5	0.00726	0.01614	70.16058	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	07.02	17	15	0.00755	0.01238	53.83167	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	08	2	1	0.01870	0.01870	81.30435	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	13	58	47	0.00389	0.00471	20.49393	0.0002	LCV_ALLO
Copper	7440-50-8	I	WHOL	21	18	4	0.01253	0.01341	58.30520	0.0002	LCV_ALLO
Copper	7440-50-8	I	FLTR	00	1	1	0.00140	0.00140	1.40000	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	01	20	15	0.00459	0.00625	6.25314	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	02.01	3	3	0.00265	0.00467	4.66866	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	02.02	13	12	0.00311	0.00378	3.77595	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	02.03	6	6	0.00328	0.00457	4.56834	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	03.01	14	13	0.00301	0.00376	3.75601	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	03.02	14	13	0.00317	0.00383	3.82705	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	03.03	14	11	0.00317	0.00380	3.80470	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	03.04	16	14	0.00705	0.01346	13.45660	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	04.01	16	14	0.01076	0.01949	19.49239	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	04.02	6	6	0.00244	0.00325	3.24540	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	04.04	10	9	0.00369	0.00530	5.29827	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	07.01	5	5	0.00400	0.00614	6.13717	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	07.02	17	14	0.00348	0.00437	4.36600	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	08	2	1	0.00430	0.00430	4.30000	0.0010	LCV_AQPL
Copper	7440-50-8	I	FLTR	13	47	46	0.00344	0.00421	4.20817	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	00	11	1	0.00230	0.00230	2.30000	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	01	51	19	0.00513	0.00789	7.89380	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	02.01	3	3	0.00413	0.00741	7.40812	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	02.02	22	12	0.00494	0.00650	6.49678	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	02.03	6	6	0.00703	0.01329	13.29052	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	02.04	11	2	0.00375	0.00873	8.73427	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	03.01	34	33	0.00367	0.00429	4.28931	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	03.02	14	13	0.00277	0.00336	3.35883	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	03.03	23	12	0.00383	0.00474	4.73830	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	03.04	16	14	0.00370	0.00471	4.71220	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	04.01	25	14	0.00977	0.01760	17.60064	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	04.02	6	6	0.00238	0.00366	3.65927	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	04.04	10	9	0.00418	0.00602	6.01628	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	07.01	5	5	0.00726	0.01614	16.13693	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	07.02	17	15	0.00755	0.01238	12.38128	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	08	2	1	0.01870	0.01870	18.70000	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	13	58	47	0.00389	0.00471	4.71360	0.0010	LCV_AQPL
Copper	7440-50-8	I	WHOL	21	18	4	0.01253	0.01341	13.41020	0.0010	LCV_AQPL

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Copper	7440-50-8	I	FLTR	00	1	1	0.00140	0.00140	6.08696	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	01	20	15	0.00459	0.00625	27.18758	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	02.01	3	3	0.00265	0.00467	20.29853	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	02.02	13	12	0.00311	0.00378	16.41716	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	02.03	6	6	0.00328	0.00457	19.86234	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	03.01	14	13	0.00301	0.00376	16.33048	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	03.02	14	13	0.00317	0.00383	16.63936	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	03.03	14	11	0.00317	0.00380	16.54216	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	03.04	16	14	0.00705	0.01346	58.50694	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	04.01	16	14	0.01076	0.01949	84.74953	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	04.02	6	6	0.00244	0.00325	14.11042	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	04.04	10	9	0.00369	0.00530	23.03597	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	07.01	5	5	0.00400	0.00614	26.68335	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	07.02	17	14	0.00348	0.00437	18.98262	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	08	2	1	0.00430	0.00430	18.69565	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	13	47	46	0.00344	0.00421	18.29638	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	00	11	1	0.00230	0.00230	10.00000	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	01	51	19	0.00513	0.00789	34.32088	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	02.01	3	3	0.00413	0.00741	32.20921	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	02.02	22	12	0.00494	0.00650	28.24685	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	02.03	6	6	0.00703	0.01329	57.78487	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	02.04	11	2	0.00375	0.00873	37.97508	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	03.01	34	33	0.00367	0.00429	18.64917	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	03.02	14	13	0.00277	0.00336	14.60363	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	03.03	23	12	0.00383	0.00474	20.60131	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	03.04	16	14	0.00370	0.00471	20.48783	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	04.01	25	14	0.00977	0.01760	76.52451	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	04.02	6	6	0.00238	0.00366	15.90985	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	04.04	10	9	0.00418	0.00602	26.15775	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	07.01	5	5	0.00726	0.01614	70.16058	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	07.02	17	15	0.00755	0.01238	53.83167	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	08	2	1	0.01870	0.01870	81.30435	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	13	58	47	0.00389	0.00471	20.49393	0.0002	LCV_DAPH
Copper	7440-50-8	I	WHOL	21	18	4	0.01253	0.01341	58.30520	0.0002	LCV_DAPH
Copper	7440-50-8	I	FLTR	00	1	1	0.00140	0.00140	0.36842	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	01	20	15	0.00459	0.00625	1.64556	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	02.01	3	3	0.00265	0.00467	1.22860	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	02.02	13	12	0.00311	0.00378	0.99367	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	02.03	6	6	0.00328	0.00457	1.20219	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	03.01	14	13	0.00301	0.00376	0.98842	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	03.02	14	13	0.00317	0.00383	1.00712	0.0038	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Copper	7440-50-8	I	FLTR	03.03	14	11	0.00317	0.00380	1.00124	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	03.04	16	14	0.00705	0.01346	3.54121	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	04.01	16	14	0.01076	0.01949	5.12958	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	04.02	6	6	0.00244	0.00325	0.85405	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	04.04	10	9	0.00369	0.00530	1.39428	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	07.01	5	5	0.00400	0.00614	1.61504	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	07.02	17	14	0.00348	0.00437	1.14895	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	08	2	1	0.00430	0.00430	1.13158	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	13	47	46	0.00344	0.00421	1.10741	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	00	11	1	0.00230	0.00230	0.60526	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	01	51	19	0.00513	0.00789	2.07732	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	02.01	3	3	0.00413	0.00741	1.94950	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	02.02	22	12	0.00494	0.00650	1.70968	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	02.03	6	6	0.00703	0.01329	3.49751	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	02.04	11	2	0.00375	0.00873	2.29849	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	03.01	34	33	0.00367	0.00429	1.12877	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	03.02	14	13	0.00277	0.00336	0.88390	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	03.03	23	12	0.00383	0.00474	1.24692	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	03.04	16	14	0.00370	0.00471	1.24005	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	04.01	25	14	0.00977	0.01760	4.63175	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	04.02	6	6	0.00238	0.00366	0.96296	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	04.04	10	9	0.00418	0.00602	1.58323	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	07.01	5	5	0.00726	0.01614	4.24656	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	07.02	17	15	0.00755	0.01238	3.25823	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	08	2	1	0.01870	0.01870	4.92105	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	13	58	47	0.00389	0.00471	1.24042	0.0038	LCV_FISH
Copper	7440-50-8	I	WHOL	21	18	4	0.01253	0.01341	3.52900	0.0038	LCV_FISH
Copper	7440-50-8	I	FLTR	00	1	1	0.00140	0.00140	0.23079	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	01	20	15	0.00459	0.00625	1.03085	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	02.01	3	3	0.00265	0.00467	0.76964	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	02.02	13	12	0.00311	0.00378	0.62248	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	02.03	6	6	0.00328	0.00457	0.75311	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	03.01	14	13	0.00301	0.00376	0.61919	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	03.02	14	13	0.00317	0.00383	0.63090	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	03.03	14	11	0.00317	0.00380	0.62722	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	03.04	16	14	0.00705	0.01346	2.21836	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	04.01	16	14	0.01076	0.01949	3.21338	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	04.02	6	6	0.00244	0.00325	0.53501	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	04.04	10	9	0.00369	0.00530	0.87344	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	07.01	5	5	0.00400	0.00614	1.01173	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	07.02	17	14	0.00348	0.00437	0.71975	0.0061	LCV_NDI

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Copper	7440-50-8	I	FLTR	08	2	1	0.00430	0.00430	0.70887	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	13	47	46	0.00344	0.00421	0.69373	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	00	11	1	0.00230	0.00230	0.37916	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	01	51	19	0.00513	0.00789	1.30132	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	02.01	3	3	0.00413	0.00741	1.22125	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	02.02	22	12	0.00494	0.00650	1.07101	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	02.03	6	6	0.00703	0.01329	2.19099	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	02.04	11	2	0.00375	0.00873	1.43987	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	03.01	34	33	0.00367	0.00429	0.70711	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	03.02	14	13	0.00277	0.00336	0.55371	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	03.03	23	12	0.00383	0.00474	0.78112	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	03.04	16	14	0.00370	0.00471	0.77682	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	04.01	25	14	0.00977	0.01760	2.90152	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	04.02	6	6	0.00238	0.00366	0.60324	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	04.04	10	9	0.00418	0.00602	0.99180	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	07.01	5	5	0.00726	0.01614	2.66023	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	07.02	17	15	0.00755	0.01238	2.04110	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	08	2	1	0.01870	0.01870	3.08276	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	13	58	47	0.00389	0.00471	0.77705	0.0061	LCV_NDI
Copper	7440-50-8	I	WHOL	21	18	4	0.01253	0.01341	2.21071	0.0061	LCV_NDI
Copper	7440-50-8	I	FLTR	00	1	1	0.00140	0.00140	6.82927	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	01	20	15	0.00459	0.00625	30.50314	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	02.01	3	3	0.00265	0.00467	22.77396	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	02.02	13	12	0.00311	0.00378	18.41925	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	02.03	6	6	0.00328	0.00457	22.28458	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	03.01	14	13	0.00301	0.00376	18.32200	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	03.02	14	13	0.00317	0.00383	18.66854	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	03.03	14	11	0.00317	0.00380	18.55949	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	03.04	16	14	0.00705	0.01346	65.64193	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	04.01	16	14	0.01076	0.01949	95.08483	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	04.02	6	6	0.00244	0.00325	15.83120	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	04.04	10	9	0.00369	0.00530	25.84523	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	07.01	5	5	0.00400	0.00614	29.93741	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	07.02	17	14	0.00348	0.00437	21.29757	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	08	2	1	0.00430	0.00430	20.97561	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	13	47	46	0.00344	0.00421	20.52765	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	00	11	1	0.00230	0.00230	11.21951	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	01	51	19	0.00513	0.00789	38.50635	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	02.01	3	3	0.00413	0.00741	36.13716	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	02.02	22	12	0.00494	0.00650	31.69159	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	02.03	6	6	0.00703	0.01329	64.83180	0.0002	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Copper	7440-50-8	I	WHOL	02.04	11	2	0.00375	0.00873	42.60619	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	03.01	34	33	0.00367	0.00429	20.92346	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	03.02	14	13	0.00277	0.00336	16.38456	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	03.03	23	12	0.00383	0.00474	23.11366	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	03.04	16	14	0.00370	0.00471	22.98634	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	04.01	25	14	0.00977	0.01760	85.85677	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	04.02	6	6	0.00238	0.00366	17.85008	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	04.04	10	9	0.00418	0.00602	29.34772	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	07.01	5	5	0.00726	0.01614	78.71675	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	07.02	17	15	0.00755	0.01238	60.39650	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	08	2	1	0.01870	0.01870	91.21951	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	13	58	47	0.00389	0.00471	22.99319	0.0002	LTV_DAPH
Copper	7440-50-8	I	WHOL	21	18	4	0.01253	0.01341	65.41559	0.0002	LTV_DAPH
Copper	7440-50-8	I	FLTR	00	1	1	0.00140	0.00140	0.28000	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	01	20	15	0.00459	0.00625	1.25063	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	02.01	3	3	0.00265	0.00467	0.93373	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	02.02	13	12	0.00311	0.00378	0.75519	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	02.03	6	6	0.00328	0.00457	0.91367	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	03.01	14	13	0.00301	0.00376	0.75120	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	03.02	14	13	0.00317	0.00383	0.76541	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	03.03	14	11	0.00317	0.00380	0.76094	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	03.04	16	14	0.00705	0.01346	2.69132	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	04.01	16	14	0.01076	0.01949	3.89848	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	04.02	6	6	0.00244	0.00325	0.64908	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	04.04	10	9	0.00369	0.00530	1.05965	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	07.01	5	5	0.00400	0.00614	1.22743	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	07.02	17	14	0.00348	0.00437	0.87320	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	08	2	1	0.00430	0.00430	0.86000	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	13	47	46	0.00344	0.00421	0.84163	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	00	11	1	0.00230	0.00230	0.46000	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	01	51	19	0.00513	0.00789	1.57876	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	02.01	3	3	0.00413	0.00741	1.48162	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	02.02	22	12	0.00494	0.00650	1.29936	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	02.03	6	6	0.00703	0.01329	2.65810	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	02.04	11	2	0.00375	0.00873	1.74685	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	03.01	34	33	0.00367	0.00429	0.85786	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	03.02	14	13	0.00277	0.00336	0.67177	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	03.03	23	12	0.00383	0.00474	0.94766	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	03.04	16	14	0.00370	0.00471	0.94244	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	04.01	25	14	0.00977	0.01760	3.52013	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	04.02	6	6	0.00238	0.00366	0.73185	0.0050	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Copper	7440-50-8	I	WHOL	04.04	10	9	0.00418	0.00602	1.20326	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	07.01	5	5	0.00726	0.01614	3.22739	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	07.02	17	15	0.00755	0.01238	2.47626	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	08	2	1	0.01870	0.01870	3.74000	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	13	58	47	0.00389	0.00471	0.94272	0.0050	LTV_FISH
Copper	7440-50-8	I	WHOL	21	18	4	0.01253	0.01341	2.68204	0.0050	LTV_FISH
Copper	7440-50-8	I	FLTR	00	1	1	0.00140	0.00140	0.07778	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	01	20	15	0.00459	0.00625	0.34740	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	02.01	3	3	0.00265	0.00467	0.25937	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	02.02	13	12	0.00311	0.00378	0.20977	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	02.03	6	6	0.00328	0.00457	0.25380	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	03.01	14	13	0.00301	0.00376	0.20867	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	03.02	14	13	0.00317	0.00383	0.21261	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	03.03	14	11	0.00317	0.00380	0.21137	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	03.04	16	14	0.00705	0.01346	0.74759	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	04.01	16	14	0.01076	0.01949	1.08291	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	04.02	6	6	0.00244	0.00325	0.18030	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	04.04	10	9	0.00369	0.00530	0.29435	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	07.01	5	5	0.00400	0.00614	0.34095	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	07.02	17	14	0.00348	0.00437	0.24256	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	08	2	1	0.00430	0.00430	0.23889	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	13	47	46	0.00344	0.00421	0.23379	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	00	11	1	0.00230	0.00230	0.12778	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	01	51	19	0.00513	0.00789	0.43854	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	02.01	3	3	0.00413	0.00741	0.41156	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	02.02	22	12	0.00494	0.00650	0.36093	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	02.03	6	6	0.00703	0.01329	0.73836	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	02.04	11	2	0.00375	0.00873	0.48524	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	03.01	34	33	0.00367	0.00429	0.23829	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	03.02	14	13	0.00277	0.00336	0.18660	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	03.03	23	12	0.00383	0.00474	0.26324	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	03.04	16	14	0.00370	0.00471	0.26179	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	04.01	25	14	0.00977	0.01760	0.97781	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	04.02	6	6	0.00238	0.00366	0.20329	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	04.04	10	9	0.00418	0.00602	0.33424	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	07.01	5	5	0.00726	0.01614	0.89650	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	07.02	17	15	0.00755	0.01238	0.68785	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	08	2	1	0.01870	0.01870	1.03889	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	13	58	47	0.00389	0.00471	0.26187	0.0180	NAWQ_ACU
Copper	7440-50-8	I	WHOL	21	18	4	0.01253	0.01341	0.74501	0.0180	NAWQ_ACU
Copper	7440-50-8	I	FLTR	00	1	1	0.00140	0.00140	0.11667	0.0120	NAWQ_CHR

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Copper	7440-50-8	I	FLTR	01	20	15	0.00459	0.00625	0.52110	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	02.01	3	3	0.00265	0.00467	0.38906	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	02.02	13	12	0.00311	0.00378	0.31466	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	02.03	6	6	0.00328	0.00457	0.38069	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	03.01	14	13	0.00301	0.00376	0.31300	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	03.02	14	13	0.00317	0.00383	0.31892	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	03.03	14	11	0.00317	0.00380	0.31706	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	03.04	16	14	0.00705	0.01346	1.12138	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	04.01	16	14	0.01076	0.01949	1.62437	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	04.02	6	6	0.00244	0.00325	0.27045	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	04.04	10	9	0.00369	0.00530	0.44152	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	07.01	5	5	0.00400	0.00614	0.51143	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	07.02	17	14	0.00348	0.00437	0.36383	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	08	2	1	0.00430	0.00430	0.35833	0.0120	NAWQ_CHR
Copper	7440-50-8	I	FLTR	13	47	46	0.00344	0.00421	0.35068	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	00	11	1	0.00230	0.00230	0.19167	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	01	51	19	0.00513	0.00789	0.65782	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	02.01	3	3	0.00413	0.00741	0.61734	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	02.02	22	12	0.00494	0.00650	0.54140	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	02.03	6	6	0.00703	0.01329	1.10754	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	02.04	11	2	0.00375	0.00873	0.72786	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	03.01	34	33	0.00367	0.00429	0.35744	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	03.02	14	13	0.00277	0.00336	0.27990	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	03.03	23	12	0.00383	0.00474	0.39486	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	03.04	16	14	0.00370	0.00471	0.39268	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	04.01	25	14	0.00977	0.01760	1.46672	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	04.02	6	6	0.00238	0.00366	0.30494	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	04.04	10	9	0.00418	0.00602	0.50136	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	07.01	5	5	0.00726	0.01614	1.34474	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	07.02	17	15	0.00755	0.01238	1.03177	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	08	2	1	0.01870	0.01870	1.55833	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	13	58	47	0.00389	0.00471	0.39280	0.0120	NAWQ_CHR
Copper	7440-50-8	I	WHOL	21	18	4	0.01253	0.01341	1.11752	0.0120	NAWQ_CHR
Cyanide	57-12-5	I	FLTR	01	28	1	0.02440	0.02440	3.12821	0.0078	LCV_ALLO
Cyanide	57-12-5	I	FLTR	01	28	1	0.02440	0.02440	0.81333	0.0300	LCV_AQPL
Cyanide	57-12-5	I	FLTR	01	28	1	0.02440	0.02440	3.12821	0.0078	LCV_FISH
Cyanide	57-12-5	I	FLTR	01	28	1	0.02440	0.02440	1.33115	0.0183	LCV_NDI
Cyanide	57-12-5	I	FLTR	01	28	1	0.02440	0.02440	4.60377	0.0053	LTV_FISH
Cyanide	57-12-5	I	FLTR	01	28	1	0.02440	0.02440	1.10909	0.0220	NAWQ_ACU
Cyanide	57-12-5	I	FLTR	01	28	1	0.02440	0.02440	4.69231	0.0052	NAWQ_CHR
Di-n-butylphthalate	84-74-2	O	FLTR	01	20	8	0.00255	0.00367	0.00527	0.6970	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Di-n-butylphthalate	84-74-2	O	FLTR	03.01	12	1	0.00100	0.00100	0.00143	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	FLTR	03.04	14	2	0.00314	0.00349	0.00500	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	FLTR	04.01	14	5	0.00160	0.00203	0.00292	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	FLTR	04.02	6	1	0.00100	0.00100	0.00143	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	FLTR	04.04	9	1	0.00150	0.00150	0.00215	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	FLTR	07.02	17	1	0.00100	0.00100	0.00143	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	FLTR	13	46	1	0.00100	0.00100	0.00143	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	WHOL	01	23	6	0.00187	0.00250	0.00359	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	WHOL	02.02	13	2	0.00200	0.00378	0.00543	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	WHOL	02.03	5	1	0.00100	0.00100	0.00143	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	WHOL	03.01	13	1	0.00100	0.00100	0.00143	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	WHOL	03.04	15	1	0.00700	0.00700	0.01004	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	WHOL	04.01	15	6	0.00133	0.00170	0.00245	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	WHOL	04.04	10	1	0.00350	0.00350	0.00502	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	WHOL	07.02	17	4	0.00300	0.00401	0.00575	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	WHOL	13	49	3	0.00133	0.00189	0.00272	0.6970	LCV_ALLO
Di-n-butylphthalate	84-74-2	O	FLTR	01	20	8	0.00255	0.00367	0.00527	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	03.01	12	1	0.00100	0.00100	0.00143	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	03.04	14	2	0.00314	0.00349	0.00500	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	04.01	14	5	0.00160	0.00203	0.00292	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	04.02	6	1	0.00100	0.00100	0.00143	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	04.04	9	1	0.00150	0.00150	0.00215	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	07.02	17	1	0.00100	0.00100	0.00143	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	13	46	1	0.00100	0.00100	0.00143	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	01	23	6	0.00187	0.00250	0.00359	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	02.02	13	2	0.00200	0.00378	0.00543	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	02.03	5	1	0.00100	0.00100	0.00143	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	03.01	13	1	0.00100	0.00100	0.00143	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	03.04	15	1	0.00700	0.00700	0.01004	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	04.01	15	6	0.00133	0.00170	0.00245	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	04.04	10	1	0.00350	0.00350	0.00502	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	07.02	17	4	0.00300	0.00401	0.00575	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	13	49	3	0.00133	0.00189	0.00272	0.6970	LCV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	01	20	8	0.00255	0.00367	0.00512	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	03.01	12	1	0.00100	0.00100	0.00139	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	03.04	14	2	0.00314	0.00349	0.00486	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	04.01	14	5	0.00160	0.00203	0.00284	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	04.02	6	1	0.00100	0.00100	0.00139	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	04.04	9	1	0.00150	0.00150	0.00209	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	07.02	17	1	0.00100	0.00100	0.00139	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	13	46	1	0.00100	0.00100	0.00139	0.7170	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Di-n-butylphthalate	84-74-2	O	WHOL	01	23	6	0.00187	0.00250	0.00349	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	02.02	13	2	0.00200	0.00378	0.00528	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	02.03	5	1	0.00100	0.00100	0.00139	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	03.01	13	1	0.00100	0.00100	0.00139	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	03.04	15	1	0.00700	0.00700	0.00976	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	04.01	15	6	0.00133	0.00170	0.00238	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	04.04	10	1	0.00350	0.00350	0.00488	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	07.02	17	4	0.00300	0.00401	0.00559	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	13	49	3	0.00133	0.00189	0.00264	0.7170	LCV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	01	20	8	0.00255	0.00367	0.00734	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	03.01	12	1	0.00100	0.00100	0.00200	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	03.04	14	2	0.00314	0.00349	0.00698	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	04.01	14	5	0.00160	0.00203	0.00407	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	04.02	6	1	0.00100	0.00100	0.00200	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	04.04	9	1	0.00150	0.00150	0.00300	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	07.02	17	1	0.00100	0.00100	0.00200	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	13	46	1	0.00100	0.00100	0.00200	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	01	23	6	0.00187	0.00250	0.00500	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	02.02	13	2	0.00200	0.00378	0.00756	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	02.03	5	1	0.00100	0.00100	0.00200	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	03.01	13	1	0.00100	0.00100	0.00200	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	03.04	15	1	0.00700	0.00700	0.01400	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	04.01	15	6	0.00133	0.00170	0.00341	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	04.04	10	1	0.00350	0.00350	0.00700	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	07.02	17	4	0.00300	0.00401	0.00802	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	WHOL	13	49	3	0.00133	0.00189	0.00378	0.5000	LTV_DAPH
Di-n-butylphthalate	84-74-2	O	FLTR	01	20	8	0.00255	0.00367	0.01360	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	03.01	12	1	0.00100	0.00100	0.00370	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	03.04	14	2	0.00314	0.00349	0.01292	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	04.01	14	5	0.00160	0.00203	0.00753	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	04.02	6	1	0.00100	0.00100	0.00370	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	04.04	9	1	0.00150	0.00150	0.00556	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	07.02	17	1	0.00100	0.00100	0.00370	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	13	46	1	0.00100	0.00100	0.00370	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	01	23	6	0.00187	0.00250	0.00926	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	02.02	13	2	0.00200	0.00378	0.01401	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	02.03	5	1	0.00100	0.00100	0.00370	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	03.01	13	1	0.00100	0.00100	0.00370	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	03.04	15	1	0.00700	0.00700	0.02593	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	04.01	15	6	0.00133	0.00170	0.00631	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	04.04	10	1	0.00350	0.00350	0.01296	0.2700	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Di-n-butylphthalate	84-74-2	O	WHOL	07.02	17	4	0.00300	0.00401	0.01484	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	WHOL	13	49	3	0.00133	0.00189	0.00701	0.2700	LTV_FISH
Di-n-butylphthalate	84-74-2	O	FLTR	01	20	8	0.00255	0.00367	0.01569	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	FLTR	03.01	12	1	0.00100	0.00100	0.00427	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	FLTR	03.04	14	2	0.00314	0.00349	0.01490	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	FLTR	04.01	14	5	0.00160	0.00203	0.00869	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	FLTR	04.02	6	1	0.00100	0.00100	0.00427	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	FLTR	04.04	9	1	0.00150	0.00150	0.00641	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	FLTR	07.02	17	1	0.00100	0.00100	0.00427	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	FLTR	13	46	1	0.00100	0.00100	0.00427	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	WHOL	01	23	6	0.00187	0.00250	0.01069	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	WHOL	02.02	13	2	0.00200	0.00378	0.01616	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	WHOL	02.03	5	1	0.00100	0.00100	0.00427	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	WHOL	03.01	13	1	0.00100	0.00100	0.00427	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	WHOL	03.04	15	1	0.00700	0.00700	0.02991	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	WHOL	04.01	15	6	0.00133	0.00170	0.00728	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	WHOL	04.04	10	1	0.00350	0.00350	0.01496	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	WHOL	07.02	17	4	0.00300	0.00401	0.01713	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	WHOL	13	49	3	0.00133	0.00189	0.00809	0.2340	S_ACU_V
Di-n-butylphthalate	84-74-2	O	FLTR	01	20	8	0.00255	0.00367	0.11229	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	FLTR	03.01	12	1	0.00100	0.00100	0.03058	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	FLTR	03.04	14	2	0.00314	0.00349	0.10666	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	FLTR	04.01	14	5	0.00160	0.00203	0.06220	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	FLTR	04.02	6	1	0.00100	0.00100	0.03058	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	FLTR	04.04	9	1	0.00150	0.00150	0.04587	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	FLTR	07.02	17	1	0.00100	0.00100	0.03058	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	FLTR	13	46	1	0.00100	0.00100	0.03058	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	WHOL	01	23	6	0.00187	0.00250	0.07649	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	WHOL	02.02	13	2	0.00200	0.00378	0.11567	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	WHOL	02.03	5	1	0.00100	0.00100	0.03058	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	WHOL	03.01	13	1	0.00100	0.00100	0.03058	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	WHOL	03.04	15	1	0.00700	0.00700	0.21407	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	WHOL	04.01	15	6	0.00133	0.00170	0.05213	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	WHOL	04.04	10	1	0.00350	0.00350	0.10703	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	WHOL	07.02	17	4	0.00300	0.00401	0.12257	0.0327	S_CHR_V
Di-n-butylphthalate	84-74-2	O	WHOL	13	49	3	0.00133	0.00189	0.05787	0.0327	S_CHR_V
Di-n-octylphthlate	117-84-0	O	WHOL	03.02	12	1	0.00200	0.00200	0.00282	0.7080	LCV_ALLO
Di-n-octylphthlate	117-84-0	O	WHOL	03.02	12	1	0.00200	0.00200	0.00282	0.7080	LCV_DAPH
Di-n-octylphthlate	117-84-0	O	WHOL	03.02	12	1	0.00200	0.00200	0.00052	3.8220	LCV_FISH
Di-n-octylphthlate	117-84-0	O	WHOL	03.02	12	1	0.00200	0.00200	0.00645	0.3100	LTV_DAPH
Di-n-octylphthlate	117-84-0	O	WHOL	03.02	12	1	0.00200	0.00200	0.02000	0.1000	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Diethylphthalate	84-66-2	O	FLTR	02.02	12	1	0.00100	0.00100	0.00001	85.6000	LCV_ALLO
Diethylphthalate	84-66-2	O	FLTR	03.03	12	1	0.00300	0.00300	0.00004	85.6000	LCV_ALLO
Diethylphthalate	84-66-2	O	FLTR	13	46	3	0.00133	0.00189	0.00002	85.6000	LCV_ALLO
Diethylphthalate	84-66-2	O	WHOL	02.02	13	1	0.00100	0.00100	0.00001	85.6000	LCV_ALLO
Diethylphthalate	84-66-2	O	WHOL	03.03	13	1	0.00200	0.00200	0.00002	85.6000	LCV_ALLO
Diethylphthalate	84-66-2	O	WHOL	13	49	4	0.00125	0.00167	0.00002	85.6000	LCV_ALLO
Diethylphthalate	84-66-2	O	FLTR	02.02	12	1	0.00100	0.00100	0.00001	85.6000	LCV_AQPL
Diethylphthalate	84-66-2	O	FLTR	03.03	12	1	0.00300	0.00300	0.00004	85.6000	LCV_AQPL
Diethylphthalate	84-66-2	O	FLTR	13	46	3	0.00133	0.00189	0.00002	85.6000	LCV_AQPL
Diethylphthalate	84-66-2	O	WHOL	02.02	13	1	0.00100	0.00100	0.00001	85.6000	LCV_AQPL
Diethylphthalate	84-66-2	O	WHOL	03.03	13	1	0.00200	0.00200	0.00002	85.6000	LCV_AQPL
Diethylphthalate	84-66-2	O	WHOL	13	49	4	0.00125	0.00167	0.00002	85.6000	LCV_AQPL
Diethylphthalate	84-66-2	O	FLTR	02.02	12	1	0.00100	0.00100	0.00025	3.9500	S_ACU_V
Diethylphthalate	84-66-2	O	FLTR	03.03	12	1	0.00300	0.00300	0.00076	3.9500	S_ACU_V
Diethylphthalate	84-66-2	O	FLTR	13	46	3	0.00133	0.00189	0.00048	3.9500	S_ACU_V
Diethylphthalate	84-66-2	O	WHOL	02.02	13	1	0.00100	0.00100	0.00025	3.9500	S_ACU_V
Diethylphthalate	84-66-2	O	WHOL	03.03	13	1	0.00200	0.00200	0.00051	3.9500	S_ACU_V
Diethylphthalate	84-66-2	O	WHOL	13	49	4	0.00125	0.00167	0.00042	3.9500	S_ACU_V
Diethylphthalate	84-66-2	O	FLTR	02.02	12	1	0.00100	0.00100	0.00455	0.2200	S_CHR_V
Diethylphthalate	84-66-2	O	FLTR	03.03	12	1	0.00300	0.00300	0.01364	0.2200	S_CHR_V
Diethylphthalate	84-66-2	O	FLTR	13	46	3	0.00133	0.00189	0.00861	0.2200	S_CHR_V
Diethylphthalate	84-66-2	O	WHOL	02.02	13	1	0.00100	0.00100	0.00455	0.2200	S_CHR_V
Diethylphthalate	84-66-2	O	WHOL	03.03	13	1	0.00200	0.00200	0.00909	0.2200	S_CHR_V
Diethylphthalate	84-66-2	O	WHOL	13	49	4	0.00125	0.00167	0.00759	0.2200	S_CHR_V
Dimethylbenzene	1330-20-7	O	WHOL	01	28	1	0.00140	0.00140	0.00002	62.3080	LCV_ALLO
Dimethylbenzene	1330-20-7	O	WHOL	01	28	1	0.00140	0.00140	0.00002	62.3080	LCV_FISH
Dimethylbenzene	1330-20-7	O	WHOL	01	28	1	0.00140	0.00140	0.00052	2.6800	LTV_FISH
Dimethylbenzene	1330-20-7	O	WHOL	01	28	1	0.00140	0.00140	0.00091	1.5400	S_ACU_V
Dimethylbenzene	1330-20-7	O	WHOL	01	28	1	0.00140	0.00140	0.01624	0.0862	S_CHR_V
Iron	7439-89-6	I	FLTR	00	1	1	0.38600	0.38600	2.44304	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	01	19	9	0.08780	0.14201	0.89878	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	02.01	3	3	0.23691	0.58423	3.69763	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	02.02	13	6	0.05183	0.10775	0.68196	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	02.03	6	4	0.13223	0.29038	1.83786	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	02.04	2	1	0.13057	0.13057	0.82636	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	03.01	14	12	0.08589	0.13358	0.84544	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	03.02	14	11	0.07638	0.11318	0.71635	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	03.03	14	8	0.08651	0.13140	0.83167	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	03.04	16	10	0.07866	0.11911	0.75387	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	04.01	16	9	0.11759	0.17659	1.11765	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	04.02	6	4	0.12736	0.30044	1.90149	0.1580	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Iron	7439-89-6	I	FLTR	04.04	10	5	0.11148	0.21572	1.36530	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	05	3	1	0.02900	0.02900	0.18354	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	07.01	5	2	0.02044	0.02109	0.13346	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	07.02	17	4	0.17098	0.47406	3.00038	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	08	2	2	0.03420	0.14217	0.89978	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	13	46	41	0.09968	0.14446	0.91433	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	22	1	1	0.02500	0.02500	0.15823	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	00	11	11	0.43400	0.62437	3.95171	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	01	51	47	0.31752	0.40888	2.58783	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	02.01	3	3	0.41333	0.63923	4.04574	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	02.02	22	20	0.27009	0.37564	2.37749	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	02.03	6	6	0.35845	0.56238	3.55935	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	02.04	11	10	0.30545	0.40714	2.57686	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	03.01	34	34	0.77467	0.89476	5.66304	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	03.02	14	14	0.53136	0.65187	4.12575	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	03.03	23	23	0.67591	0.81998	5.18978	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	03.04	16	16	0.58975	0.75841	4.80009	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	04.01	25	24	0.41990	0.54079	3.42273	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	04.02	6	6	0.30335	0.53148	3.36383	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	04.04	10	10	0.33861	0.48584	3.07494	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	05	4	4	0.27775	0.52607	3.32954	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	07.01	5	5	0.19840	0.28869	1.82713	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	07.02	17	16	0.21739	0.30566	1.93456	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	08	2	2	0.10350	0.35289	2.23350	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	13	58	57	0.65821	0.75250	4.76265	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	18	9	8	0.64256	1.18747	7.51564	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	20.01	9	7	0.18956	0.29655	1.87689	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	20.02	10	10	0.20667	0.28288	1.79041	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	21	18	17	1.62656	3.20237	20.26819	0.1580	LCV_ALLO
Iron	7439-89-6	I	WHOL	22	11	11	0.89473	1.15593	7.31604	0.1580	LCV_ALLO
Iron	7439-89-6	I	FLTR	00	1	1	0.38600	0.38600	2.44304	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	01	19	9	0.08780	0.14201	0.89878	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	02.01	3	3	0.23691	0.58423	3.69763	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	02.02	13	6	0.05183	0.10775	0.68196	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	02.03	6	4	0.13223	0.29038	1.83786	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	02.04	2	1	0.13057	0.13057	0.82636	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	03.01	14	12	0.08589	0.13358	0.84544	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	03.02	14	11	0.07638	0.11318	0.71635	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	03.03	14	8	0.08651	0.13140	0.83167	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	03.04	16	10	0.07866	0.11911	0.75387	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	04.01	16	9	0.11759	0.17659	1.11765	0.1580	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Iron	7439-89-6	I	FLTR	04.02	6	4	0.12736	0.30044	1.90149	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	04.04	10	5	0.11148	0.21572	1.36530	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	05	3	1	0.02900	0.02900	0.18354	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	07.01	5	2	0.02044	0.02109	0.13346	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	07.02	17	4	0.17098	0.47406	3.00038	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	08	2	2	0.03420	0.14217	0.89978	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	13	46	41	0.09968	0.14446	0.91433	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	22	1	1	0.02500	0.02500	0.15823	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	00	11	11	0.43400	0.62437	3.95171	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	01	51	47	0.31752	0.40888	2.58783	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	02.01	3	3	0.41333	0.63923	4.04574	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	02.02	22	20	0.27009	0.37564	2.37749	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	02.03	6	6	0.35845	0.56238	3.55935	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	02.04	11	10	0.30545	0.40714	2.57686	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	03.01	34	34	0.77467	0.89476	5.66304	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	03.02	14	14	0.53136	0.65187	4.12575	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	03.03	23	23	0.67591	0.81998	5.18978	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	03.04	16	16	0.58975	0.75841	4.80009	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	04.01	25	24	0.41990	0.54079	3.42273	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	04.02	6	6	0.30335	0.53148	3.36383	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	04.04	10	10	0.33861	0.48584	3.07494	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	05	4	4	0.27775	0.52607	3.32954	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	07.01	5	5	0.19840	0.28869	1.82713	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	07.02	17	16	0.21739	0.30566	1.93456	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	08	2	2	0.10350	0.35289	2.23350	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	13	58	57	0.65821	0.75250	4.76265	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	18	9	8	0.64256	1.18747	7.51564	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	20.01	9	7	0.18956	0.29655	1.87689	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	20.02	10	10	0.20667	0.28288	1.79041	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	21	18	17	1.62656	3.20237	20.26819	0.1580	LCV_DAPH
Iron	7439-89-6	I	WHOL	22	11	11	0.89473	1.15593	7.31604	0.1580	LCV_DAPH
Iron	7439-89-6	I	FLTR	00	1	1	0.38600	0.38600	0.29692	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	01	19	9	0.08780	0.14201	0.10924	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	02.01	3	3	0.23691	0.58423	0.44940	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	02.02	13	6	0.05183	0.10775	0.08288	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	02.03	6	4	0.13223	0.29038	0.22337	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	02.04	2	1	0.13057	0.13057	0.10043	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	03.01	14	12	0.08589	0.13358	0.10275	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	03.02	14	11	0.07638	0.11318	0.08706	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	03.03	14	8	0.08651	0.13140	0.10108	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	03.04	16	10	0.07866	0.11911	0.09162	1.3000	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Iron	7439-89-6	I	FLTR	04.01	16	9	0.11759	0.17659	0.13584	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	04.02	6	4	0.12736	0.30044	0.23110	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	04.04	10	5	0.11148	0.21572	0.16594	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	05	3	1	0.02900	0.02900	0.02231	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	07.01	5	2	0.02044	0.02109	0.01622	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	07.02	17	4	0.17098	0.47406	0.36466	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	08	2	2	0.03420	0.14217	0.10936	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	13	46	41	0.09968	0.14446	0.11113	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	22	1	1	0.02500	0.02500	0.01923	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	00	11	11	0.43400	0.62437	0.48029	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	01	51	47	0.31752	0.40888	0.31452	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	02.01	3	3	0.41333	0.63923	0.49171	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	02.02	22	20	0.27009	0.37564	0.28896	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	02.03	6	6	0.35845	0.56238	0.43260	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	02.04	11	10	0.30545	0.40714	0.31319	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	03.01	34	34	0.77467	0.89476	0.68828	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	03.02	14	14	0.53136	0.65187	0.50144	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	03.03	23	23	0.67591	0.81998	0.63076	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	03.04	16	16	0.58975	0.75841	0.58340	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	04.01	25	24	0.41990	0.54079	0.41599	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	04.02	6	6	0.30335	0.53148	0.40883	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	04.04	10	10	0.33861	0.48584	0.37372	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	05	4	4	0.27775	0.52607	0.40467	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	07.01	5	5	0.19840	0.28869	0.22207	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	07.02	17	16	0.21739	0.30566	0.23512	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	08	2	2	0.10350	0.35289	0.27146	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	13	58	57	0.65821	0.75250	0.57885	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	18	9	8	0.64256	1.18747	0.91344	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	20.01	9	7	0.18956	0.29655	0.22811	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	20.02	10	10	0.20667	0.28288	0.21760	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	21	18	17	1.62656	3.20237	2.46337	1.3000	LCV_FISH
Iron	7439-89-6	I	WHOL	22	11	11	0.89473	1.15593	0.88918	1.3000	LCV_FISH
Iron	7439-89-6	I	FLTR	00	1	1	0.38600	0.38600	24.12500	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	01	19	9	0.08780	0.14201	8.87546	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	02.01	3	3	0.23691	0.58423	36.51409	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	02.02	13	6	0.05183	0.10775	6.73435	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	02.03	6	4	0.13223	0.29038	18.14883	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	02.04	2	1	0.13057	0.13057	8.16031	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	03.01	14	12	0.08589	0.13358	8.34872	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	03.02	14	11	0.07638	0.11318	7.07399	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	03.03	14	8	0.08651	0.13140	8.21275	0.0160	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Iron	7439-89-6	I	FLTR	03.04	16	10	0.07866	0.11911	7.44442	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	04.01	16	9	0.11759	0.17659	11.03683	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	04.02	6	4	0.12736	0.30044	18.77721	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	04.04	10	5	0.11148	0.21572	13.48236	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	05	3	1	0.02900	0.02900	1.81250	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	07.01	5	2	0.02044	0.02109	1.31795	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	07.02	17	4	0.17098	0.47406	29.62873	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	08	2	2	0.03420	0.14217	8.88532	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	13	46	41	0.09968	0.14446	9.02901	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	22	1	1	0.02500	0.02500	1.56250	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	00	11	11	0.43400	0.62437	39.02317	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	01	51	47	0.31752	0.40888	25.55481	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	02.01	3	3	0.41333	0.63923	39.95171	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	02.02	22	20	0.27009	0.37564	23.47772	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	02.03	6	6	0.35845	0.56238	35.14856	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	02.04	11	10	0.30545	0.40714	25.44648	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	03.01	34	34	0.77467	0.89476	55.92251	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	03.02	14	14	0.53136	0.65187	40.74180	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	03.03	23	23	0.67591	0.81998	51.24904	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	03.04	16	16	0.58975	0.75841	47.40090	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	04.01	25	24	0.41990	0.54079	33.79947	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	04.02	6	6	0.30335	0.53148	33.21778	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	04.04	10	10	0.33861	0.48584	30.36507	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	05	4	4	0.27775	0.52607	32.87917	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	07.01	5	5	0.19840	0.28869	18.04295	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	07.02	17	16	0.21739	0.30566	19.10374	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	08	2	2	0.10350	0.35289	22.05582	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	13	58	57	0.65821	0.75250	47.03118	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	18	9	8	0.64256	1.18747	74.21693	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	20.01	9	7	0.18956	0.29655	18.53428	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	20.02	10	10	0.20667	0.28288	17.68028	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	21	18	17	1.62656	3.20237	200.14841	0.0160	LTV_DAPH
Iron	7439-89-6	I	WHOL	22	11	11	0.89473	1.15593	72.24590	0.0160	LTV_DAPH
Iron	7439-89-6	I	FLTR	00	1	1	0.38600	0.38600	0.38600	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	01	19	9	0.08780	0.14201	0.14201	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	02.01	3	3	0.23691	0.58423	0.58423	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	02.02	13	6	0.05183	0.10775	0.10775	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	02.03	6	4	0.13223	0.29038	0.29038	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	02.04	2	1	0.13057	0.13057	0.13057	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	03.01	14	12	0.08589	0.13358	0.13358	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	03.02	14	11	0.07638	0.11318	0.11318	1.0000	NAWQ_CHR

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Iron	7439-89-6	I	FLTR	03.03	14	8	0.08651	0.13140	0.13140	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	03.04	16	10	0.07866	0.11911	0.11911	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	04.01	16	9	0.11759	0.17659	0.17659	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	04.02	6	4	0.12736	0.30044	0.30044	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	04.04	10	5	0.11148	0.21572	0.21572	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	05	3	1	0.02900	0.02900	0.02900	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	07.01	5	2	0.02044	0.02109	0.02109	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	07.02	17	4	0.17098	0.47406	0.47406	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	08	2	2	0.03420	0.14217	0.14217	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	13	46	41	0.09968	0.14446	0.14446	1.0000	NAWQ_CHR
Iron	7439-89-6	I	FLTR	22	1	1	0.02500	0.02500	0.02500	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	00	11	11	0.43400	0.62437	0.62437	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	01	51	47	0.31752	0.40888	0.40888	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	02.01	3	3	0.41333	0.63923	0.63923	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	02.02	22	20	0.27009	0.37564	0.37564	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	02.03	6	6	0.35845	0.56238	0.56238	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	02.04	11	10	0.30545	0.40714	0.40714	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	03.01	34	34	0.77467	0.89476	0.89476	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	03.02	14	14	0.53136	0.65187	0.65187	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	03.03	23	23	0.67591	0.81998	0.81998	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	03.04	16	16	0.58975	0.75841	0.75841	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	04.01	25	24	0.41990	0.54079	0.54079	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	04.02	6	6	0.30335	0.53148	0.53148	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	04.04	10	10	0.33861	0.48584	0.48584	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	05	4	4	0.27775	0.52607	0.52607	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	07.01	5	5	0.19840	0.28869	0.28869	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	07.02	17	16	0.21739	0.30566	0.30566	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	08	2	2	0.10350	0.35289	0.35289	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	13	58	57	0.65821	0.75250	0.75250	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	18	9	8	0.64256	1.18747	1.18747	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	20.01	9	7	0.18956	0.29655	0.29655	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	20.02	10	10	0.20667	0.28288	0.28288	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	21	18	17	1.62656	3.20237	3.20237	1.0000	NAWQ_CHR
Iron	7439-89-6	I	WHOL	22	11	11	0.89473	1.15593	1.15593	1.0000	NAWQ_CHR
Lead	7439-92-1	I	FLTR	01	20	5	0.00120	0.00139	0.11323	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	02.01	3	1	0.00250	0.00250	0.20392	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	02.03	6	1	0.00150	0.00150	0.12235	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	03.01	14	2	0.00141	0.00143	0.11658	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	03.02	14	1	0.00220	0.00220	0.17945	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	03.03	14	1	0.00120	0.00120	0.09788	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	03.04	16	1	0.00110	0.00110	0.08972	0.0123	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Lead	7439-92-1	I	FLTR	04.01	16	2	0.00131	0.00132	0.10777	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	04.04	11	2	0.00087	0.00105	0.08568	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	07.02	17	1	0.00170	0.00170	0.13866	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	13	47	4	0.00064	0.00068	0.05544	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	00	11	1	0.00100	0.00100	0.08157	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	01	51	10	0.00153	0.00170	0.13874	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	02.01	3	2	0.00157	0.00348	0.28363	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	02.02	22	7	0.00122	0.00136	0.11089	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	02.03	6	3	0.00182	0.00200	0.16349	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	03.01	34	19	0.00159	0.00176	0.14321	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	03.02	14	5	0.00116	0.00131	0.10678	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	03.03	23	9	0.00163	0.00193	0.15738	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	03.04	16	8	0.00152	0.00189	0.15395	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	04.01	25	7	0.00148	0.00176	0.14344	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	04.02	6	1	0.00280	0.00280	0.22838	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	04.04	11	4	0.00117	0.00136	0.11055	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	07.01	5	3	0.00132	0.00155	0.12614	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	07.02	17	7	0.00140	0.00150	0.12235	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	08	2	1	0.00230	0.00230	0.18760	0.0123	LCV_ALLO
Lead	7439-92-1	I	WHOL	13	58	22	0.00144	0.00160	0.13013	0.0123	LCV_ALLO
Lead	7439-92-1	I	FLTR	01	20	5	0.00120	0.00139	0.00278	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	02.01	3	1	0.00250	0.00250	0.00500	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	02.03	6	1	0.00150	0.00150	0.00300	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	03.01	14	2	0.00141	0.00143	0.00286	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	03.02	14	1	0.00220	0.00220	0.00440	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	03.03	14	1	0.00120	0.00120	0.00240	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	03.04	16	1	0.00110	0.00110	0.00220	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	04.01	16	2	0.00131	0.00132	0.00264	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	04.04	11	2	0.00087	0.00105	0.00210	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	07.02	17	1	0.00170	0.00170	0.00340	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	13	47	4	0.00064	0.00068	0.00136	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	00	11	1	0.00100	0.00100	0.00200	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	01	51	10	0.00153	0.00170	0.00340	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	02.01	3	2	0.00157	0.00348	0.00695	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	02.02	22	7	0.00122	0.00136	0.00272	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	02.03	6	3	0.00182	0.00200	0.00401	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	03.01	34	19	0.00159	0.00176	0.00351	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	03.02	14	5	0.00116	0.00131	0.00262	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	03.03	23	9	0.00163	0.00193	0.00386	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	03.04	16	8	0.00152	0.00189	0.00377	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	04.01	25	7	0.00148	0.00176	0.00352	0.5000	LCV_AQPL

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Lead	7439-92-1	I	WHOL	04.02	6	1	0.00280	0.00280	0.00560	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	04.04	11	4	0.00117	0.00136	0.00271	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	07.01	5	3	0.00132	0.00155	0.00309	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	07.02	17	7	0.00140	0.00150	0.00300	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	08	2	1	0.00230	0.00230	0.00460	0.5000	LCV_AQPL
Lead	7439-92-1	I	WHOL	13	58	22	0.00144	0.00160	0.00319	0.5000	LCV_AQPL
Lead	7439-92-1	I	FLTR	01	20	5	0.00120	0.00139	0.11323	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	02.01	3	1	0.00250	0.00250	0.20392	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	02.03	6	1	0.00150	0.00150	0.12235	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	03.01	14	2	0.00141	0.00143	0.11658	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	03.02	14	1	0.00220	0.00220	0.17945	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	03.03	14	1	0.00120	0.00120	0.09788	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	03.04	16	1	0.00110	0.00110	0.08972	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	04.01	16	2	0.00131	0.00132	0.10777	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	04.04	11	2	0.00087	0.00105	0.08568	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	07.02	17	1	0.00170	0.00170	0.13866	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	13	47	4	0.00064	0.00068	0.05544	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	00	11	1	0.00100	0.00100	0.08157	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	01	51	10	0.00153	0.00170	0.13874	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	02.01	3	2	0.00157	0.00348	0.28363	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	02.02	22	7	0.00122	0.00136	0.11089	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	02.03	6	3	0.00182	0.00200	0.16349	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	03.01	34	19	0.00159	0.00176	0.14321	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	03.02	14	5	0.00116	0.00131	0.10678	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	03.03	23	9	0.00163	0.00193	0.15738	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	03.04	16	8	0.00152	0.00189	0.15395	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	04.01	25	7	0.00148	0.00176	0.14344	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	04.02	6	1	0.00280	0.00280	0.22838	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	04.04	11	4	0.00117	0.00136	0.11055	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	07.01	5	3	0.00132	0.00155	0.12614	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	07.02	17	7	0.00140	0.00150	0.12235	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	08	2	1	0.00230	0.00230	0.18760	0.0123	LCV_DAPH
Lead	7439-92-1	I	WHOL	13	58	22	0.00144	0.00160	0.13013	0.0123	LCV_DAPH
Lead	7439-92-1	I	FLTR	01	20	5	0.00120	0.00139	0.07353	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	02.01	3	1	0.00250	0.00250	0.13242	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	02.03	6	1	0.00150	0.00150	0.07945	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	03.01	14	2	0.00141	0.00143	0.07570	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	03.02	14	1	0.00220	0.00220	0.11653	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	03.03	14	1	0.00120	0.00120	0.06356	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	03.04	16	1	0.00110	0.00110	0.05826	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	04.01	16	2	0.00131	0.00132	0.06998	0.0189	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Lead	7439-92-1	I	FLTR	04.04	11	2	0.00087	0.00105	0.05564	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	07.02	17	1	0.00170	0.00170	0.09004	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	13	47	4	0.00064	0.00068	0.03600	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	00	11	1	0.00100	0.00100	0.05297	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	01	51	10	0.00153	0.00170	0.09009	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	02.01	3	2	0.00157	0.00348	0.18418	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	02.02	22	7	0.00122	0.00136	0.07201	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	02.03	6	3	0.00182	0.00200	0.10617	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	03.01	34	19	0.00159	0.00176	0.09300	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	03.02	14	5	0.00116	0.00131	0.06934	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	03.03	23	9	0.00163	0.00193	0.10219	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	03.04	16	8	0.00152	0.00189	0.09997	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	04.01	25	7	0.00148	0.00176	0.09314	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	04.02	6	1	0.00280	0.00280	0.14831	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	04.04	11	4	0.00117	0.00136	0.07179	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	07.01	5	3	0.00132	0.00155	0.08191	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	07.02	17	7	0.00140	0.00150	0.07945	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	08	2	1	0.00230	0.00230	0.12182	0.0189	LCV_FISH
Lead	7439-92-1	I	WHOL	13	58	22	0.00144	0.00160	0.08450	0.0189	LCV_FISH
Lead	7439-92-1	I	FLTR	01	20	5	0.00120	0.00139	0.05453	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	02.01	3	1	0.00250	0.00250	0.09819	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	02.03	6	1	0.00150	0.00150	0.05892	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	03.01	14	2	0.00141	0.00143	0.05614	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	03.02	14	1	0.00220	0.00220	0.08641	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	03.03	14	1	0.00120	0.00120	0.04713	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	03.04	16	1	0.00110	0.00110	0.04321	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	04.01	16	2	0.00131	0.00132	0.05190	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	04.04	11	2	0.00087	0.00105	0.04126	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	07.02	17	1	0.00170	0.00170	0.06677	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	13	47	4	0.00064	0.00068	0.02669	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	00	11	1	0.00100	0.00100	0.03928	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	01	51	10	0.00153	0.00170	0.06681	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	02.01	3	2	0.00157	0.00348	0.13658	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	02.02	22	7	0.00122	0.00136	0.05340	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	02.03	6	3	0.00182	0.00200	0.07873	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	03.01	34	19	0.00159	0.00176	0.06896	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	03.02	14	5	0.00116	0.00131	0.05142	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	03.03	23	9	0.00163	0.00193	0.07578	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	03.04	16	8	0.00152	0.00189	0.07414	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	04.01	25	7	0.00148	0.00176	0.06907	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	04.02	6	1	0.00280	0.00280	0.10998	0.0255	LCV_NDI

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Lead	7439-92-1	I	WHOL	04.04	11	4	0.00117	0.00136	0.05324	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	07.01	5	3	0.00132	0.00155	0.06074	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	07.02	17	7	0.00140	0.00150	0.05892	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	08	2	1	0.00230	0.00230	0.09034	0.0255	LCV_NDI
Lead	7439-92-1	I	WHOL	13	58	22	0.00144	0.00160	0.06266	0.0255	LCV_NDI
Lead	7439-92-1	I	FLTR	01	20	5	0.00120	0.00139	0.06310	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	02.01	3	1	0.00250	0.00250	0.11364	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	02.03	6	1	0.00150	0.00150	0.06818	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	03.01	14	2	0.00141	0.00143	0.06497	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	03.02	14	1	0.00220	0.00220	0.10000	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	03.03	14	1	0.00120	0.00120	0.05455	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	03.04	16	1	0.00110	0.00110	0.05000	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	04.01	16	2	0.00131	0.00132	0.06006	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	04.04	11	2	0.00087	0.00105	0.04775	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	07.02	17	1	0.00170	0.00170	0.07727	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	13	47	4	0.00064	0.00068	0.03089	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	00	11	1	0.00100	0.00100	0.04545	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	01	51	10	0.00153	0.00170	0.07732	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	02.01	3	2	0.00157	0.00348	0.15806	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	02.02	22	7	0.00122	0.00136	0.06180	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	02.03	6	3	0.00182	0.00200	0.09111	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	03.01	34	19	0.00159	0.00176	0.07981	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	03.02	14	5	0.00116	0.00131	0.05950	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	03.03	23	9	0.00163	0.00193	0.08770	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	03.04	16	8	0.00152	0.00189	0.08579	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	04.01	25	7	0.00148	0.00176	0.07993	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	04.02	6	1	0.00280	0.00280	0.12727	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	04.04	11	4	0.00117	0.00136	0.06161	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	07.01	5	3	0.00132	0.00155	0.07029	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	07.02	17	7	0.00140	0.00150	0.06818	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	08	2	1	0.00230	0.00230	0.10455	0.0220	LTV_FISH
Lead	7439-92-1	I	WHOL	13	58	22	0.00144	0.00160	0.07252	0.0220	LTV_FISH
Lead	7439-92-1	I	FLTR	01	20	5	0.00120	0.00139	0.01693	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	02.01	3	1	0.00250	0.00250	0.03049	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	02.03	6	1	0.00150	0.00150	0.01829	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	03.01	14	2	0.00141	0.00143	0.01743	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	03.02	14	1	0.00220	0.00220	0.02683	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	03.03	14	1	0.00120	0.00120	0.01463	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	03.04	16	1	0.00110	0.00110	0.01341	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	04.01	16	2	0.00131	0.00132	0.01611	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	04.04	11	2	0.00087	0.00105	0.01281	0.0820	NAWQ_ACU

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Lead	7439-92-1	I	FLTR	07.02	17	1	0.00170	0.00170	0.02073	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	13	47	4	0.00064	0.00068	0.00829	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	00	11	1	0.00100	0.00100	0.01220	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	01	51	10	0.00153	0.00170	0.02074	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	02.01	3	2	0.00157	0.00348	0.04241	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	02.02	22	7	0.00122	0.00136	0.01658	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	02.03	6	3	0.00182	0.00200	0.02444	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	03.01	34	19	0.00159	0.00176	0.02141	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	03.02	14	5	0.00116	0.00131	0.01596	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	03.03	23	9	0.00163	0.00193	0.02353	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	03.04	16	8	0.00152	0.00189	0.02302	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	04.01	25	7	0.00148	0.00176	0.02145	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	04.02	6	1	0.00280	0.00280	0.03415	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	04.04	11	4	0.00117	0.00136	0.01653	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	07.01	5	3	0.00132	0.00155	0.01886	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	07.02	17	7	0.00140	0.00150	0.01829	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	08	2	1	0.00230	0.00230	0.02805	0.0820	NAWQ_ACU
Lead	7439-92-1	I	WHOL	13	58	22	0.00144	0.00160	0.01946	0.0820	NAWQ_ACU
Lead	7439-92-1	I	FLTR	01	20	5	0.00120	0.00139	0.43382	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	02.01	3	1	0.00250	0.00250	0.78125	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	02.03	6	1	0.00150	0.00150	0.46875	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	03.01	14	2	0.00141	0.00143	0.44664	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	03.02	14	1	0.00220	0.00220	0.68750	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	03.03	14	1	0.00120	0.00120	0.37500	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	03.04	16	1	0.00110	0.00110	0.34375	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	04.01	16	2	0.00131	0.00132	0.41289	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	04.04	11	2	0.00087	0.00105	0.32827	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	07.02	17	1	0.00170	0.00170	0.53125	0.0032	NAWQ_CHR
Lead	7439-92-1	I	FLTR	13	47	4	0.00064	0.00068	0.21239	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	00	11	1	0.00100	0.00100	0.31250	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	01	51	10	0.00153	0.00170	0.53154	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	02.01	3	2	0.00157	0.00348	1.08666	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	02.02	22	7	0.00122	0.00136	0.42486	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	02.03	6	3	0.00182	0.00200	0.62638	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	03.01	34	19	0.00159	0.00176	0.54868	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	03.02	14	5	0.00116	0.00131	0.40909	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	03.03	23	9	0.00163	0.00193	0.60295	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	03.04	16	8	0.00152	0.00189	0.58984	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	04.01	25	7	0.00148	0.00176	0.54955	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	04.02	6	1	0.00280	0.00280	0.87500	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	04.04	11	4	0.00117	0.00136	0.42356	0.0032	NAWQ_CHR

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Lead	7439-92-1	I	WHOL	07.01	5	3	0.00132	0.00155	0.48326	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	07.02	17	7	0.00140	0.00150	0.46876	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	08	2	1	0.00230	0.00230	0.71875	0.0032	NAWQ_CHR
Lead	7439-92-1	I	WHOL	13	58	22	0.00144	0.00160	0.49856	0.0032	NAWQ_CHR
Magnesium	7439-95-4	I	FLTR	00	1	1	10.10000	10.10000	0.12317	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	01	20	20	8.33357	8.70002	0.10610	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	02.01	3	3	7.69106	10.77408	0.13139	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	02.02	13	13	7.60769	8.23375	0.10041	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	02.03	6	6	7.59517	8.57958	0.10463	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	02.04	2	2	10.09265	12.66458	0.15445	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	03.01	14	14	6.93106	7.78785	0.09497	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	03.02	14	14	7.59500	8.43569	0.10287	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	03.03	14	14	6.65172	7.32014	0.08927	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	03.04	16	15	6.91520	7.64299	0.09321	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	04.01	16	16	7.84614	8.22460	0.10030	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	04.02	6	6	7.77017	8.40390	0.10249	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	04.04	10	10	6.72896	7.35502	0.08970	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	05	4	4	5.93000	8.80141	0.10733	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	07.01	5	5	7.74600	8.83747	0.10777	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	07.02	17	16	7.82765	8.20039	0.10000	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	08	2	2	8.45000	8.76569	0.10690	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	10	2	2	10.25000	11.19706	0.13655	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	13	47	47	7.95242	8.46630	0.10325	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	22	1	1	6.24000	6.24000	0.07610	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	00	11	11	9.07727	9.71053	0.11842	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	01	51	51	8.60239	8.87755	0.10826	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	02.01	3	3	7.94667	10.41530	0.12702	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	02.02	22	22	7.94818	8.38779	0.10229	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	02.03	6	6	7.83167	8.93519	0.10897	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	02.04	11	11	8.67545	9.35576	0.11409	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	03.01	34	33	6.12720	6.62816	0.08083	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	03.02	14	14	7.73786	8.58763	0.10473	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	03.03	23	23	6.90478	7.50299	0.09150	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	03.04	16	15	6.99188	7.68556	0.09373	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	04.01	25	25	7.93040	8.27325	0.10089	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	04.02	6	6	7.98167	8.69165	0.10600	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	04.04	10	10	6.73450	7.32269	0.08930	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	05	4	4	5.92000	8.81500	0.10750	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	07.01	5	5	7.85600	8.85780	0.10802	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	07.02	17	17	8.01213	8.33846	0.10169	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	08	2	2	8.59500	8.81598	0.10751	82.0000	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Magnesium	7439-95-4	I	WHOL	10	2	2	10.35000	11.29706	0.13777	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	13	58	58	8.10827	8.59809	0.10485	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	18	9	9	4.40667	5.09063	0.06208	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	20.01	9	9	8.15444	9.29624	0.11337	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	20.02	10	10	12.54000	14.50051	0.17684	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	21	18	18	7.70667	8.67669	0.10581	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	WHOL	22	11	11	7.64909	8.74591	0.10666	82.0000	LCV_ALLO
Magnesium	7439-95-4	I	FLTR	00	1	1	10.10000	10.10000	0.12317	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	01	20	20	8.33357	8.70002	0.10610	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	02.01	3	3	7.69106	10.77408	0.13139	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	02.02	13	13	7.60769	8.23375	0.10041	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	02.03	6	6	7.59517	8.57958	0.10463	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	02.04	2	2	10.09265	12.66458	0.15445	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	03.01	14	14	6.93106	7.78785	0.09497	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	03.02	14	14	7.59500	8.43569	0.10287	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	03.03	14	14	6.65172	7.32014	0.08927	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	03.04	16	15	6.91520	7.64299	0.09321	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	04.01	16	16	7.84614	8.22460	0.10030	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	04.02	6	6	7.77017	8.40390	0.10249	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	04.04	10	10	6.72896	7.35502	0.08970	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	05	4	4	5.93000	8.80141	0.10733	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	07.01	5	5	7.74600	8.83747	0.10777	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	07.02	17	16	7.82765	8.20039	0.10000	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	08	2	2	8.45000	8.76569	0.10690	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	10	2	2	10.25000	11.19706	0.13655	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	13	47	47	7.95242	8.46630	0.10325	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	FLTR	22	1	1	6.24000	6.24000	0.07610	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	00	11	11	9.07727	9.71053	0.11842	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	01	51	51	8.60239	8.87755	0.10826	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	02.01	3	3	7.94667	10.41530	0.12702	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	02.02	22	22	7.94818	8.38779	0.10229	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	02.03	6	6	7.83167	8.93519	0.10897	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	02.04	11	11	8.67545	9.35576	0.11409	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	03.01	34	33	6.12720	6.62816	0.08083	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	03.02	14	14	7.73786	8.58763	0.10473	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	03.03	23	23	6.90478	7.50299	0.09150	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	03.04	16	15	6.99188	7.68556	0.09373	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	04.01	25	25	7.93040	8.27325	0.10089	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	04.02	6	6	7.98167	8.69165	0.10600	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	04.04	10	10	6.73450	7.32269	0.08930	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	05	4	4	5.92000	8.81500	0.10750	82.0000	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Magnesium	7439-95-4	I	WHOL	07.01	5	5	7.85600	8.85780	0.10802	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	07.02	17	17	8.01213	8.33846	0.10169	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	08	2	2	8.59500	8.81598	0.10751	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	10	2	2	10.35000	11.29706	0.13777	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	13	58	58	8.10827	8.59809	0.10485	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	18	9	9	4.40667	5.09063	0.06208	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	20.01	9	9	8.15444	9.29624	0.11337	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	20.02	10	10	12.54000	14.50051	0.17684	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	21	18	18	7.70667	8.67669	0.10581	82.0000	LCV_DAPH
Magnesium	7439-95-4	I	WHOL	22	11	11	7.64909	8.74591	0.10666	82.0000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	00	1	1	0.01040	0.01040	0.00945	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	01	17	14	0.01021	0.01332	0.01211	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	02.01	3	3	0.00421	0.00799	0.00726	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	02.02	12	11	0.00548	0.00889	0.00808	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	02.03	6	6	0.00344	0.00506	0.00460	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	02.04	1	1	0.00119	0.00119	0.00108	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	03.01	13	13	0.05237	0.06435	0.05850	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	03.02	13	13	0.04842	0.06064	0.05513	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	03.03	13	13	0.04410	0.05378	0.04890	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	03.04	15	15	0.04308	0.05637	0.05125	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	04.01	15	14	0.00512	0.00689	0.00626	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	04.02	6	6	0.00348	0.00480	0.00436	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	04.04	9	9	0.00577	0.00965	0.00877	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	07.01	5	4	0.00562	0.01400	0.01273	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	07.02	17	11	0.00744	0.01381	0.01255	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	08	2	1	0.07100	0.07100	0.06455	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	13	46	46	0.07019	0.07984	0.07259	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	00	11	11	0.08064	0.10362	0.09420	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	01	48	47	0.05631	0.06260	0.05690	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	02.01	3	3	0.03933	0.05211	0.04737	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	02.02	21	21	0.04855	0.05545	0.05041	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	02.03	6	6	0.04340	0.05192	0.04720	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	02.04	10	10	0.08106	0.14350	0.13046	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	03.01	33	33	0.08342	0.09084	0.08258	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	03.02	13	13	0.07645	0.08856	0.08051	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	03.03	22	22	0.08226	0.08943	0.08130	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	03.04	15	15	0.08030	0.08887	0.08080	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	04.01	24	24	0.04982	0.05782	0.05256	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	04.02	6	6	0.05388	0.06947	0.06316	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	04.04	9	9	0.06248	0.07209	0.06553	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	07.01	5	5	0.05014	0.05739	0.05217	1.1000	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Manganese	7439-96-5	I	WHOL	07.02	17	16	0.05716	0.07702	0.07002	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	08	2	2	0.03005	0.10297	0.09361	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	13	57	57	0.11786	0.13031	0.11846	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	18	9	9	0.05973	0.08551	0.07774	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	20.01	9	8	0.02094	0.03178	0.02889	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	20.02	10	9	0.02471	0.03272	0.02974	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	21	18	18	0.24533	0.40127	0.36479	1.1000	LCV_ALLO
Manganese	7439-96-5	I	WHOL	22	10	10	0.11785	0.15068	0.13698	1.1000	LCV_ALLO
Manganese	7439-96-5	I	FLTR	00	1	1	0.01040	0.01040	0.00945	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	01	17	14	0.01021	0.01332	0.01211	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	02.01	3	3	0.00421	0.00799	0.00726	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	02.02	12	11	0.00548	0.00889	0.00808	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	02.03	6	6	0.00344	0.00506	0.00460	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	02.04	1	1	0.00119	0.00119	0.00108	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	03.01	13	13	0.05237	0.06435	0.05850	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	03.02	13	13	0.04842	0.06064	0.05513	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	03.03	13	13	0.04410	0.05378	0.04890	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	03.04	15	15	0.04308	0.05637	0.05125	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	04.01	15	14	0.00512	0.00689	0.00626	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	04.02	6	6	0.00348	0.00480	0.00436	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	04.04	9	9	0.00577	0.00965	0.00877	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	07.01	5	4	0.00562	0.01400	0.01273	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	07.02	17	11	0.00744	0.01381	0.01255	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	08	2	1	0.07100	0.07100	0.06455	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	13	46	46	0.07019	0.07984	0.07259	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	00	11	11	0.08064	0.10362	0.09420	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	01	48	47	0.05631	0.06260	0.05690	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	02.01	3	3	0.03933	0.05211	0.04737	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	02.02	21	21	0.04855	0.05545	0.05041	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	02.03	6	6	0.04340	0.05192	0.04720	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	02.04	10	10	0.08106	0.14350	0.13046	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	03.01	33	33	0.08342	0.09084	0.08258	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	03.02	13	13	0.07645	0.08856	0.08051	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	03.03	22	22	0.08226	0.08943	0.08130	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	03.04	15	15	0.08030	0.08887	0.08080	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	04.01	24	24	0.04982	0.05782	0.05256	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	04.02	6	6	0.05388	0.06947	0.06316	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	04.04	9	9	0.06248	0.07209	0.06553	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	07.01	5	5	0.05014	0.05739	0.05217	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	07.02	17	16	0.05716	0.07702	0.07002	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	08	2	2	0.03005	0.10297	0.09361	1.1000	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Manganese	7439-96-5	I	WHOL	13	57	57	0.11786	0.13031	0.11846	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	18	9	9	0.05973	0.08551	0.07774	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	20.01	9	8	0.02094	0.03178	0.02889	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	20.02	10	9	0.02471	0.03272	0.02974	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	21	18	18	0.24533	0.40127	0.36479	1.1000	LCV_DAPH
Manganese	7439-96-5	I	WHOL	22	10	10	0.11785	0.15068	0.13698	1.1000	LCV_DAPH
Manganese	7439-96-5	I	FLTR	00	1	1	0.01040	0.01040	0.00588	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	01	17	14	0.01021	0.01332	0.00752	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	02.01	3	3	0.00421	0.00799	0.00451	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	02.02	12	11	0.00548	0.00889	0.00502	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	02.03	6	6	0.00344	0.00506	0.00286	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	02.04	1	1	0.00119	0.00119	0.00067	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	03.01	13	13	0.05237	0.06435	0.03635	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	03.02	13	13	0.04842	0.06064	0.03426	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	03.03	13	13	0.04410	0.05378	0.03039	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	03.04	15	15	0.04308	0.05637	0.03185	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	04.01	15	14	0.00512	0.00689	0.00389	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	04.02	6	6	0.00348	0.00480	0.00271	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	04.04	9	9	0.00577	0.00965	0.00545	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	07.01	5	4	0.00562	0.01400	0.00791	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	07.02	17	11	0.00744	0.01381	0.00780	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	08	2	1	0.07100	0.07100	0.04011	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	13	46	46	0.07019	0.07984	0.04511	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	00	11	11	0.08064	0.10362	0.05854	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	01	48	47	0.05631	0.06260	0.03536	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	02.01	3	3	0.03933	0.05211	0.02944	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	02.02	21	21	0.04855	0.05545	0.03133	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	02.03	6	6	0.04340	0.05192	0.02933	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	02.04	10	10	0.08106	0.14350	0.08108	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	03.01	33	33	0.08342	0.09084	0.05132	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	03.02	13	13	0.07645	0.08856	0.05004	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	03.03	22	22	0.08226	0.08943	0.05053	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	03.04	15	15	0.08030	0.08887	0.05021	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	04.01	24	24	0.04982	0.05782	0.03266	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	04.02	6	6	0.05388	0.06947	0.03925	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	04.04	9	9	0.06248	0.07209	0.04073	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	07.01	5	5	0.05014	0.05739	0.03242	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	07.02	17	16	0.05716	0.07702	0.04352	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	08	2	2	0.03005	0.10297	0.05818	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	13	57	57	0.11786	0.13031	0.07362	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	18	9	9	0.05973	0.08551	0.04831	1.7700	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Manganese	7439-96-5	I	WHOL	20.01	9	8	0.02094	0.03178	0.01795	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	20.02	10	9	0.02471	0.03272	0.01848	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	21	18	18	0.24533	0.40127	0.22670	1.7700	LCV_FISH
Manganese	7439-96-5	I	WHOL	22	10	10	0.11785	0.15068	0.08513	1.7700	LCV_FISH
Manganese	7439-96-5	I	FLTR	00	1	1	0.01040	0.01040	0.00945	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	01	17	14	0.01021	0.01332	0.01211	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	02.01	3	3	0.00421	0.00799	0.00726	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	02.02	12	11	0.00548	0.00889	0.00808	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	02.03	6	6	0.00344	0.00506	0.00460	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	02.04	1	1	0.00119	0.00119	0.00108	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	03.01	13	13	0.05237	0.06435	0.05850	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	03.02	13	13	0.04842	0.06064	0.05513	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	03.03	13	13	0.04410	0.05378	0.04890	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	03.04	15	15	0.04308	0.05637	0.05125	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	04.01	15	14	0.00512	0.00689	0.00626	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	04.02	6	6	0.00348	0.00480	0.00436	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	04.04	9	9	0.00577	0.00965	0.00877	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	07.01	5	4	0.00562	0.01400	0.01273	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	07.02	17	11	0.00744	0.01381	0.01255	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	08	2	1	0.07100	0.07100	0.06455	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	13	46	46	0.07019	0.07984	0.07259	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	00	11	11	0.08064	0.10362	0.09420	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	01	48	47	0.05631	0.06260	0.05690	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	02.01	3	3	0.03933	0.05211	0.04737	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	02.02	21	21	0.04855	0.05545	0.05041	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	02.03	6	6	0.04340	0.05192	0.04720	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	02.04	10	10	0.08106	0.14350	0.13046	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	03.01	33	33	0.08342	0.09084	0.08258	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	03.02	13	13	0.07645	0.08856	0.08051	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	03.03	22	22	0.08226	0.08943	0.08130	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	03.04	15	15	0.08030	0.08887	0.08080	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	04.01	24	24	0.04982	0.05782	0.05256	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	04.02	6	6	0.05388	0.06947	0.06316	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	04.04	9	9	0.06248	0.07209	0.06553	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	07.01	5	5	0.05014	0.05739	0.05217	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	07.02	17	16	0.05716	0.07702	0.07002	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	08	2	2	0.03005	0.10297	0.09361	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	13	57	57	0.11786	0.13031	0.11846	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	18	9	9	0.05973	0.08551	0.07774	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	20.01	9	8	0.02094	0.03178	0.02889	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	20.02	10	9	0.02471	0.03272	0.02974	1.1000	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Manganese	7439-96-5	I	WHOL	21	18	18	0.24533	0.40127	0.36479	1.1000	LTV_DAPH
Manganese	7439-96-5	I	WHOL	22	10	10	0.11785	0.15068	0.13698	1.1000	LTV_DAPH
Manganese	7439-96-5	I	FLTR	00	1	1	0.01040	0.01040	0.00819	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	01	17	14	0.01021	0.01332	0.01049	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	02.01	3	3	0.00421	0.00799	0.00629	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	02.02	12	11	0.00548	0.00889	0.00700	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	02.03	6	6	0.00344	0.00506	0.00399	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	02.04	1	1	0.00119	0.00119	0.00093	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	03.01	13	13	0.05237	0.06435	0.05067	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	03.02	13	13	0.04842	0.06064	0.04775	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	03.03	13	13	0.04410	0.05378	0.04235	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	03.04	15	15	0.04308	0.05637	0.04439	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	04.01	15	14	0.00512	0.00689	0.00542	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	04.02	6	6	0.00348	0.00480	0.00378	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	04.04	9	9	0.00577	0.00965	0.00760	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	07.01	5	4	0.00562	0.01400	0.01102	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	07.02	17	11	0.00744	0.01381	0.01087	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	08	2	1	0.07100	0.07100	0.05591	1.2700	LTV_FISH
Manganese	7439-96-5	I	FLTR	13	46	46	0.07019	0.07984	0.06287	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	00	11	11	0.08064	0.10362	0.08159	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	01	48	47	0.05631	0.06260	0.04929	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	02.01	3	3	0.03933	0.05211	0.04103	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	02.02	21	21	0.04855	0.05545	0.04366	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	02.03	6	6	0.04340	0.05192	0.04088	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	02.04	10	10	0.08106	0.14350	0.11299	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	03.01	33	33	0.08342	0.09084	0.07153	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	03.02	13	13	0.07645	0.08856	0.06973	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	03.03	22	22	0.08226	0.08943	0.07042	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	03.04	15	15	0.08030	0.08887	0.06998	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	04.01	24	24	0.04982	0.05782	0.04552	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	04.02	6	6	0.05388	0.06947	0.05470	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	04.04	9	9	0.06248	0.07209	0.05676	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	07.01	5	5	0.05014	0.05739	0.04519	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	07.02	17	16	0.05716	0.07702	0.06065	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	08	2	2	0.03005	0.10297	0.08108	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	13	57	57	0.11786	0.13031	0.10260	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	18	9	9	0.05973	0.08551	0.06733	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	20.01	9	8	0.02094	0.03178	0.02502	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	20.02	10	9	0.02471	0.03272	0.02576	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	21	18	18	0.24533	0.40127	0.31596	1.2700	LTV_FISH
Manganese	7439-96-5	I	WHOL	22	10	10	0.11785	0.15068	0.11864	1.2700	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Manganese	7439-96-5	I	FLTR	00	1	1	0.01040	0.01040	0.00707	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	01	17	14	0.01021	0.01332	0.00906	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	02.01	3	3	0.00421	0.00799	0.00543	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	02.02	12	11	0.00548	0.00889	0.00604	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	02.03	6	6	0.00344	0.00506	0.00344	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	02.04	1	1	0.00119	0.00119	0.00081	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	03.01	13	13	0.05237	0.06435	0.04377	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	03.02	13	13	0.04842	0.06064	0.04125	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	03.03	13	13	0.04410	0.05378	0.03659	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	03.04	15	15	0.04308	0.05637	0.03835	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	04.01	15	14	0.00512	0.00689	0.00468	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	04.02	6	6	0.00348	0.00480	0.00326	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	04.04	9	9	0.00577	0.00965	0.00656	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	07.01	5	4	0.00562	0.01400	0.00952	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	07.02	17	11	0.00744	0.01381	0.00939	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	08	2	1	0.07100	0.07100	0.04830	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	13	46	46	0.07019	0.07984	0.05432	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	00	11	11	0.08064	0.10362	0.07049	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	01	48	47	0.05631	0.06260	0.04258	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	02.01	3	3	0.03933	0.05211	0.03545	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	02.02	21	21	0.04855	0.05545	0.03772	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	02.03	6	6	0.04340	0.05192	0.03532	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	02.04	10	10	0.08106	0.14350	0.09762	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	03.01	33	33	0.08342	0.09084	0.06180	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	03.02	13	13	0.07645	0.08856	0.06025	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	03.03	22	22	0.08226	0.08943	0.06084	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	03.04	15	15	0.08030	0.08887	0.06046	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	04.01	24	24	0.04982	0.05782	0.03933	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	04.02	6	6	0.05388	0.06947	0.04726	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	04.04	9	9	0.06248	0.07209	0.04904	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	07.01	5	5	0.05014	0.05739	0.03904	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	07.02	17	16	0.05716	0.07702	0.05240	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	08	2	2	0.03005	0.10297	0.07005	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	13	57	57	0.11786	0.13031	0.08864	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	18	9	9	0.05973	0.08551	0.05817	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	20.01	9	8	0.02094	0.03178	0.02162	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	20.02	10	9	0.02471	0.03272	0.02226	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	21	18	18	0.24533	0.40127	0.27297	1.4700	S_ACU_V
Manganese	7439-96-5	I	WHOL	22	10	10	0.11785	0.15068	0.10250	1.4700	S_ACU_V
Manganese	7439-96-5	I	FLTR	00	1	1	0.01040	0.01040	0.12951	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	01	17	14	0.01021	0.01332	0.16586	0.0803	S_CHR_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Manganese	7439-96-5	I	FLTR	02.01	3	3	0.00421	0.00799	0.09946	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	02.02	12	11	0.00548	0.00889	0.11066	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	02.03	6	6	0.00344	0.00506	0.06304	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	02.04	1	1	0.00119	0.00119	0.01476	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	03.01	13	13	0.05237	0.06435	0.80134	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	03.02	13	13	0.04842	0.06064	0.75517	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	03.03	13	13	0.04410	0.05378	0.66980	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	03.04	15	15	0.04308	0.05637	0.70201	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	04.01	15	14	0.00512	0.00689	0.08575	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	04.02	6	6	0.00348	0.00480	0.05973	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	04.04	9	9	0.00577	0.00965	0.12016	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	07.01	5	4	0.00562	0.01400	0.17433	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	07.02	17	11	0.00744	0.01381	0.17198	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	08	2	1	0.07100	0.07100	0.88418	0.0803	S_CHR_V
Manganese	7439-96-5	I	FLTR	13	46	46	0.07019	0.07984	0.99433	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	00	11	11	0.08064	0.10362	1.29044	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	01	48	47	0.05631	0.06260	0.77952	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	02.01	3	3	0.03933	0.05211	0.64895	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	02.02	21	21	0.04855	0.05545	0.69057	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	02.03	6	6	0.04340	0.05192	0.64658	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	02.04	10	10	0.08106	0.14350	1.78709	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	03.01	33	33	0.08342	0.09084	1.13127	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	03.02	13	13	0.07645	0.08856	1.10290	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	03.03	22	22	0.08226	0.08943	1.11369	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	03.04	15	15	0.08030	0.08887	1.10679	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	04.01	24	24	0.04982	0.05782	0.72000	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	04.02	6	6	0.05388	0.06947	0.86514	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	04.04	9	9	0.06248	0.07209	0.89772	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	07.01	5	5	0.05014	0.05739	0.71464	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	07.02	17	16	0.05716	0.07702	0.95918	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	08	2	2	0.03005	0.10297	1.28236	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	13	57	57	0.11786	0.13031	1.62273	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	18	9	9	0.05973	0.08551	1.06490	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	20.01	9	8	0.02094	0.03178	0.39576	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	20.02	10	9	0.02471	0.03272	0.40743	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	21	18	18	0.24533	0.40127	4.99710	0.0803	S_CHR_V
Manganese	7439-96-5	I	WHOL	22	10	10	0.11785	0.15068	1.87644	0.0803	S_CHR_V
Mercury	7439-97-6	I	FLTR	01	38	1	0.00001	0.00001	0.03600	0.0002	LCV_ALLO
Mercury	7439-97-6	I	FLTR	02.04	3	1	0.00000	0.00000	0.01537	0.0002	LCV_ALLO
Mercury	7439-97-6	I	FLTR	03.01	27	2	0.00001	0.00001	0.02920	0.0002	LCV_ALLO
Mercury	7439-97-6	I	FLTR	03.02	27	6	0.00003	0.00007	0.30664	0.0002	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Mercury	7439-97-6	I	FLTR	03.03	27	3	0.00003	0.00009	0.38359	0.0002	LCV_ALLO
Mercury	7439-97-6	I	FLTR	03.04	31	3	0.00001	0.00003	0.11845	0.0002	LCV_ALLO
Mercury	7439-97-6	I	FLTR	04.02	12	1	0.00130	0.00130	5.65217	0.0002	LCV_ALLO
Mercury	7439-97-6	I	FLTR	07.02	34	1	0.00000	0.00000	0.01430	0.0002	LCV_ALLO
Mercury	7439-97-6	I	FLTR	13	93	3	0.00002	0.00003	0.13596	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	00	12	2	0.00006	0.00006	0.27024	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	01	71	8	0.00001	0.00002	0.06603	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	02.02	22	1	0.00007	0.00007	0.30000	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	02.04	12	2	0.00001	0.00002	0.09158	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	03.01	67	38	0.00010	0.00013	0.55790	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	03.02	27	13	0.00009	0.00012	0.50295	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	03.03	36	18	0.00010	0.00013	0.55702	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	03.04	31	20	0.00019	0.00026	1.13265	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	04.01	40	8	0.00004	0.00005	0.23129	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	04.02	12	4	0.00003	0.00004	0.19146	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	04.04	20	6	0.00002	0.00003	0.12714	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	07.01	10	2	0.00000	0.00001	0.02386	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	07.02	34	4	0.00000	0.00000	0.01587	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	08	4	1	0.00001	0.00001	0.02935	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	13	106	18	0.00001	0.00002	0.07200	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	18	9	1	0.00007	0.00007	0.30870	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	20.01	9	5	0.00008	0.00009	0.38908	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	20.02	10	3	0.00007	0.00008	0.35569	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	21	18	3	0.00007	0.00007	0.30259	0.0002	LCV_ALLO
Mercury	7439-97-6	I	WHOL	22	11	2	0.00011	0.00013	0.56959	0.0002	LCV_ALLO
Mercury	7439-97-6	I	FLTR	01	38	1	0.00001	0.00001	0.00166	0.0050	LCV_AQPL
Mercury	7439-97-6	I	FLTR	02.04	3	1	0.00000	0.00000	0.00071	0.0050	LCV_AQPL
Mercury	7439-97-6	I	FLTR	03.01	27	2	0.00001	0.00001	0.00134	0.0050	LCV_AQPL
Mercury	7439-97-6	I	FLTR	03.02	27	6	0.00003	0.00007	0.01411	0.0050	LCV_AQPL
Mercury	7439-97-6	I	FLTR	03.03	27	3	0.00003	0.00009	0.01765	0.0050	LCV_AQPL
Mercury	7439-97-6	I	FLTR	03.04	31	3	0.00001	0.00003	0.00545	0.0050	LCV_AQPL
Mercury	7439-97-6	I	FLTR	04.02	12	1	0.00130	0.00130	0.26000	0.0050	LCV_AQPL
Mercury	7439-97-6	I	FLTR	07.02	34	1	0.00000	0.00000	0.00066	0.0050	LCV_AQPL
Mercury	7439-97-6	I	FLTR	13	93	3	0.00002	0.00003	0.00625	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	00	12	2	0.00006	0.00006	0.01243	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	01	71	8	0.00001	0.00002	0.00304	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	02.02	22	1	0.00007	0.00007	0.01380	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	02.04	12	2	0.00001	0.00002	0.00421	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	03.01	67	38	0.00010	0.00013	0.02566	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	03.02	27	13	0.00009	0.00012	0.02314	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	03.03	36	18	0.00010	0.00013	0.02562	0.0050	LCV_AQPL

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Mercury	7439-97-6	I	WHOL	03.04	31	20	0.00019	0.00026	0.05210	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	04.01	40	8	0.00004	0.00005	0.01064	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	04.02	12	4	0.00003	0.00004	0.00881	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	04.04	20	6	0.00002	0.00003	0.00585	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	07.01	10	2	0.00000	0.00001	0.00110	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	07.02	34	4	0.00000	0.00000	0.00073	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	08	4	1	0.00001	0.00001	0.00135	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	13	106	18	0.00001	0.00002	0.00331	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	18	9	1	0.00007	0.00007	0.01420	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	20.01	9	5	0.00008	0.00009	0.01790	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	20.02	10	3	0.00007	0.00008	0.01636	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	21	18	3	0.00007	0.00007	0.01392	0.0050	LCV_AQPL
Mercury	7439-97-6	I	WHOL	22	11	2	0.00011	0.00013	0.02620	0.0050	LCV_AQPL
Mercury	7439-97-6	I	FLTR	01	38	1	0.00001	0.00001	0.00863	0.0010	LCV_DAPH
Mercury	7439-97-6	I	FLTR	02.04	3	1	0.00000	0.00000	0.00368	0.0010	LCV_DAPH
Mercury	7439-97-6	I	FLTR	03.01	27	2	0.00001	0.00001	0.00700	0.0010	LCV_DAPH
Mercury	7439-97-6	I	FLTR	03.02	27	6	0.00003	0.00007	0.07347	0.0010	LCV_DAPH
Mercury	7439-97-6	I	FLTR	03.03	27	3	0.00003	0.00009	0.09190	0.0010	LCV_DAPH
Mercury	7439-97-6	I	FLTR	03.04	31	3	0.00001	0.00003	0.02838	0.0010	LCV_DAPH
Mercury	7439-97-6	I	FLTR	04.02	12	1	0.00130	0.00130	1.35417	0.0010	LCV_DAPH
Mercury	7439-97-6	I	FLTR	07.02	34	1	0.00000	0.00000	0.00343	0.0010	LCV_DAPH
Mercury	7439-97-6	I	FLTR	13	93	3	0.00002	0.00003	0.03257	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	00	12	2	0.00006	0.00006	0.06474	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	01	71	8	0.00001	0.00002	0.01582	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	02.02	22	1	0.00007	0.00007	0.07188	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	02.04	12	2	0.00001	0.00002	0.02194	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	03.01	67	38	0.00010	0.00013	0.13366	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	03.02	27	13	0.00009	0.00012	0.12050	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	03.03	36	18	0.00010	0.00013	0.13345	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	03.04	31	20	0.00019	0.00026	0.27136	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	04.01	40	8	0.00004	0.00005	0.05541	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	04.02	12	4	0.00003	0.00004	0.04587	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	04.04	20	6	0.00002	0.00003	0.03046	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	07.01	10	2	0.00000	0.00001	0.00572	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	07.02	34	4	0.00000	0.00000	0.00380	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	08	4	1	0.00001	0.00001	0.00703	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	13	106	18	0.00001	0.00002	0.01725	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	18	9	1	0.00007	0.00007	0.07396	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	20.01	9	5	0.00008	0.00009	0.09322	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	20.02	10	3	0.00007	0.00008	0.08522	0.0010	LCV_DAPH
Mercury	7439-97-6	I	WHOL	21	18	3	0.00007	0.00007	0.07250	0.0010	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Mercury	7439-97-6	I	WHOL	22	11	2	0.00011	0.00013	0.13646	0.0010	LCV_DAPH
Mercury	7439-97-6	I	FLTR	01	38	1	0.00001	0.00001	0.03600	0.0002	LCV_FISH
Mercury	7439-97-6	I	FLTR	02.04	3	1	0.00000	0.00000	0.01537	0.0002	LCV_FISH
Mercury	7439-97-6	I	FLTR	03.01	27	2	0.00001	0.00001	0.02920	0.0002	LCV_FISH
Mercury	7439-97-6	I	FLTR	03.02	27	6	0.00003	0.00007	0.30664	0.0002	LCV_FISH
Mercury	7439-97-6	I	FLTR	03.03	27	3	0.00003	0.00009	0.38359	0.0002	LCV_FISH
Mercury	7439-97-6	I	FLTR	03.04	31	3	0.00001	0.00003	0.11845	0.0002	LCV_FISH
Mercury	7439-97-6	I	FLTR	04.02	12	1	0.00130	0.00130	5.65217	0.0002	LCV_FISH
Mercury	7439-97-6	I	FLTR	07.02	34	1	0.00000	0.00000	0.01430	0.0002	LCV_FISH
Mercury	7439-97-6	I	FLTR	13	93	3	0.00002	0.00003	0.13596	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	00	12	2	0.00006	0.00006	0.27024	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	01	71	8	0.00001	0.00002	0.06603	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	02.02	22	1	0.00007	0.00007	0.30000	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	02.04	12	2	0.00001	0.00002	0.09158	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	03.01	67	38	0.00010	0.00013	0.55790	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	03.02	27	13	0.00009	0.00012	0.50295	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	03.03	36	18	0.00010	0.00013	0.55702	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	03.04	31	20	0.00019	0.00026	1.13265	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	04.01	40	8	0.00004	0.00005	0.23129	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	04.02	12	4	0.00003	0.00004	0.19146	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	04.04	20	6	0.00002	0.00003	0.12714	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	07.01	10	2	0.00000	0.00001	0.02386	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	07.02	34	4	0.00000	0.00000	0.01587	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	08	4	1	0.00001	0.00001	0.02935	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	13	106	18	0.00001	0.00002	0.07200	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	18	9	1	0.00007	0.00007	0.30870	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	20.01	9	5	0.00008	0.00009	0.38908	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	20.02	10	3	0.00007	0.00008	0.35569	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	21	18	3	0.00007	0.00007	0.30259	0.0002	LCV_FISH
Mercury	7439-97-6	I	WHOL	22	11	2	0.00011	0.00013	0.56959	0.0002	LCV_FISH
Mercury	7439-97-6	I	FLTR	01	38	1	0.00001	0.00001	0.00952	0.0009	LTV_DAPH
Mercury	7439-97-6	I	FLTR	02.04	3	1	0.00000	0.00000	0.00406	0.0009	LTV_DAPH
Mercury	7439-97-6	I	FLTR	03.01	27	2	0.00001	0.00001	0.00772	0.0009	LTV_DAPH
Mercury	7439-97-6	I	FLTR	03.02	27	6	0.00003	0.00007	0.08107	0.0009	LTV_DAPH
Mercury	7439-97-6	I	FLTR	03.03	27	3	0.00003	0.00009	0.10141	0.0009	LTV_DAPH
Mercury	7439-97-6	I	FLTR	03.04	31	3	0.00001	0.00003	0.03131	0.0009	LTV_DAPH
Mercury	7439-97-6	I	FLTR	04.02	12	1	0.00130	0.00130	1.49425	0.0009	LTV_DAPH
Mercury	7439-97-6	I	FLTR	07.02	34	1	0.00000	0.00000	0.00378	0.0009	LTV_DAPH
Mercury	7439-97-6	I	FLTR	13	93	3	0.00002	0.00003	0.03594	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	00	12	2	0.00006	0.00006	0.07144	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	01	71	8	0.00001	0.00002	0.01746	0.0009	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Mercury	7439-97-6	I	WHOL	02.02	22	1	0.00007	0.00007	0.07931	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	02.04	12	2	0.00001	0.00002	0.02421	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	03.01	67	38	0.00010	0.00013	0.14749	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	03.02	27	13	0.00009	0.00012	0.13296	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	03.03	36	18	0.00010	0.00013	0.14726	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	03.04	31	20	0.00019	0.00026	0.29943	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	04.01	40	8	0.00004	0.00005	0.06114	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	04.02	12	4	0.00003	0.00004	0.05062	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	04.04	20	6	0.00002	0.00003	0.03361	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	07.01	10	2	0.00000	0.00001	0.00631	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	07.02	34	4	0.00000	0.00000	0.00420	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	08	4	1	0.00001	0.00001	0.00776	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	13	106	18	0.00001	0.00002	0.01904	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	18	9	1	0.00007	0.00007	0.08161	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	20.01	9	5	0.00008	0.00009	0.10286	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	20.02	10	3	0.00007	0.00008	0.09403	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	21	18	3	0.00007	0.00007	0.07999	0.0009	LTV_DAPH
Mercury	7439-97-6	I	WHOL	22	11	2	0.00011	0.00013	0.15058	0.0009	LTV_DAPH
Mercury	7439-97-6	I	FLTR	01	38	1	0.00001	0.00001	0.00952	0.0009	LTV_FISH
Mercury	7439-97-6	I	FLTR	02.04	3	1	0.00000	0.00000	0.00406	0.0009	LTV_FISH
Mercury	7439-97-6	I	FLTR	03.01	27	2	0.00001	0.00001	0.00772	0.0009	LTV_FISH
Mercury	7439-97-6	I	FLTR	03.02	27	6	0.00003	0.00007	0.08107	0.0009	LTV_FISH
Mercury	7439-97-6	I	FLTR	03.03	27	3	0.00003	0.00009	0.10141	0.0009	LTV_FISH
Mercury	7439-97-6	I	FLTR	03.04	31	3	0.00001	0.00003	0.03131	0.0009	LTV_FISH
Mercury	7439-97-6	I	FLTR	04.02	12	1	0.00130	0.00130	1.49425	0.0009	LTV_FISH
Mercury	7439-97-6	I	FLTR	07.02	34	1	0.00000	0.00000	0.00378	0.0009	LTV_FISH
Mercury	7439-97-6	I	FLTR	13	93	3	0.00002	0.00003	0.03594	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	00	12	2	0.00006	0.00006	0.07144	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	01	71	8	0.00001	0.00002	0.01746	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	02.02	22	1	0.00007	0.00007	0.07931	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	02.04	12	2	0.00001	0.00002	0.02421	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	03.01	67	38	0.00010	0.00013	0.14749	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	03.02	27	13	0.00009	0.00012	0.13296	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	03.03	36	18	0.00010	0.00013	0.14726	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	03.04	31	20	0.00019	0.00026	0.29943	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	04.01	40	8	0.00004	0.00005	0.06114	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	04.02	12	4	0.00003	0.00004	0.05062	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	04.04	20	6	0.00002	0.00003	0.03361	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	07.01	10	2	0.00000	0.00001	0.00631	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	07.02	34	4	0.00000	0.00000	0.00420	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	08	4	1	0.00001	0.00001	0.00776	0.0009	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Mercury	7439-97-6	I	WHOL	13	106	18	0.00001	0.00002	0.01904	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	18	9	1	0.00007	0.00007	0.08161	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	20.01	9	5	0.00008	0.00009	0.10286	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	20.02	10	3	0.00007	0.00008	0.09403	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	21	18	3	0.00007	0.00007	0.07999	0.0009	LTV_FISH
Mercury	7439-97-6	I	WHOL	22	11	2	0.00011	0.00013	0.15058	0.0009	LTV_FISH
Mercury	7439-97-6	I	FLTR	01	38	1	0.00001	0.00001	0.00345	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	FLTR	02.04	3	1	0.00000	0.00000	0.00147	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	FLTR	03.01	27	2	0.00001	0.00001	0.00280	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	FLTR	03.02	27	6	0.00003	0.00007	0.02939	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	FLTR	03.03	27	3	0.00003	0.00009	0.03676	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	FLTR	03.04	31	3	0.00001	0.00003	0.01135	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	FLTR	04.02	12	1	0.00130	0.00130	0.54167	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	FLTR	07.02	34	1	0.00000	0.00000	0.00137	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	FLTR	13	93	3	0.00002	0.00003	0.01303	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	00	12	2	0.00006	0.00006	0.02590	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	01	71	8	0.00001	0.00002	0.00633	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	02.02	22	1	0.00007	0.00007	0.02875	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	02.04	12	2	0.00001	0.00002	0.00878	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	03.01	67	38	0.00010	0.00013	0.05347	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	03.02	27	13	0.00009	0.00012	0.04820	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	03.03	36	18	0.00010	0.00013	0.05338	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	03.04	31	20	0.00019	0.00026	0.10855	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	04.01	40	8	0.00004	0.00005	0.02217	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	04.02	12	4	0.00003	0.00004	0.01835	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	04.04	20	6	0.00002	0.00003	0.01218	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	07.01	10	2	0.00000	0.00001	0.00229	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	07.02	34	4	0.00000	0.00000	0.00152	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	08	4	1	0.00001	0.00001	0.00281	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	13	106	18	0.00001	0.00002	0.00690	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	18	9	1	0.00007	0.00007	0.02958	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	20.01	9	5	0.00008	0.00009	0.03729	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	20.02	10	3	0.00007	0.00008	0.03409	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	21	18	3	0.00007	0.00007	0.02900	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	WHOL	22	11	2	0.00011	0.00013	0.05459	0.0024	NAWQ_ACU
Mercury	7439-97-6	I	FLTR	01	38	1	0.00001	0.00001	0.00637	0.0013	S_CHR_V
Mercury	7439-97-6	I	FLTR	02.04	3	1	0.00000	0.00000	0.00272	0.0013	S_CHR_V
Mercury	7439-97-6	I	FLTR	03.01	27	2	0.00001	0.00001	0.00517	0.0013	S_CHR_V
Mercury	7439-97-6	I	FLTR	03.02	27	6	0.00003	0.00007	0.05425	0.0013	S_CHR_V
Mercury	7439-97-6	I	FLTR	03.03	27	3	0.00003	0.00009	0.06787	0.0013	S_CHR_V
Mercury	7439-97-6	I	FLTR	03.04	31	3	0.00001	0.00003	0.02096	0.0013	S_CHR_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Mercury	7439-97-6	I	FLTR	04.02	12	1	0.00130	0.00130	1.00000	0.0013	S_CHR_V
Mercury	7439-97-6	I	FLTR	07.02	34	1	0.00000	0.00000	0.00253	0.0013	S_CHR_V
Mercury	7439-97-6	I	FLTR	13	93	3	0.00002	0.00003	0.02405	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	00	12	2	0.00006	0.00006	0.04781	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	01	71	8	0.00001	0.00002	0.01168	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	02.02	22	1	0.00007	0.00007	0.05308	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	02.04	12	2	0.00001	0.00002	0.01620	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	03.01	67	38	0.00010	0.00013	0.09871	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	03.02	27	13	0.00009	0.00012	0.08898	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	03.03	36	18	0.00010	0.00013	0.09855	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	03.04	31	20	0.00019	0.00026	0.20039	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	04.01	40	8	0.00004	0.00005	0.04092	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	04.02	12	4	0.00003	0.00004	0.03387	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	04.04	20	6	0.00002	0.00003	0.02249	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	07.01	10	2	0.00000	0.00001	0.00422	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	07.02	34	4	0.00000	0.00000	0.00281	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	08	4	1	0.00001	0.00001	0.00519	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	13	106	18	0.00001	0.00002	0.01274	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	18	9	1	0.00007	0.00007	0.05462	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	20.01	9	5	0.00008	0.00009	0.06884	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	20.02	10	3	0.00007	0.00008	0.06293	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	21	18	3	0.00007	0.00007	0.05353	0.0013	S_CHR_V
Mercury	7439-97-6	I	WHOL	22	11	2	0.00011	0.00013	0.10077	0.0013	S_CHR_V
Methyl mercury	22967-92-6	I	FLTR	01	18	1	0.00000	0.00000	0.01333	0.0000	LCV_ALLO
Methyl mercury	22967-92-6	I	FLTR	02.04	1	1	0.00000	0.00000	0.00091	0.0000	LCV_ALLO
Methyl mercury	22967-92-6	I	FLTR	03.03	13	1	0.00000	0.00000	0.00178	0.0000	LCV_ALLO
Methyl mercury	22967-92-6	I	WHOL	02.04	1	1	0.00000	0.00000	0.00125	0.0000	LCV_ALLO
Methyl mercury	22967-92-6	I	WHOL	03.01	32	11	0.00000	0.00000	0.00406	0.0000	LCV_ALLO
Methyl mercury	22967-92-6	I	WHOL	03.02	12	4	0.00000	0.00000	0.00811	0.0000	LCV_ALLO
Methyl mercury	22967-92-6	I	WHOL	03.03	13	4	0.00000	0.00000	0.00685	0.0000	LCV_ALLO
Methyl mercury	22967-92-6	I	WHOL	03.04	14	2	0.00000	0.00000	0.00974	0.0000	LCV_ALLO
Methyl mercury	22967-92-6	I	WHOL	13	47	3	0.00000	0.00000	0.00281	0.0000	LCV_ALLO
Methyl mercury	22967-92-6	I	FLTR	01	18	1	0.00000	0.00000	0.00067	0.0008	LCV_AQPL
Methyl mercury	22967-92-6	I	FLTR	02.04	1	1	0.00000	0.00000	0.00005	0.0008	LCV_AQPL
Methyl mercury	22967-92-6	I	FLTR	03.03	13	1	0.00000	0.00000	0.00009	0.0008	LCV_AQPL
Methyl mercury	22967-92-6	I	WHOL	02.04	1	1	0.00000	0.00000	0.00006	0.0008	LCV_AQPL
Methyl mercury	22967-92-6	I	WHOL	03.01	32	11	0.00000	0.00000	0.00020	0.0008	LCV_AQPL
Methyl mercury	22967-92-6	I	WHOL	03.02	12	4	0.00000	0.00000	0.00041	0.0008	LCV_AQPL
Methyl mercury	22967-92-6	I	WHOL	03.03	13	4	0.00000	0.00000	0.00034	0.0008	LCV_AQPL
Methyl mercury	22967-92-6	I	WHOL	03.04	14	2	0.00000	0.00000	0.00049	0.0008	LCV_AQPL
Methyl mercury	22967-92-6	I	WHOL	13	47	3	0.00000	0.00000	0.00014	0.0008	LCV_AQPL

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Methyl mercury	22967-92-6	I	FLTR	01	18	1	0.00000	0.00000	0.01333	0.0000	LCV_DAPH
Methyl mercury	22967-92-6	I	FLTR	02.04	1	1	0.00000	0.00000	0.00091	0.0000	LCV_DAPH
Methyl mercury	22967-92-6	I	FLTR	03.03	13	1	0.00000	0.00000	0.00178	0.0000	LCV_DAPH
Methyl mercury	22967-92-6	I	WHOL	02.04	1	1	0.00000	0.00000	0.00125	0.0000	LCV_DAPH
Methyl mercury	22967-92-6	I	WHOL	03.01	32	11	0.00000	0.00000	0.00406	0.0000	LCV_DAPH
Methyl mercury	22967-92-6	I	WHOL	03.02	12	4	0.00000	0.00000	0.00811	0.0000	LCV_DAPH
Methyl mercury	22967-92-6	I	WHOL	03.03	13	4	0.00000	0.00000	0.00685	0.0000	LCV_DAPH
Methyl mercury	22967-92-6	I	WHOL	03.04	14	2	0.00000	0.00000	0.00974	0.0000	LCV_DAPH
Methyl mercury	22967-92-6	I	WHOL	13	47	3	0.00000	0.00000	0.00281	0.0000	LCV_DAPH
Methyl mercury	22967-92-6	I	FLTR	01	18	1	0.00000	0.00000	0.00103	0.0005	LCV_FISH
Methyl mercury	22967-92-6	I	FLTR	02.04	1	1	0.00000	0.00000	0.00007	0.0005	LCV_FISH
Methyl mercury	22967-92-6	I	FLTR	03.03	13	1	0.00000	0.00000	0.00014	0.0005	LCV_FISH
Methyl mercury	22967-92-6	I	WHOL	02.04	1	1	0.00000	0.00000	0.00010	0.0005	LCV_FISH
Methyl mercury	22967-92-6	I	WHOL	03.01	32	11	0.00000	0.00000	0.00031	0.0005	LCV_FISH
Methyl mercury	22967-92-6	I	WHOL	03.02	12	4	0.00000	0.00000	0.00062	0.0005	LCV_FISH
Methyl mercury	22967-92-6	I	WHOL	03.03	13	4	0.00000	0.00000	0.00053	0.0005	LCV_FISH
Methyl mercury	22967-92-6	I	WHOL	03.04	14	2	0.00000	0.00000	0.00075	0.0005	LCV_FISH
Methyl mercury	22967-92-6	I	WHOL	13	47	3	0.00000	0.00000	0.00022	0.0005	LCV_FISH
Methyl mercury	22967-92-6	I	FLTR	01	18	1	0.00000	0.00000	0.00061	0.0009	LTV_DAPH
Methyl mercury	22967-92-6	I	FLTR	02.04	1	1	0.00000	0.00000	0.00004	0.0009	LTV_DAPH
Methyl mercury	22967-92-6	I	FLTR	03.03	13	1	0.00000	0.00000	0.00008	0.0009	LTV_DAPH
Methyl mercury	22967-92-6	I	WHOL	02.04	1	1	0.00000	0.00000	0.00006	0.0009	LTV_DAPH
Methyl mercury	22967-92-6	I	WHOL	03.01	32	11	0.00000	0.00000	0.00019	0.0009	LTV_DAPH
Methyl mercury	22967-92-6	I	WHOL	03.02	12	4	0.00000	0.00000	0.00037	0.0009	LTV_DAPH
Methyl mercury	22967-92-6	I	WHOL	03.03	13	4	0.00000	0.00000	0.00031	0.0009	LTV_DAPH
Methyl mercury	22967-92-6	I	WHOL	03.04	14	2	0.00000	0.00000	0.00045	0.0009	LTV_DAPH
Methyl mercury	22967-92-6	I	WHOL	13	47	3	0.00000	0.00000	0.00013	0.0009	LTV_DAPH
Methyl mercury	22967-92-6	I	FLTR	01	18	1	0.00000	0.00000	0.01777	0.0000	LTV_FISH
Methyl mercury	22967-92-6	I	FLTR	02.04	1	1	0.00000	0.00000	0.00122	0.0000	LTV_FISH
Methyl mercury	22967-92-6	I	FLTR	03.03	13	1	0.00000	0.00000	0.00237	0.0000	LTV_FISH
Methyl mercury	22967-92-6	I	WHOL	02.04	1	1	0.00000	0.00000	0.00167	0.0000	LTV_FISH
Methyl mercury	22967-92-6	I	WHOL	03.01	32	11	0.00000	0.00000	0.00542	0.0000	LTV_FISH
Methyl mercury	22967-92-6	I	WHOL	03.02	12	4	0.00000	0.00000	0.01082	0.0000	LTV_FISH
Methyl mercury	22967-92-6	I	WHOL	03.03	13	4	0.00000	0.00000	0.00913	0.0000	LTV_FISH
Methyl mercury	22967-92-6	I	WHOL	03.04	14	2	0.00000	0.00000	0.01298	0.0000	LTV_FISH
Methyl mercury	22967-92-6	I	WHOL	13	47	3	0.00000	0.00000	0.00374	0.0000	LTV_FISH
Methyl mercury	22967-92-6	I	FLTR	01	18	1	0.00000	0.00000	0.00463	0.0001	S_ACU_V
Methyl mercury	22967-92-6	I	FLTR	02.04	1	1	0.00000	0.00000	0.00032	0.0001	S_ACU_V
Methyl mercury	22967-92-6	I	FLTR	03.03	13	1	0.00000	0.00000	0.00062	0.0001	S_ACU_V
Methyl mercury	22967-92-6	I	WHOL	02.04	1	1	0.00000	0.00000	0.00043	0.0001	S_ACU_V
Methyl mercury	22967-92-6	I	WHOL	03.01	32	11	0.00000	0.00000	0.00141	0.0001	S_ACU_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Methyl mercury	22967-92-6	I	WHOL	03.02	12	4	0.00000	0.00000	0.00282	0.0001	S_ACU_V
Methyl mercury	22967-92-6	I	WHOL	03.03	13	4	0.00000	0.00000	0.00238	0.0001	S_ACU_V
Methyl mercury	22967-92-6	I	WHOL	03.04	14	2	0.00000	0.00000	0.00339	0.0001	S_ACU_V
Methyl mercury	22967-92-6	I	WHOL	13	47	3	0.00000	0.00000	0.00098	0.0001	S_ACU_V
Methyl mercury	22967-92-6	I	FLTR	01	18	1	0.00000	0.00000	0.17767	0.0000	S_CHR_V
Methyl mercury	22967-92-6	I	FLTR	02.04	1	1	0.00000	0.00000	0.01217	0.0000	S_CHR_V
Methyl mercury	22967-92-6	I	FLTR	03.03	13	1	0.00000	0.00000	0.02367	0.0000	S_CHR_V
Methyl mercury	22967-92-6	I	WHOL	02.04	1	1	0.00000	0.00000	0.01667	0.0000	S_CHR_V
Methyl mercury	22967-92-6	I	WHOL	03.01	32	11	0.00000	0.00000	0.05418	0.0000	S_CHR_V
Methyl mercury	22967-92-6	I	WHOL	03.02	12	4	0.00000	0.00000	0.10819	0.0000	S_CHR_V
Methyl mercury	22967-92-6	I	WHOL	03.03	13	4	0.00000	0.00000	0.09132	0.0000	S_CHR_V
Methyl mercury	22967-92-6	I	WHOL	03.04	14	2	0.00000	0.00000	0.12983	0.0000	S_CHR_V
Methyl mercury	22967-92-6	I	WHOL	13	47	3	0.00000	0.00000	0.03740	0.0000	S_CHR_V
Methylene chloride	75-09-2	O	WHOL	20.02	10	1	0.00260	0.00260	0.00006	42.6670	LCV_ALLO
Methylene chloride	75-09-2	O	WHOL	20.02	10	1	0.00260	0.00260	0.00006	42.6670	LCV_DAPH
Methylene chloride	75-09-2	O	WHOL	20.02	10	1	0.00260	0.00260	0.00002	108.0000	LCV_FISH
Methylene chloride	75-09-2	O	WHOL	20.02	10	1	0.00260	0.00260	0.00634	0.4100	LTV_FISH
Methylene chloride	75-09-2	O	WHOL	20.02	10	1	0.00260	0.00260	0.00010	25.6000	S_ACU_V
Methylene chloride	75-09-2	O	WHOL	20.02	10	1	0.00260	0.00260	0.00116	2.2400	S_CHR_V
Molybdenum	7439-98-7	I	FLTR	01	17	1	0.00220	0.00220	0.00250	0.8800	LCV_ALLO
Molybdenum	7439-98-7	I	FLTR	03.01	13	1	0.00120	0.00120	0.00136	0.8800	LCV_ALLO
Molybdenum	7439-98-7	I	FLTR	03.02	13	2	0.00114	0.00122	0.00139	0.8800	LCV_ALLO
Molybdenum	7439-98-7	I	FLTR	07.01	5	1	0.00120	0.00120	0.00136	0.8800	LCV_ALLO
Molybdenum	7439-98-7	I	WHOL	03.01	33	2	0.00110	0.00111	0.00126	0.8800	LCV_ALLO
Molybdenum	7439-98-7	I	WHOL	03.02	13	2	0.00104	0.00112	0.00128	0.8800	LCV_ALLO
Molybdenum	7439-98-7	I	WHOL	03.04	15	1	0.00205	0.00205	0.00233	0.8800	LCV_ALLO
Molybdenum	7439-98-7	I	WHOL	04.01	15	1	0.00180	0.00180	0.00205	0.8800	LCV_ALLO
Molybdenum	7439-98-7	I	WHOL	13	48	1	0.00150	0.00150	0.00170	0.8800	LCV_ALLO
Molybdenum	7439-98-7	I	FLTR	01	17	1	0.00220	0.00220	0.00250	0.8800	LCV_DAPH
Molybdenum	7439-98-7	I	FLTR	03.01	13	1	0.00120	0.00120	0.00136	0.8800	LCV_DAPH
Molybdenum	7439-98-7	I	FLTR	03.02	13	2	0.00114	0.00122	0.00139	0.8800	LCV_DAPH
Molybdenum	7439-98-7	I	FLTR	07.01	5	1	0.00120	0.00120	0.00136	0.8800	LCV_DAPH
Molybdenum	7439-98-7	I	WHOL	03.01	33	2	0.00110	0.00111	0.00126	0.8800	LCV_DAPH
Molybdenum	7439-98-7	I	WHOL	03.02	13	2	0.00104	0.00112	0.00128	0.8800	LCV_DAPH
Molybdenum	7439-98-7	I	WHOL	03.04	15	1	0.00205	0.00205	0.00233	0.8800	LCV_DAPH
Molybdenum	7439-98-7	I	WHOL	04.01	15	1	0.00180	0.00180	0.00205	0.8800	LCV_DAPH
Molybdenum	7439-98-7	I	WHOL	13	48	1	0.00150	0.00150	0.00170	0.8800	LCV_DAPH
Molybdenum	7439-98-7	I	FLTR	01	17	1	0.00220	0.00220	0.00611	0.3600	LTV_DAPH
Molybdenum	7439-98-7	I	FLTR	03.01	13	1	0.00120	0.00120	0.00333	0.3600	LTV_DAPH
Molybdenum	7439-98-7	I	FLTR	03.02	13	2	0.00114	0.00122	0.00340	0.3600	LTV_DAPH
Molybdenum	7439-98-7	I	FLTR	07.01	5	1	0.00120	0.00120	0.00333	0.3600	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Molybdenum	7439-98-7	I	WHOL	03.01	33	2	0.00110	0.00111	0.00309	0.3600	LTV_DAPH
Molybdenum	7439-98-7	I	WHOL	03.02	13	2	0.00104	0.00112	0.00312	0.3600	LTV_DAPH
Molybdenum	7439-98-7	I	WHOL	03.04	15	1	0.00205	0.00205	0.00569	0.3600	LTV_DAPH
Molybdenum	7439-98-7	I	WHOL	04.01	15	1	0.00180	0.00180	0.00500	0.3600	LTV_DAPH
Molybdenum	7439-98-7	I	WHOL	13	48	1	0.00150	0.00150	0.00417	0.3600	LTV_DAPH
Molybdenum	7439-98-7	I	FLTR	01	17	1	0.00220	0.00220	0.00022	10.1000	S_ACU_V
Molybdenum	7439-98-7	I	FLTR	03.01	13	1	0.00120	0.00120	0.00012	10.1000	S_ACU_V
Molybdenum	7439-98-7	I	FLTR	03.02	13	2	0.00114	0.00122	0.00012	10.1000	S_ACU_V
Molybdenum	7439-98-7	I	FLTR	07.01	5	1	0.00120	0.00120	0.00012	10.1000	S_ACU_V
Molybdenum	7439-98-7	I	WHOL	03.01	33	2	0.00110	0.00111	0.00011	10.1000	S_ACU_V
Molybdenum	7439-98-7	I	WHOL	03.02	13	2	0.00104	0.00112	0.00011	10.1000	S_ACU_V
Molybdenum	7439-98-7	I	WHOL	03.04	15	1	0.00205	0.00205	0.00020	10.1000	S_ACU_V
Molybdenum	7439-98-7	I	WHOL	04.01	15	1	0.00180	0.00180	0.00018	10.1000	S_ACU_V
Molybdenum	7439-98-7	I	WHOL	13	48	1	0.00150	0.00150	0.00015	10.1000	S_ACU_V
Molybdenum	7439-98-7	I	FLTR	01	17	1	0.00220	0.00220	0.00921	0.2390	S_CHR_V
Molybdenum	7439-98-7	I	FLTR	03.01	13	1	0.00120	0.00120	0.00502	0.2390	S_CHR_V
Molybdenum	7439-98-7	I	FLTR	03.02	13	2	0.00114	0.00122	0.00512	0.2390	S_CHR_V
Molybdenum	7439-98-7	I	FLTR	07.01	5	1	0.00120	0.00120	0.00502	0.2390	S_CHR_V
Molybdenum	7439-98-7	I	WHOL	03.01	33	2	0.00110	0.00111	0.00465	0.2390	S_CHR_V
Molybdenum	7439-98-7	I	WHOL	03.02	13	2	0.00104	0.00112	0.00470	0.2390	S_CHR_V
Molybdenum	7439-98-7	I	WHOL	03.04	15	1	0.00205	0.00205	0.00858	0.2390	S_CHR_V
Molybdenum	7439-98-7	I	WHOL	04.01	15	1	0.00180	0.00180	0.00753	0.2390	S_CHR_V
Molybdenum	7439-98-7	I	WHOL	13	48	1	0.00150	0.00150	0.00628	0.2390	S_CHR_V
Nickel	7440-02-0	I	FLTR	00	1	1	0.00490	0.00490	0.98000	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	01	20	16	0.00288	0.00376	0.75110	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	02.01	3	3	0.00486	0.01027	2.05409	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	02.02	13	10	0.00241	0.00317	0.63310	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	02.03	6	6	0.00350	0.00560	1.11951	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	02.04	2	1	0.00187	0.00187	0.37400	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	03.01	14	13	0.00425	0.00522	1.04312	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	03.02	14	13	0.00407	0.00486	0.97272	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	03.03	14	13	0.00444	0.00592	1.18405	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	03.04	16	15	0.00362	0.00461	0.92165	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	04.01	16	14	0.00300	0.00371	0.74175	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	04.02	6	4	0.00277	0.00394	0.78718	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	04.04	10	7	0.00334	0.00581	1.16149	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	07.01	5	4	0.00366	0.00725	1.45095	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	07.02	17	15	0.00308	0.00453	0.90604	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	08	2	1	0.00520	0.00520	1.04000	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	13	47	46	0.00457	0.00538	1.07645	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	00	11	1	0.00550	0.00550	1.10000	0.0050	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Nickel	7440-02-0	I	WHOL	01	51	18	0.00303	0.00360	0.71915	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	02.01	3	2	0.00597	0.01395	2.78928	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	02.02	22	11	0.00339	0.00451	0.90245	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	02.03	6	5	0.00355	0.00512	1.02375	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	02.04	11	1	0.00200	0.00200	0.40000	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	03.01	34	33	0.00440	0.00469	0.93843	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	03.02	14	13	0.00354	0.00418	0.83537	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	03.03	23	13	0.00358	0.00421	0.84212	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	03.04	16	15	0.00360	0.00425	0.85074	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	04.01	25	13	0.00228	0.00272	0.54344	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	04.02	6	4	0.00187	0.00293	0.58508	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	04.04	10	7	0.00280	0.00368	0.73614	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	07.01	5	3	0.00326	0.00458	0.91605	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	07.02	17	11	0.00307	0.00424	0.84873	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	08	2	1	0.00290	0.00290	0.58000	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	13	58	49	0.00403	0.00446	0.89122	0.0050	LCV_ALLO
Nickel	7440-02-0	I	WHOL	21	18	5	0.01661	0.02189	4.37735	0.0050	LCV_ALLO
Nickel	7440-02-0	I	FLTR	00	1	1	0.00490	0.00490	0.98000	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	01	20	16	0.00288	0.00376	0.75110	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	02.01	3	3	0.00486	0.01027	2.05409	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	02.02	13	10	0.00241	0.00317	0.63310	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	02.03	6	6	0.00350	0.00560	1.11951	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	02.04	2	1	0.00187	0.00187	0.37400	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	03.01	14	13	0.00425	0.00522	1.04312	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	03.02	14	13	0.00407	0.00486	0.97272	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	03.03	14	13	0.00444	0.00592	1.18405	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	03.04	16	15	0.00362	0.00461	0.92165	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	04.01	16	14	0.00300	0.00371	0.74175	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	04.02	6	4	0.00277	0.00394	0.78718	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	04.04	10	7	0.00334	0.00581	1.16149	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	07.01	5	4	0.00366	0.00725	1.45095	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	07.02	17	15	0.00308	0.00453	0.90604	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	08	2	1	0.00520	0.00520	1.04000	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	13	47	46	0.00457	0.00538	1.07645	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	00	11	1	0.00550	0.00550	1.10000	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	01	51	18	0.00303	0.00360	0.71915	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	02.01	3	2	0.00597	0.01395	2.78928	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	02.02	22	11	0.00339	0.00451	0.90245	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	02.03	6	5	0.00355	0.00512	1.02375	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	02.04	11	1	0.00200	0.00200	0.40000	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	03.01	34	33	0.00440	0.00469	0.93843	0.0050	LCV_AQPL

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Nickel	7440-02-0	I	WHOL	03.02	14	13	0.00354	0.00418	0.83537	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	03.03	23	13	0.00358	0.00421	0.84212	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	03.04	16	15	0.00360	0.00425	0.85074	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	04.01	25	13	0.00228	0.00272	0.54344	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	04.02	6	4	0.00187	0.00293	0.58508	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	04.04	10	7	0.00280	0.00368	0.73614	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	07.01	5	3	0.00326	0.00458	0.91605	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	07.02	17	11	0.00307	0.00424	0.84873	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	08	2	1	0.00290	0.00290	0.58000	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	13	58	49	0.00403	0.00446	0.89122	0.0050	LCV_AQPL
Nickel	7440-02-0	I	WHOL	21	18	5	0.01661	0.02189	4.37735	0.0050	LCV_AQPL
Nickel	7440-02-0	I	FLTR	00	1	1	0.00490	0.00490	0.98000	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	01	20	16	0.00288	0.00376	0.75110	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	02.01	3	3	0.00486	0.01027	2.05409	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	02.02	13	10	0.00241	0.00317	0.63310	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	02.03	6	6	0.00350	0.00560	1.11951	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	02.04	2	1	0.00187	0.00187	0.37400	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	03.01	14	13	0.00425	0.00522	1.04312	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	03.02	14	13	0.00407	0.00486	0.97272	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	03.03	14	13	0.00444	0.00592	1.18405	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	03.04	16	15	0.00362	0.00461	0.92165	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	04.01	16	14	0.00300	0.00371	0.74175	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	04.02	6	4	0.00277	0.00394	0.78718	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	04.04	10	7	0.00334	0.00581	1.16149	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	07.01	5	4	0.00366	0.00725	1.45095	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	07.02	17	15	0.00308	0.00453	0.90604	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	08	2	1	0.00520	0.00520	1.04000	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	13	47	46	0.00457	0.00538	1.07645	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	00	11	1	0.00550	0.00550	1.10000	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	01	51	18	0.00303	0.00360	0.71915	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	02.01	3	2	0.00597	0.01395	2.78928	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	02.02	22	11	0.00339	0.00451	0.90245	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	02.03	6	5	0.00355	0.00512	1.02375	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	02.04	11	1	0.00200	0.00200	0.40000	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	03.01	34	33	0.00440	0.00469	0.93843	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	03.02	14	13	0.00354	0.00418	0.83537	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	03.03	23	13	0.00358	0.00421	0.84212	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	03.04	16	15	0.00360	0.00425	0.85074	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	04.01	25	13	0.00228	0.00272	0.54344	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	04.02	6	4	0.00187	0.00293	0.58508	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	04.04	10	7	0.00280	0.00368	0.73614	0.0050	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Nickel	7440-02-0	I	WHOL	07.01	5	3	0.00326	0.00458	0.91605	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	07.02	17	11	0.00307	0.00424	0.84873	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	08	2	1	0.00290	0.00290	0.58000	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	13	58	49	0.00403	0.00446	0.89122	0.0050	LCV_DAPH
Nickel	7440-02-0	I	WHOL	21	18	5	0.01661	0.02189	4.37735	0.0050	LCV_DAPH
Nickel	7440-02-0	I	FLTR	00	1	1	0.00490	0.00490	0.14000	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	01	20	16	0.00288	0.00376	0.10730	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	02.01	3	3	0.00486	0.01027	0.29344	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	02.02	13	10	0.00241	0.00317	0.09044	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	02.03	6	6	0.00350	0.00560	0.15993	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	02.04	2	1	0.00187	0.00187	0.05343	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	03.01	14	13	0.00425	0.00522	0.14902	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	03.02	14	13	0.00407	0.00486	0.13896	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	03.03	14	13	0.00444	0.00592	0.16915	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	03.04	16	15	0.00362	0.00461	0.13166	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	04.01	16	14	0.00300	0.00371	0.10596	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	04.02	6	4	0.00277	0.00394	0.11245	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	04.04	10	7	0.00334	0.00581	0.16593	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	07.01	5	4	0.00366	0.00725	0.20728	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	07.02	17	15	0.00308	0.00453	0.12943	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	08	2	1	0.00520	0.00520	0.14857	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	13	47	46	0.00457	0.00538	0.15378	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	00	11	1	0.00550	0.00550	0.15714	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	01	51	18	0.00303	0.00360	0.10274	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	02.01	3	2	0.00597	0.01395	0.39847	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	02.02	22	11	0.00339	0.00451	0.12892	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	02.03	6	5	0.00355	0.00512	0.14625	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	02.04	11	1	0.00200	0.00200	0.05714	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	03.01	34	33	0.00440	0.00469	0.13406	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	03.02	14	13	0.00354	0.00418	0.11934	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	03.03	23	13	0.00358	0.00421	0.12030	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	03.04	16	15	0.00360	0.00425	0.12153	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	04.01	25	13	0.00228	0.00272	0.07763	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	04.02	6	4	0.00187	0.00293	0.08358	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	04.04	10	7	0.00280	0.00368	0.10516	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	07.01	5	3	0.00326	0.00458	0.13086	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	07.02	17	11	0.00307	0.00424	0.12125	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	08	2	1	0.00290	0.00290	0.08286	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	13	58	49	0.00403	0.00446	0.12732	0.0350	LCV_FISH
Nickel	7440-02-0	I	WHOL	21	18	5	0.01661	0.02189	0.62534	0.0350	LCV_FISH
Nickel	7440-02-0	I	FLTR	00	1	1	0.00490	0.00490	0.03816	0.1284	LCV_NDI

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Nickel	7440-02-0	I	FLTR	01	20	16	0.00288	0.00376	0.02925	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	02.01	3	3	0.00486	0.01027	0.07999	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	02.02	13	10	0.00241	0.00317	0.02465	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	02.03	6	6	0.00350	0.00560	0.04359	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	02.04	2	1	0.00187	0.00187	0.01456	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	03.01	14	13	0.00425	0.00522	0.04062	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	03.02	14	13	0.00407	0.00486	0.03788	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	03.03	14	13	0.00444	0.00592	0.04611	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	03.04	16	15	0.00362	0.00461	0.03589	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	04.01	16	14	0.00300	0.00371	0.02888	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	04.02	6	4	0.00277	0.00394	0.03065	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	04.04	10	7	0.00334	0.00581	0.04523	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	07.01	5	4	0.00366	0.00725	0.05650	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	07.02	17	15	0.00308	0.00453	0.03528	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	08	2	1	0.00520	0.00520	0.04050	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	13	47	46	0.00457	0.00538	0.04192	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	00	11	1	0.00550	0.00550	0.04283	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	01	51	18	0.00303	0.00360	0.02800	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	02.01	3	2	0.00597	0.01395	0.10862	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	02.02	22	11	0.00339	0.00451	0.03514	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	02.03	6	5	0.00355	0.00512	0.03987	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	02.04	11	1	0.00200	0.00200	0.01558	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	03.01	34	33	0.00440	0.00469	0.03654	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	03.02	14	13	0.00354	0.00418	0.03253	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	03.03	23	13	0.00358	0.00421	0.03279	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	03.04	16	15	0.00360	0.00425	0.03313	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	04.01	25	13	0.00228	0.00272	0.02116	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	04.02	6	4	0.00187	0.00293	0.02278	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	04.04	10	7	0.00280	0.00368	0.02867	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	07.01	5	3	0.00326	0.00458	0.03567	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	07.02	17	11	0.00307	0.00424	0.03305	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	08	2	1	0.00290	0.00290	0.02259	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	13	58	49	0.00403	0.00446	0.03470	0.1284	LCV_NDI
Nickel	7440-02-0	I	WHOL	21	18	5	0.01661	0.02189	0.17046	0.1284	LCV_NDI
Nickel	7440-02-0	I	FLTR	00	1	1	0.00490	0.00490	0.10889	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	01	20	16	0.00288	0.00376	0.08346	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	02.01	3	3	0.00486	0.01027	0.22823	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	02.02	13	10	0.00241	0.00317	0.07034	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	02.03	6	6	0.00350	0.00560	0.12439	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	02.04	2	1	0.00187	0.00187	0.04156	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	03.01	14	13	0.00425	0.00522	0.11590	0.0450	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Nickel	7440-02-0	I	FLTR	03.02	14	13	0.00407	0.00486	0.10808	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	03.03	14	13	0.00444	0.00592	0.13156	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	03.04	16	15	0.00362	0.00461	0.10241	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	04.01	16	14	0.00300	0.00371	0.08242	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	04.02	6	4	0.00277	0.00394	0.08746	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	04.04	10	7	0.00334	0.00581	0.12905	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	07.01	5	4	0.00366	0.00725	0.16122	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	07.02	17	15	0.00308	0.00453	0.10067	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	08	2	1	0.00520	0.00520	0.11556	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	13	47	46	0.00457	0.00538	0.11961	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	00	11	1	0.00550	0.00550	0.12222	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	01	51	18	0.00303	0.00360	0.07991	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	02.01	3	2	0.00597	0.01395	0.30992	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	02.02	22	11	0.00339	0.00451	0.10027	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	02.03	6	5	0.00355	0.00512	0.11375	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	02.04	11	1	0.00200	0.00200	0.04444	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	03.01	34	33	0.00440	0.00469	0.10427	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	03.02	14	13	0.00354	0.00418	0.09282	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	03.03	23	13	0.00358	0.00421	0.09357	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	03.04	16	15	0.00360	0.00425	0.09453	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	04.01	25	13	0.00228	0.00272	0.06038	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	04.02	6	4	0.00187	0.00293	0.06501	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	04.04	10	7	0.00280	0.00368	0.08179	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	07.01	5	3	0.00326	0.00458	0.10178	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	07.02	17	11	0.00307	0.00424	0.09430	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	08	2	1	0.00290	0.00290	0.06444	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	13	58	49	0.00403	0.00446	0.09902	0.0450	LTV_DAPH
Nickel	7440-02-0	I	WHOL	21	18	5	0.01661	0.02189	0.48637	0.0450	LTV_DAPH
Nickel	7440-02-0	I	FLTR	00	1	1	0.00490	0.00490	0.07903	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	01	20	16	0.00288	0.00376	0.06057	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	02.01	3	3	0.00486	0.01027	0.16565	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	02.02	13	10	0.00241	0.00317	0.05106	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	02.03	6	6	0.00350	0.00560	0.09028	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	02.04	2	1	0.00187	0.00187	0.03016	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	03.01	14	13	0.00425	0.00522	0.08412	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	03.02	14	13	0.00407	0.00486	0.07845	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	03.03	14	13	0.00444	0.00592	0.09549	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	03.04	16	15	0.00362	0.00461	0.07433	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	04.01	16	14	0.00300	0.00371	0.05982	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	04.02	6	4	0.00277	0.00394	0.06348	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	04.04	10	7	0.00334	0.00581	0.09367	0.0620	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Nickel	7440-02-0	I	FLTR	07.01	5	4	0.00366	0.00725	0.11701	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	07.02	17	15	0.00308	0.00453	0.07307	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	08	2	1	0.00520	0.00520	0.08387	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	13	47	46	0.00457	0.00538	0.08681	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	00	11	1	0.00550	0.00550	0.08871	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	01	51	18	0.00303	0.00360	0.05800	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	02.01	3	2	0.00597	0.01395	0.22494	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	02.02	22	11	0.00339	0.00451	0.07278	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	02.03	6	5	0.00355	0.00512	0.08256	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	02.04	11	1	0.00200	0.00200	0.03226	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	03.01	34	33	0.00440	0.00469	0.07568	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	03.02	14	13	0.00354	0.00418	0.06737	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	03.03	23	13	0.00358	0.00421	0.06791	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	03.04	16	15	0.00360	0.00425	0.06861	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	04.01	25	13	0.00228	0.00272	0.04383	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	04.02	6	4	0.00187	0.00293	0.04718	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	04.04	10	7	0.00280	0.00368	0.05937	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	07.01	5	3	0.00326	0.00458	0.07387	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	07.02	17	11	0.00307	0.00424	0.06845	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	08	2	1	0.00290	0.00290	0.04677	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	13	58	49	0.00403	0.00446	0.07187	0.0620	LTV_FISH
Nickel	7440-02-0	I	WHOL	21	18	5	0.01661	0.02189	0.35301	0.0620	LTV_FISH
Nickel	7440-02-0	I	FLTR	00	1	1	0.00490	0.00490	0.00350	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	01	20	16	0.00288	0.00376	0.00268	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	02.01	3	3	0.00486	0.01027	0.00734	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	02.02	13	10	0.00241	0.00317	0.00226	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	02.03	6	6	0.00350	0.00560	0.00400	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	02.04	2	1	0.00187	0.00187	0.00134	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	03.01	14	13	0.00425	0.00522	0.00373	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	03.02	14	13	0.00407	0.00486	0.00347	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	03.03	14	13	0.00444	0.00592	0.00423	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	03.04	16	15	0.00362	0.00461	0.00329	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	04.01	16	14	0.00300	0.00371	0.00265	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	04.02	6	4	0.00277	0.00394	0.00281	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	04.04	10	7	0.00334	0.00581	0.00415	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	07.01	5	4	0.00366	0.00725	0.00518	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	07.02	17	15	0.00308	0.00453	0.00324	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	08	2	1	0.00520	0.00520	0.00371	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	13	47	46	0.00457	0.00538	0.00384	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	00	11	1	0.00550	0.00550	0.00393	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	01	51	18	0.00303	0.00360	0.00257	1.4000	NAWQ_ACU

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Nickel	7440-02-0	I	WHOL	02.01	3	2	0.00597	0.01395	0.00996	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	02.02	22	11	0.00339	0.00451	0.00322	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	02.03	6	5	0.00355	0.00512	0.00366	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	02.04	11	1	0.00200	0.00200	0.00143	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	03.01	34	33	0.00440	0.00469	0.00335	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	03.02	14	13	0.00354	0.00418	0.00298	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	03.03	23	13	0.00358	0.00421	0.00301	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	03.04	16	15	0.00360	0.00425	0.00304	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	04.01	25	13	0.00228	0.00272	0.00194	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	04.02	6	4	0.00187	0.00293	0.00209	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	04.04	10	7	0.00280	0.00368	0.00263	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	07.01	5	3	0.00326	0.00458	0.00327	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	07.02	17	11	0.00307	0.00424	0.00303	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	08	2	1	0.00290	0.00290	0.00207	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	13	58	49	0.00403	0.00446	0.00318	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	WHOL	21	18	5	0.01661	0.02189	0.01563	1.4000	NAWQ_ACU
Nickel	7440-02-0	I	FLTR	00	1	1	0.00490	0.00490	0.03063	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	01	20	16	0.00288	0.00376	0.02347	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	02.01	3	3	0.00486	0.01027	0.06419	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	02.02	13	10	0.00241	0.00317	0.01978	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	02.03	6	6	0.00350	0.00560	0.03498	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	02.04	2	1	0.00187	0.00187	0.01169	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	03.01	14	13	0.00425	0.00522	0.03260	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	03.02	14	13	0.00407	0.00486	0.03040	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	03.03	14	13	0.00444	0.00592	0.03700	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	03.04	16	15	0.00362	0.00461	0.02880	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	04.01	16	14	0.00300	0.00371	0.02318	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	04.02	6	4	0.00277	0.00394	0.02460	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	04.04	10	7	0.00334	0.00581	0.03630	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	07.01	5	4	0.00366	0.00725	0.04534	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	07.02	17	15	0.00308	0.00453	0.02831	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	08	2	1	0.00520	0.00520	0.03250	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	FLTR	13	47	46	0.00457	0.00538	0.03364	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	00	11	1	0.00550	0.00550	0.03438	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	01	51	18	0.00303	0.00360	0.02247	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	02.01	3	2	0.00597	0.01395	0.08716	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	02.02	22	11	0.00339	0.00451	0.02820	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	02.03	6	5	0.00355	0.00512	0.03199	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	02.04	11	1	0.00200	0.00200	0.01250	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	03.01	34	33	0.00440	0.00469	0.02933	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	03.02	14	13	0.00354	0.00418	0.02611	0.1600	NAWQ_CHR

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Nickel	7440-02-0	I	WHOL	03.03	23	13	0.00358	0.00421	0.02632	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	03.04	16	15	0.00360	0.00425	0.02659	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	04.01	25	13	0.00228	0.00272	0.01698	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	04.02	6	4	0.00187	0.00293	0.01828	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	04.04	10	7	0.00280	0.00368	0.02300	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	07.01	5	3	0.00326	0.00458	0.02863	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	07.02	17	11	0.00307	0.00424	0.02652	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	08	2	1	0.00290	0.00290	0.01813	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	13	58	49	0.00403	0.00446	0.02785	0.1600	NAWQ_CHR
Nickel	7440-02-0	I	WHOL	21	18	5	0.01661	0.02189	0.13679	0.1600	NAWQ_CHR
PCB-1254	11097-69-1	O	WHOL	03.01	12	1	0.00029	0.00029	2.90000	0.0001	LCV_ALLO
PCB-1254	11097-69-1	O	WHOL	03.04	14	1	0.00014	0.00014	1.40000	0.0001	LCV_ALLO
PCB-1254	11097-69-1	O	WHOL	13	48	1	0.00046	0.00046	4.60000	0.0001	LCV_ALLO
PCB-1254	11097-69-1	O	WHOL	03.01	12	1	0.00029	0.00029	2.90000	0.0001	LCV_AQPL
PCB-1254	11097-69-1	O	WHOL	03.04	14	1	0.00014	0.00014	1.40000	0.0001	LCV_AQPL
PCB-1254	11097-69-1	O	WHOL	13	48	1	0.00046	0.00046	4.60000	0.0001	LCV_AQPL
PCB-1254	11097-69-1	O	WHOL	03.01	12	1	0.00029	0.00029	0.13810	0.0021	LCV_DAPH
PCB-1254	11097-69-1	O	WHOL	03.04	14	1	0.00014	0.00014	0.06667	0.0021	LCV_DAPH
PCB-1254	11097-69-1	O	WHOL	13	48	1	0.00046	0.00046	0.21905	0.0021	LCV_DAPH
PCB-1254	11097-69-1	O	WHOL	03.01	12	1	0.00029	0.00029	0.29000	0.0010	LCV_FISH
PCB-1254	11097-69-1	O	WHOL	03.04	14	1	0.00014	0.00014	0.14000	0.0010	LCV_FISH
PCB-1254	11097-69-1	O	WHOL	13	48	1	0.00046	0.00046	0.46000	0.0010	LCV_FISH
PCB-1254	11097-69-1	O	WHOL	03.01	12	1	0.00029	0.00029	0.36250	0.0008	LCV_NDI
PCB-1254	11097-69-1	O	WHOL	03.04	14	1	0.00014	0.00014	0.17500	0.0008	LCV_NDI
PCB-1254	11097-69-1	O	WHOL	13	48	1	0.00046	0.00046	0.57500	0.0008	LCV_NDI
PCB-1254	11097-69-1	O	WHOL	03.01	12	1	0.00029	0.00029	0.24167	0.0012	LTV_DAPH
PCB-1254	11097-69-1	O	WHOL	03.04	14	1	0.00014	0.00014	0.11667	0.0012	LTV_DAPH
PCB-1254	11097-69-1	O	WHOL	13	48	1	0.00046	0.00046	0.38333	0.0012	LTV_DAPH
PCB-1254	11097-69-1	O	WHOL	03.01	12	1	0.00029	0.00029	0.55769	0.0005	LTV_FISH
PCB-1254	11097-69-1	O	WHOL	03.04	14	1	0.00014	0.00014	0.26923	0.0005	LTV_FISH
PCB-1254	11097-69-1	O	WHOL	13	48	1	0.00046	0.00046	0.88462	0.0005	LTV_FISH
PCB-1254	11097-69-1	O	WHOL	03.01	12	1	0.00029	0.00029	1.38095	0.0002	S_ACU_V
PCB-1254	11097-69-1	O	WHOL	03.04	14	1	0.00014	0.00014	0.66667	0.0002	S_ACU_V
PCB-1254	11097-69-1	O	WHOL	13	48	1	0.00046	0.00046	2.19048	0.0002	S_ACU_V
PCB-1254	11097-69-1	O	WHOL	03.01	12	1	0.00029	0.00029	14.50000	0.0000	S_CHR_V
PCB-1254	11097-69-1	O	WHOL	03.04	14	1	0.00014	0.00014	7.00000	0.0000	S_CHR_V
PCB-1254	11097-69-1	O	WHOL	13	48	1	0.00046	0.00046	23.00000	0.0000	S_CHR_V
PCB-1260	11096-82-5	O	WHOL	13	48	1	0.00102	0.00102	0.78462	0.0013	LCV_ALLO
PCB-1260	11096-82-5	O	WHOL	13	48	1	0.00102	0.00102	0.78462	0.0013	LCV_FISH
PCB-1260	11096-82-5	O	WHOL	13	48	1	0.00102	0.00102	0.48571	0.0021	LTV_FISH
PCB-1260	11096-82-5	O	WHOL	13	48	1	0.00102	0.00102	0.00545	0.1870	S_ACU_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
PCB-1260	11096-82-5	O	WHOL	13	48	1	0.00102	0.00102	0.09714	0.0105	S_CHR_V
Potassium	7440-09-7	I	FLTR	00	1	1	1.67000	1.67000	0.03151	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	01	20	20	1.41756	1.48258	0.02797	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	02.01	3	3	1.34308	1.59963	0.03018	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	02.02	13	13	1.41077	1.44849	0.02733	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	02.03	6	6	1.36383	1.44755	0.02731	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	02.04	2	2	1.60785	2.50534	0.04727	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	03.01	14	14	1.79043	2.12528	0.04010	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	03.02	14	14	1.72506	1.97964	0.03735	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	03.03	14	14	1.73318	1.99634	0.03767	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	03.04	16	15	1.61341	1.83094	0.03455	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	04.01	16	16	1.58915	1.71765	0.03241	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	04.02	6	6	1.35183	1.39260	0.02628	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	04.04	10	10	1.40466	1.50059	0.02831	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	05	4	4	1.46500	1.63043	0.03076	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	07.01	5	5	1.44200	1.57122	0.02965	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	07.02	17	16	1.38676	1.43296	0.02704	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	08	2	2	1.42500	1.58284	0.02986	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	10	2	2	1.77500	2.18539	0.04123	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	13	47	47	1.75250	1.89152	0.03569	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	22	1	1	1.31000	1.31000	0.02472	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	00	10	4	1.65325	1.81952	0.03433	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	01	48	34	1.59440	1.68669	0.03182	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	02.01	3	3	1.43667	1.64268	0.03099	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	02.02	21	16	1.53175	1.62660	0.03069	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	02.03	6	6	1.46333	1.54455	0.02914	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	02.04	10	3	1.50000	1.67978	0.03169	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	03.01	34	33	1.53647	1.68059	0.03171	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	03.02	14	14	1.77643	2.02386	0.03819	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	03.03	22	19	1.88118	2.09027	0.03944	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	03.04	16	15	1.66094	1.88777	0.03562	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	04.01	24	19	1.61013	1.73138	0.03267	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	04.02	6	6	1.41500	1.46722	0.02768	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	04.04	10	10	1.41150	1.48039	0.02793	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	05	4	4	1.46500	1.74568	0.03294	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	07.01	5	5	1.49200	1.61472	0.03047	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	07.02	17	17	1.45451	1.49196	0.02815	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	08	2	2	1.51500	1.73598	0.03275	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	10	2	2	1.62000	1.74628	0.03295	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	13	57	51	1.79530	1.92475	0.03632	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	18	8	2	1.64750	1.91693	0.03617	53.0000	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Potassium	7440-09-7	I	WHOL	20.01	8	5	3.14250	4.12071	0.07775	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	20.02	9	6	2.24889	2.57242	0.04854	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	21	16	10	2.53938	2.95569	0.05577	53.0000	LCV_ALLO
Potassium	7440-09-7	I	WHOL	22	10	5	1.88600	2.29774	0.04335	53.0000	LCV_ALLO
Potassium	7440-09-7	I	FLTR	00	1	1	1.67000	1.67000	0.03151	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	01	20	20	1.41756	1.48258	0.02797	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	02.01	3	3	1.34308	1.59963	0.03018	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	02.02	13	13	1.41077	1.44849	0.02733	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	02.03	6	6	1.36383	1.44755	0.02731	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	02.04	2	2	1.60785	2.50534	0.04727	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	03.01	14	14	1.79043	2.12528	0.04010	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	03.02	14	14	1.72506	1.97964	0.03735	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	03.03	14	14	1.73318	1.99634	0.03767	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	03.04	16	15	1.61341	1.83094	0.03455	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	04.01	16	16	1.58915	1.71765	0.03241	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	04.02	6	6	1.35183	1.39260	0.02628	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	04.04	10	10	1.40466	1.50059	0.02831	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	05	4	4	1.46500	1.63043	0.03076	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	07.01	5	5	1.44200	1.57122	0.02965	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	07.02	17	16	1.38676	1.43296	0.02704	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	08	2	2	1.42500	1.58284	0.02986	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	10	2	2	1.77500	2.18539	0.04123	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	13	47	47	1.75250	1.89152	0.03569	53.0000	LCV_DAPH
Potassium	7440-09-7	I	FLTR	22	1	1	1.31000	1.31000	0.02472	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	00	10	4	1.65325	1.81952	0.03433	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	01	48	34	1.59440	1.68669	0.03182	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	02.01	3	3	1.43667	1.64268	0.03099	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	02.02	21	16	1.53175	1.62660	0.03069	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	02.03	6	6	1.46333	1.54455	0.02914	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	02.04	10	3	1.50000	1.67978	0.03169	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	03.01	34	33	1.53647	1.68059	0.03171	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	03.02	14	14	1.77643	2.02386	0.03819	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	03.03	22	19	1.88118	2.09027	0.03944	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	03.04	16	15	1.66094	1.88777	0.03562	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	04.01	24	19	1.61013	1.73138	0.03267	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	04.02	6	6	1.41500	1.46722	0.02768	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	04.04	10	10	1.41150	1.48039	0.02793	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	05	4	4	1.46500	1.74568	0.03294	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	07.01	5	5	1.49200	1.61472	0.03047	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	07.02	17	17	1.45451	1.49196	0.02815	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	08	2	2	1.51500	1.73598	0.03275	53.0000	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Potassium	7440-09-7	I	WHOL	10	2	2	1.62000	1.74628	0.03295	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	13	57	51	1.79530	1.92475	0.03632	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	18	8	2	1.64750	1.91693	0.03617	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	20.01	8	5	3.14250	4.12071	0.07775	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	20.02	9	6	2.24889	2.57242	0.04854	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	21	16	10	2.53938	2.95569	0.05577	53.0000	LCV_DAPH
Potassium	7440-09-7	I	WHOL	22	10	5	1.88600	2.29774	0.04335	53.0000	LCV_DAPH
Selenium	7782-49-2	I	FLTR	01	20	2	0.00136	0.00164	0.01853	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	02.01	3	1	0.00320	0.00320	0.03623	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	02.03	6	1	0.00500	0.00500	0.05661	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	03.01	14	2	0.00461	0.00462	0.05236	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	03.02	14	2	0.00368	0.00386	0.04369	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	03.04	16	1	0.00330	0.00330	0.03736	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	04.01	16	4	0.00134	0.00179	0.02032	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	04.02	6	1	0.00330	0.00330	0.03736	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	04.04	11	1	0.00160	0.00160	0.01812	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	07.02	17	2	0.00345	0.00406	0.04596	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	08	2	1	0.00420	0.00420	0.04755	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	13	47	5	0.00133	0.00155	0.01756	0.0883	LCV_ALLO
Selenium	7782-49-2	I	WHOL	07.02	17	1	0.00110	0.00110	0.01245	0.0883	LCV_ALLO
Selenium	7782-49-2	I	WHOL	13	58	1	0.00120	0.00120	0.01359	0.0883	LCV_ALLO
Selenium	7782-49-2	I	FLTR	01	20	2	0.00136	0.00164	0.01637	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	02.01	3	1	0.00320	0.00320	0.03200	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	02.03	6	1	0.00500	0.00500	0.05000	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	03.01	14	2	0.00461	0.00462	0.04624	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	03.02	14	2	0.00368	0.00386	0.03858	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	03.04	16	1	0.00330	0.00330	0.03300	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	04.01	16	4	0.00134	0.00179	0.01794	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	04.02	6	1	0.00330	0.00330	0.03300	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	04.04	11	1	0.00160	0.00160	0.01600	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	07.02	17	2	0.00345	0.00406	0.04059	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	08	2	1	0.00420	0.00420	0.04200	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	13	47	5	0.00133	0.00155	0.01551	0.1000	LCV_AQPL
Selenium	7782-49-2	I	WHOL	07.02	17	1	0.00110	0.00110	0.01100	0.1000	LCV_AQPL
Selenium	7782-49-2	I	WHOL	13	58	1	0.00120	0.00120	0.01200	0.1000	LCV_AQPL
Selenium	7782-49-2	I	FLTR	01	20	2	0.00136	0.00164	0.01786	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	02.01	3	1	0.00320	0.00320	0.03492	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	02.03	6	1	0.00500	0.00500	0.05456	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	03.01	14	2	0.00461	0.00462	0.05046	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	03.02	14	2	0.00368	0.00386	0.04210	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	03.04	16	1	0.00330	0.00330	0.03601	0.0917	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Selenium	7782-49-2	I	FLTR	04.01	16	4	0.00134	0.00179	0.01958	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	04.02	6	1	0.00330	0.00330	0.03601	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	04.04	11	1	0.00160	0.00160	0.01746	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	07.02	17	2	0.00345	0.00406	0.04429	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	08	2	1	0.00420	0.00420	0.04583	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	13	47	5	0.00133	0.00155	0.01692	0.0917	LCV_DAPH
Selenium	7782-49-2	I	WHOL	07.02	17	1	0.00110	0.00110	0.01200	0.0917	LCV_DAPH
Selenium	7782-49-2	I	WHOL	13	58	1	0.00120	0.00120	0.01309	0.0917	LCV_DAPH
Selenium	7782-49-2	I	FLTR	01	20	2	0.00136	0.00164	0.01853	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	02.01	3	1	0.00320	0.00320	0.03623	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	02.03	6	1	0.00500	0.00500	0.05661	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	03.01	14	2	0.00461	0.00462	0.05236	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	03.02	14	2	0.00368	0.00386	0.04369	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	03.04	16	1	0.00330	0.00330	0.03736	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	04.01	16	4	0.00134	0.00179	0.02032	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	04.02	6	1	0.00330	0.00330	0.03736	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	04.04	11	1	0.00160	0.00160	0.01812	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	07.02	17	2	0.00345	0.00406	0.04596	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	08	2	1	0.00420	0.00420	0.04755	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	13	47	5	0.00133	0.00155	0.01756	0.0883	LCV_FISH
Selenium	7782-49-2	I	WHOL	07.02	17	1	0.00110	0.00110	0.01245	0.0883	LCV_FISH
Selenium	7782-49-2	I	WHOL	13	58	1	0.00120	0.00120	0.01359	0.0883	LCV_FISH
Selenium	7782-49-2	I	FLTR	01	20	2	0.00136	0.00164	0.06547	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	02.01	3	1	0.00320	0.00320	0.12800	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	02.03	6	1	0.00500	0.00500	0.20000	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	03.01	14	2	0.00461	0.00462	0.18498	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	03.02	14	2	0.00368	0.00386	0.15434	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	03.04	16	1	0.00330	0.00330	0.13200	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	04.01	16	4	0.00134	0.00179	0.07177	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	04.02	6	1	0.00330	0.00330	0.13200	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	04.04	11	1	0.00160	0.00160	0.06400	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	07.02	17	2	0.00345	0.00406	0.16235	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	08	2	1	0.00420	0.00420	0.16800	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	13	47	5	0.00133	0.00155	0.06205	0.0250	LTV_DAPH
Selenium	7782-49-2	I	WHOL	07.02	17	1	0.00110	0.00110	0.04400	0.0250	LTV_DAPH
Selenium	7782-49-2	I	WHOL	13	58	1	0.00120	0.00120	0.04800	0.0250	LTV_DAPH
Selenium	7782-49-2	I	FLTR	01	20	2	0.00136	0.00164	0.04092	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	02.01	3	1	0.00320	0.00320	0.08000	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	02.03	6	1	0.00500	0.00500	0.12500	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	03.01	14	2	0.00461	0.00462	0.11561	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	03.02	14	2	0.00368	0.00386	0.09646	0.0400	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Selenium	7782-49-2	I	FLTR	03.04	16	1	0.00330	0.00330	0.08250	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	04.01	16	4	0.00134	0.00179	0.04486	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	04.02	6	1	0.00330	0.00330	0.08250	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	04.04	11	1	0.00160	0.00160	0.04000	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	07.02	17	2	0.00345	0.00406	0.10147	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	08	2	1	0.00420	0.00420	0.10500	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	13	47	5	0.00133	0.00155	0.03878	0.0400	LTV_FISH
Selenium	7782-49-2	I	WHOL	07.02	17	1	0.00110	0.00110	0.02750	0.0400	LTV_FISH
Selenium	7782-49-2	I	WHOL	13	58	1	0.00120	0.00120	0.03000	0.0400	LTV_FISH
Selenium	7782-49-2	I	FLTR	01	20	2	0.00136	0.00164	0.00630	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	02.01	3	1	0.00320	0.00320	0.01231	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	02.03	6	1	0.00500	0.00500	0.01923	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	03.01	14	2	0.00461	0.00462	0.01779	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	03.02	14	2	0.00368	0.00386	0.01484	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	03.04	16	1	0.00330	0.00330	0.01269	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	04.01	16	4	0.00134	0.00179	0.00690	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	04.02	6	1	0.00330	0.00330	0.01269	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	04.04	11	1	0.00160	0.00160	0.00615	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	07.02	17	2	0.00345	0.00406	0.01561	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	08	2	1	0.00420	0.00420	0.01615	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	13	47	5	0.00133	0.00155	0.00597	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	WHOL	07.02	17	1	0.00110	0.00110	0.00423	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	WHOL	13	58	1	0.00120	0.00120	0.00462	0.2600	NAWQ_ACU
Selenium	7782-49-2	I	FLTR	01	20	2	0.00136	0.00164	0.04677	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	02.01	3	1	0.00320	0.00320	0.09143	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	02.03	6	1	0.00500	0.00500	0.14286	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	03.01	14	2	0.00461	0.00462	0.13213	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	03.02	14	2	0.00368	0.00386	0.11024	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	03.04	16	1	0.00330	0.00330	0.09429	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	04.01	16	4	0.00134	0.00179	0.05127	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	04.02	6	1	0.00330	0.00330	0.09429	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	04.04	11	1	0.00160	0.00160	0.04571	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	07.02	17	2	0.00345	0.00406	0.11597	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	08	2	1	0.00420	0.00420	0.12000	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	FLTR	13	47	5	0.00133	0.00155	0.04432	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	WHOL	07.02	17	1	0.00110	0.00110	0.03143	0.0350	NAWQ_CHR
Selenium	7782-49-2	I	WHOL	13	58	1	0.00120	0.00120	0.03429	0.0350	NAWQ_CHR
Silver	7440-22-4	I	FLTR	03.02	14	1	0.01300	0.01300	108.33333	0.0001	LCV_ALLO
Silver	7440-22-4	I	FLTR	07.01	5	1	0.00160	0.00160	13.33333	0.0001	LCV_ALLO
Silver	7440-22-4	I	FLTR	13	47	1	0.00150	0.00150	12.50000	0.0001	LCV_ALLO
Silver	7440-22-4	I	WHOL	03.01	34	1	0.00480	0.00480	40.00000	0.0001	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Silver	7440-22-4	I	WHOL	13	58	1	0.00160	0.00160	13.33333	0.0001	LCV_ALLO
Silver	7440-22-4	I	WHOL	21	18	1	0.01100	0.01100	91.66667	0.0001	LCV_ALLO
Silver	7440-22-4	I	FLTR	03.02	14	1	0.01300	0.01300	0.43333	0.0300	LCV_AQPL
Silver	7440-22-4	I	FLTR	07.01	5	1	0.00160	0.00160	0.05333	0.0300	LCV_AQPL
Silver	7440-22-4	I	FLTR	13	47	1	0.00150	0.00150	0.05000	0.0300	LCV_AQPL
Silver	7440-22-4	I	WHOL	03.01	34	1	0.00480	0.00480	0.16000	0.0300	LCV_AQPL
Silver	7440-22-4	I	WHOL	13	58	1	0.00160	0.00160	0.05333	0.0300	LCV_AQPL
Silver	7440-22-4	I	WHOL	21	18	1	0.01100	0.01100	0.36667	0.0300	LCV_AQPL
Silver	7440-22-4	I	FLTR	03.02	14	1	0.01300	0.01300	5.00000	0.0026	LCV_DAPH
Silver	7440-22-4	I	FLTR	07.01	5	1	0.00160	0.00160	0.61538	0.0026	LCV_DAPH
Silver	7440-22-4	I	FLTR	13	47	1	0.00150	0.00150	0.57692	0.0026	LCV_DAPH
Silver	7440-22-4	I	WHOL	03.01	34	1	0.00480	0.00480	1.84615	0.0026	LCV_DAPH
Silver	7440-22-4	I	WHOL	13	58	1	0.00160	0.00160	0.61538	0.0026	LCV_DAPH
Silver	7440-22-4	I	WHOL	21	18	1	0.01100	0.01100	4.23077	0.0026	LCV_DAPH
Silver	7440-22-4	I	FLTR	03.02	14	1	0.01300	0.01300	108.33333	0.0001	LCV_FISH
Silver	7440-22-4	I	FLTR	07.01	5	1	0.00160	0.00160	13.33333	0.0001	LCV_FISH
Silver	7440-22-4	I	FLTR	13	47	1	0.00150	0.00150	12.50000	0.0001	LCV_FISH
Silver	7440-22-4	I	WHOL	03.01	34	1	0.00480	0.00480	40.00000	0.0001	LCV_FISH
Silver	7440-22-4	I	WHOL	13	58	1	0.00160	0.00160	13.33333	0.0001	LCV_FISH
Silver	7440-22-4	I	WHOL	21	18	1	0.01100	0.01100	91.66667	0.0001	LCV_FISH
Silver	7440-22-4	I	FLTR	03.02	14	1	0.01300	0.01300	23.21429	0.0006	LTV_DAPH
Silver	7440-22-4	I	FLTR	07.01	5	1	0.00160	0.00160	2.85714	0.0006	LTV_DAPH
Silver	7440-22-4	I	FLTR	13	47	1	0.00150	0.00150	2.67857	0.0006	LTV_DAPH
Silver	7440-22-4	I	WHOL	03.01	34	1	0.00480	0.00480	8.57143	0.0006	LTV_DAPH
Silver	7440-22-4	I	WHOL	13	58	1	0.00160	0.00160	2.85714	0.0006	LTV_DAPH
Silver	7440-22-4	I	WHOL	21	18	1	0.01100	0.01100	19.64286	0.0006	LTV_DAPH
Silver	7440-22-4	I	FLTR	03.02	14	1	0.01300	0.01300	65.00000	0.0002	LTV_FISH
Silver	7440-22-4	I	FLTR	07.01	5	1	0.00160	0.00160	8.00000	0.0002	LTV_FISH
Silver	7440-22-4	I	FLTR	13	47	1	0.00150	0.00150	7.50000	0.0002	LTV_FISH
Silver	7440-22-4	I	WHOL	03.01	34	1	0.00480	0.00480	24.00000	0.0002	LTV_FISH
Silver	7440-22-4	I	WHOL	13	58	1	0.00160	0.00160	8.00000	0.0002	LTV_FISH
Silver	7440-22-4	I	WHOL	21	18	1	0.01100	0.01100	55.00000	0.0002	LTV_FISH
Silver	7440-22-4	I	FLTR	03.02	14	1	0.01300	0.01300	3.17073	0.0041	NAWQ_ACU
Silver	7440-22-4	I	FLTR	07.01	5	1	0.00160	0.00160	0.39024	0.0041	NAWQ_ACU
Silver	7440-22-4	I	FLTR	13	47	1	0.00150	0.00150	0.36585	0.0041	NAWQ_ACU
Silver	7440-22-4	I	WHOL	03.01	34	1	0.00480	0.00480	1.17073	0.0041	NAWQ_ACU
Silver	7440-22-4	I	WHOL	13	58	1	0.00160	0.00160	0.39024	0.0041	NAWQ_ACU
Silver	7440-22-4	I	WHOL	21	18	1	0.01100	0.01100	2.68293	0.0041	NAWQ_ACU
Silver	7440-22-4	I	FLTR	03.02	14	1	0.01300	0.01300	36.11111	0.0004	S_CHR_V
Silver	7440-22-4	I	FLTR	07.01	5	1	0.00160	0.00160	4.44444	0.0004	S_CHR_V
Silver	7440-22-4	I	FLTR	13	47	1	0.00150	0.00150	4.16667	0.0004	S_CHR_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Silver	7440-22-4	I	WHOL	03.01	34	1	0.00480	0.00480	13.33333	0.0004	S_CHR_V
Silver	7440-22-4	I	WHOL	13	58	1	0.00160	0.00160	4.44444	0.0004	S_CHR_V
Silver	7440-22-4	I	WHOL	21	18	1	0.01100	0.01100	30.55556	0.0004	S_CHR_V
Sodium	7440-23-5	I	FLTR	00	1	1	5.37000	5.37000	0.00790	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	01	20	20	3.81784	4.23513	0.00623	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	02.01	3	3	3.90369	5.73250	0.00843	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	02.02	13	13	3.52154	3.85078	0.00566	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	02.03	6	6	3.43317	4.24583	0.00624	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	02.04	2	2	4.86560	7.10319	0.01045	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	03.01	14	14	4.00665	4.79285	0.00705	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	03.02	14	14	4.70534	5.69583	0.00838	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	03.03	14	14	4.17325	4.89238	0.00719	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	03.04	16	15	3.77357	4.43543	0.00652	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	04.01	16	16	3.74281	4.23494	0.00623	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	04.02	6	6	3.41617	3.63508	0.00535	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	04.04	10	10	3.63759	4.37274	0.00643	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	05	4	4	4.71500	5.11421	0.00752	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	07.01	5	5	2.84400	3.60640	0.00530	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	07.02	17	17	3.10493	3.46568	0.00510	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	08	2	2	3.33500	3.93481	0.00579	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	10	2	2	5.00000	5.37883	0.00791	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	13	47	47	3.18330	3.38586	0.00498	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	22	1	1	5.91000	5.91000	0.00869	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	00	11	11	4.36818	5.14982	0.00757	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	01	51	51	4.42220	4.71273	0.00693	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	02.01	3	3	5.43333	8.62140	0.01268	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	02.02	22	22	4.76864	5.26801	0.00775	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	02.03	6	6	5.01833	5.78598	0.00851	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	02.04	11	11	4.15136	4.54272	0.00668	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	03.01	34	33	4.46867	4.93115	0.00725	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	03.02	14	14	5.16214	6.14328	0.00903	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	03.03	23	23	5.11087	5.77646	0.00849	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	03.04	16	15	4.64781	5.44520	0.00801	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	04.01	25	25	4.16660	4.64324	0.00683	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	04.02	6	6	3.86333	4.57387	0.00673	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	04.04	10	10	4.10600	4.87618	0.00717	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	05	4	4	4.65000	5.12399	0.00754	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	07.01	5	5	4.46400	6.07541	0.00893	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	07.02	17	17	4.31486	4.89274	0.00720	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	08	2	2	5.08000	15.81338	0.02325	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	10	2	2	4.96500	5.37539	0.00790	680.0000	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Sodium	7440-23-5	I	WHOL	13	58	58	3.93608	4.20795	0.00619	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	18	9	9	5.79000	7.55516	0.01111	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	20.01	9	9	12.66333	16.27140	0.02393	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	20.02	10	10	4.80800	6.16425	0.00907	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	21	18	18	5.24444	6.16665	0.00907	680.0000	LCV_ALLO
Sodium	7440-23-5	I	WHOL	22	11	11	12.51273	15.57959	0.02291	680.0000	LCV_ALLO
Sodium	7440-23-5	I	FLTR	00	1	1	5.37000	5.37000	0.00790	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	01	20	20	3.81784	4.23513	0.00623	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	02.01	3	3	3.90369	5.73250	0.00843	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	02.02	13	13	3.52154	3.85078	0.00566	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	02.03	6	6	3.43317	4.24583	0.00624	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	02.04	2	2	4.86560	7.10319	0.01045	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	03.01	14	14	4.00665	4.79285	0.00705	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	03.02	14	14	4.70534	5.69583	0.00838	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	03.03	14	14	4.17325	4.89238	0.00719	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	03.04	16	15	3.77357	4.43543	0.00652	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	04.01	16	16	3.74281	4.23494	0.00623	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	04.02	6	6	3.41617	3.63508	0.00535	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	04.04	10	10	3.63759	4.37274	0.00643	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	05	4	4	4.71500	5.11421	0.00752	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	07.01	5	5	2.84400	3.60640	0.00530	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	07.02	17	17	3.10493	3.46568	0.00510	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	08	2	2	3.33500	3.93481	0.00579	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	10	2	2	5.00000	5.37883	0.00791	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	13	47	47	3.18330	3.38586	0.00498	680.0000	LCV_DAPH
Sodium	7440-23-5	I	FLTR	22	1	1	5.91000	5.91000	0.00869	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	00	11	11	4.36818	5.14982	0.00757	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	01	51	51	4.42220	4.71273	0.00693	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	02.01	3	3	5.43333	8.62140	0.01268	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	02.02	22	22	4.76864	5.26801	0.00775	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	02.03	6	6	5.01833	5.78598	0.00851	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	02.04	11	11	4.15136	4.54272	0.00668	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	03.01	34	33	4.46867	4.93115	0.00725	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	03.02	14	14	5.16214	6.14328	0.00903	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	03.03	23	23	5.11087	5.77646	0.00849	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	03.04	16	15	4.64781	5.44520	0.00801	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	04.01	25	25	4.16660	4.64324	0.00683	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	04.02	6	6	3.86333	4.57387	0.00673	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	04.04	10	10	4.10600	4.87618	0.00717	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	05	4	4	4.65000	5.12399	0.00754	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	07.01	5	5	4.46400	6.07541	0.00893	680.0000	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Sodium	7440-23-5	I	WHOL	07.02	17	17	4.31486	4.89274	0.00720	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	08	2	2	5.08000	15.81338	0.02325	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	10	2	2	4.96500	5.37539	0.00790	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	13	58	58	3.93608	4.20795	0.00619	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	18	9	9	5.79000	7.55516	0.01111	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	20.01	9	9	12.66333	16.27140	0.02393	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	20.02	10	10	4.80800	6.16425	0.00907	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	21	18	18	5.24444	6.16665	0.00907	680.0000	LCV_DAPH
Sodium	7440-23-5	I	WHOL	22	11	11	12.51273	15.57959	0.02291	680.0000	LCV_DAPH
Tetrachloroethene	127-18-4	O	WHOL	21	18	2	0.00125	0.00134	0.00178	0.7500	LCV_ALLO
Tetrachloroethene	127-18-4	O	WHOL	21	18	2	0.00125	0.00134	0.00000	816.0000	LCV_AQPL
Tetrachloroethene	127-18-4	O	WHOL	21	18	2	0.00125	0.00134	0.00178	0.7500	LCV_DAPH
Tetrachloroethene	127-18-4	O	WHOL	21	18	2	0.00125	0.00134	0.00159	0.8400	LCV_FISH
Tetrachloroethene	127-18-4	O	WHOL	21	18	2	0.00125	0.00134	0.00262	0.5100	LTV_DAPH
Tetrachloroethene	127-18-4	O	WHOL	21	18	2	0.00125	0.00134	0.00267	0.5000	LTV_FISH
Tetrachloroethene	127-18-4	O	WHOL	21	18	2	0.00125	0.00134	0.00134	0.9980	S_ACU_V
Tetrachloroethene	127-18-4	O	WHOL	21	18	2	0.00125	0.00134	0.01070	0.1250	S_CHR_V
Thallium	7440-28-0	I	WHOL	01	48	1	1.10000	1.10000	19.29825	0.0570	LCV_ALLO
Thallium	7440-28-0	I	WHOL	03.03	22	1	0.00700	0.00700	0.12281	0.0570	LCV_ALLO
Thallium	7440-28-0	I	WHOL	20.02	9	1	0.00560	0.00560	0.09825	0.0570	LCV_ALLO
Thallium	7440-28-0	I	WHOL	01	48	1	1.10000	1.10000	11.00000	0.1000	LCV_AQPL
Thallium	7440-28-0	I	WHOL	03.03	22	1	0.00700	0.00700	0.07000	0.1000	LCV_AQPL
Thallium	7440-28-0	I	WHOL	20.02	9	1	0.00560	0.00560	0.05600	0.1000	LCV_AQPL
Thallium	7440-28-0	I	WHOL	01	48	1	1.10000	1.10000	8.46154	0.1300	LCV_DAPH
Thallium	7440-28-0	I	WHOL	03.03	22	1	0.00700	0.00700	0.05385	0.1300	LCV_DAPH
Thallium	7440-28-0	I	WHOL	20.02	9	1	0.00560	0.00560	0.04308	0.1300	LCV_DAPH
Thallium	7440-28-0	I	WHOL	01	48	1	1.10000	1.10000	19.29825	0.0570	LCV_FISH
Thallium	7440-28-0	I	WHOL	03.03	22	1	0.00700	0.00700	0.12281	0.0570	LCV_FISH
Thallium	7440-28-0	I	WHOL	20.02	9	1	0.00560	0.00560	0.09825	0.0570	LCV_FISH
Thallium	7440-28-0	I	WHOL	01	48	1	1.10000	1.10000	17.18750	0.0640	LTV_DAPH
Thallium	7440-28-0	I	WHOL	03.03	22	1	0.00700	0.00700	0.10938	0.0640	LTV_DAPH
Thallium	7440-28-0	I	WHOL	20.02	9	1	0.00560	0.00560	0.08750	0.0640	LTV_DAPH
Thallium	7440-28-0	I	WHOL	01	48	1	1.10000	1.10000	13.58025	0.0810	LTV_FISH
Thallium	7440-28-0	I	WHOL	03.03	22	1	0.00700	0.00700	0.08642	0.0810	LTV_FISH
Thallium	7440-28-0	I	WHOL	20.02	9	1	0.00560	0.00560	0.06914	0.0810	LTV_FISH
Thallium	7440-28-0	I	WHOL	01	48	1	1.10000	1.10000	6.70732	0.1640	S_ACU_V
Thallium	7440-28-0	I	WHOL	03.03	22	1	0.00700	0.00700	0.04268	0.1640	S_ACU_V
Thallium	7440-28-0	I	WHOL	20.02	9	1	0.00560	0.00560	0.03415	0.1640	S_ACU_V
Thallium	7440-28-0	I	WHOL	01	48	1	1.10000	1.10000	61.11111	0.0180	S_CHR_V
Thallium	7440-28-0	I	WHOL	03.03	22	1	0.00700	0.00700	0.38889	0.0180	S_CHR_V
Thallium	7440-28-0	I	WHOL	20.02	9	1	0.00560	0.00560	0.31111	0.0180	S_CHR_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Toluene	108-88-3	O	WHOL	02.04	9	1	0.00100	0.00100	0.00079	1.2690	LCV_ALLO
Toluene	108-88-3	O	WHOL	02.04	9	1	0.00100	0.00100	0.00000	245.0000	LCV_AQPL
Toluene	108-88-3	O	WHOL	02.04	9	1	0.00100	0.00100	0.00004	25.2290	LCV_DAPH
Toluene	108-88-3	O	WHOL	02.04	9	1	0.00100	0.00100	0.00079	1.2690	LCV_FISH
Toluene	108-88-3	O	WHOL	02.04	9	1	0.00100	0.00100	0.03846	0.0260	LTV_FISH
Toluene	108-88-3	O	WHOL	02.04	9	1	0.00100	0.00100	0.00032	3.1500	S_ACU_V
Toluene	108-88-3	O	WHOL	02.04	9	1	0.00100	0.00100	0.00568	0.1760	S_CHR_V
Trichloroethene	79-01-6	O	WHOL	02.02	9	1	0.00300	0.00300	0.00041	7.2570	LCV_ALLO
Trichloroethene	79-01-6	O	WHOL	21	18	8	0.01967	0.02565	0.00353	7.2570	LCV_ALLO
Trichloroethene	79-01-6	O	WHOL	02.02	9	1	0.00300	0.00300	0.00041	7.2570	LCV_DAPH
Trichloroethene	79-01-6	O	WHOL	21	18	8	0.01967	0.02565	0.00353	7.2570	LCV_DAPH
Trichloroethene	79-01-6	O	WHOL	02.02	9	1	0.00300	0.00300	0.00020	14.8670	LCV_FISH
Trichloroethene	79-01-6	O	WHOL	21	18	8	0.01967	0.02565	0.00173	14.8670	LCV_FISH
Trichloroethene	79-01-6	O	WHOL	02.02	9	1	0.00300	0.00300	0.00052	5.7580	LTV_FISH
Trichloroethene	79-01-6	O	WHOL	21	18	8	0.01967	0.02565	0.00445	5.7580	LTV_FISH
Trichloroethene	79-01-6	O	WHOL	02.02	9	1	0.00300	0.00300	0.00069	4.3500	S_ACU_V
Trichloroethene	79-01-6	O	WHOL	21	18	8	0.01967	0.02565	0.00590	4.3500	S_ACU_V
Trichloroethene	79-01-6	O	WHOL	02.02	9	1	0.00300	0.00300	0.00645	0.4650	S_CHR_V
Trichloroethene	79-01-6	O	WHOL	21	18	8	0.01967	0.02565	0.05516	0.4650	S_CHR_V
Uranium	7440-61-1	I	FLTR	02.02	12	1	0.00310	0.00310	0.02183	0.1420	LCV_ALLO
Uranium	7440-61-1	I	FLTR	03.01	13	8	0.00159	0.00180	0.01270	0.1420	LCV_ALLO
Uranium	7440-61-1	I	FLTR	03.02	13	12	0.00220	0.00255	0.01793	0.1420	LCV_ALLO
Uranium	7440-61-1	I	FLTR	03.03	13	10	0.00205	0.00231	0.01626	0.1420	LCV_ALLO
Uranium	7440-61-1	I	FLTR	03.04	15	11	0.00178	0.00206	0.01451	0.1420	LCV_ALLO
Uranium	7440-61-1	I	FLTR	04.01	15	3	0.00117	0.00126	0.00890	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	00	10	6	0.00018	0.00028	0.00198	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	01	45	17	0.00032	0.00042	0.00298	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	02.02	20	4	0.00035	0.00068	0.00480	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	02.04	9	5	0.00022	0.00038	0.00267	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	03.01	33	24	0.00270	0.00327	0.02303	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	03.02	13	13	0.00236	0.00270	0.01899	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	03.03	21	18	0.00249	0.00306	0.02158	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	03.04	15	12	0.00195	0.00224	0.01581	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	04.01	23	10	0.00048	0.00071	0.00501	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	07.01	5	1	0.00210	0.00210	0.01479	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	07.02	17	1	0.00540	0.00540	0.03803	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	13	56	3	0.00020	0.00026	0.00185	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	18	8	3	0.00030	0.00052	0.00364	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	20.01	8	7	0.00816	0.01031	0.07258	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	20.02	9	8	0.02211	0.02658	0.18717	0.1420	LCV_ALLO
Uranium	7440-61-1	I	WHOL	21	16	10	0.00629	0.00933	0.06574	0.1420	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Uranium	7440-61-1	I	WHOL	22	9	9	0.00315	0.00491	0.03458	0.1420	LCV_ALLO
Uranium	7440-61-1	I	FLTR	02.02	12	1	0.00310	0.00310	0.02183	0.1420	LCV_FISH
Uranium	7440-61-1	I	FLTR	03.01	13	8	0.00159	0.00180	0.01270	0.1420	LCV_FISH
Uranium	7440-61-1	I	FLTR	03.02	13	12	0.00220	0.00255	0.01793	0.1420	LCV_FISH
Uranium	7440-61-1	I	FLTR	03.03	13	10	0.00205	0.00231	0.01626	0.1420	LCV_FISH
Uranium	7440-61-1	I	FLTR	03.04	15	11	0.00178	0.00206	0.01451	0.1420	LCV_FISH
Uranium	7440-61-1	I	FLTR	04.01	15	3	0.00117	0.00126	0.00890	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	00	10	6	0.00018	0.00028	0.00198	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	01	45	17	0.00032	0.00042	0.00298	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	02.02	20	4	0.00035	0.00068	0.00480	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	02.04	9	5	0.00022	0.00038	0.00267	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	03.01	33	24	0.00270	0.00327	0.02303	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	03.02	13	13	0.00236	0.00270	0.01899	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	03.03	21	18	0.00249	0.00306	0.02158	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	03.04	15	12	0.00195	0.00224	0.01581	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	04.01	23	10	0.00048	0.00071	0.00501	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	07.01	5	1	0.00210	0.00210	0.01479	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	07.02	17	1	0.00540	0.00540	0.03803	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	13	56	3	0.00020	0.00026	0.00185	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	18	8	3	0.00030	0.00052	0.00364	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	20.01	8	7	0.00816	0.01031	0.07258	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	20.02	9	8	0.02211	0.02658	0.18717	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	21	16	10	0.00629	0.00933	0.06574	0.1420	LCV_FISH
Uranium	7440-61-1	I	WHOL	22	9	9	0.00315	0.00491	0.03458	0.1420	LCV_FISH
Uranium	7440-61-1	I	FLTR	02.02	12	1	0.00310	0.00310	0.00681	0.4550	LTV_FISH
Uranium	7440-61-1	I	FLTR	03.01	13	8	0.00159	0.00180	0.00396	0.4550	LTV_FISH
Uranium	7440-61-1	I	FLTR	03.02	13	12	0.00220	0.00255	0.00559	0.4550	LTV_FISH
Uranium	7440-61-1	I	FLTR	03.03	13	10	0.00205	0.00231	0.00507	0.4550	LTV_FISH
Uranium	7440-61-1	I	FLTR	03.04	15	11	0.00178	0.00206	0.00453	0.4550	LTV_FISH
Uranium	7440-61-1	I	FLTR	04.01	15	3	0.00117	0.00126	0.00278	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	00	10	6	0.00018	0.00028	0.00062	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	01	45	17	0.00032	0.00042	0.00093	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	02.02	20	4	0.00035	0.00068	0.00150	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	02.04	9	5	0.00022	0.00038	0.00083	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	03.01	33	24	0.00270	0.00327	0.00719	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	03.02	13	13	0.00236	0.00270	0.00593	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	03.03	21	18	0.00249	0.00306	0.00673	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	03.04	15	12	0.00195	0.00224	0.00493	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	04.01	23	10	0.00048	0.00071	0.00156	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	07.01	5	1	0.00210	0.00210	0.00462	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	07.02	17	1	0.00540	0.00540	0.01187	0.4550	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Uranium	7440-61-1	I	WHOL	13	56	3	0.00020	0.00026	0.00058	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	18	8	3	0.00030	0.00052	0.00114	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	20.01	8	7	0.00816	0.01031	0.02265	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	20.02	9	8	0.02211	0.02658	0.05841	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	21	16	10	0.00629	0.00933	0.02052	0.4550	LTV_FISH
Uranium	7440-61-1	I	WHOL	22	9	9	0.00315	0.00491	0.01079	0.4550	LTV_FISH
Uranium	7440-61-1	I	FLTR	02.02	12	1	0.00310	0.00310	0.09254	0.0335	S_ACU_V
Uranium	7440-61-1	I	FLTR	03.01	13	8	0.00159	0.00180	0.05382	0.0335	S_ACU_V
Uranium	7440-61-1	I	FLTR	03.02	13	12	0.00220	0.00255	0.07599	0.0335	S_ACU_V
Uranium	7440-61-1	I	FLTR	03.03	13	10	0.00205	0.00231	0.06893	0.0335	S_ACU_V
Uranium	7440-61-1	I	FLTR	03.04	15	11	0.00178	0.00206	0.06151	0.0335	S_ACU_V
Uranium	7440-61-1	I	FLTR	04.01	15	3	0.00117	0.00126	0.03772	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	00	10	6	0.00018	0.00028	0.00841	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	01	45	17	0.00032	0.00042	0.01264	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	02.02	20	4	0.00035	0.00068	0.02035	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	02.04	9	5	0.00022	0.00038	0.01133	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	03.01	33	24	0.00270	0.00327	0.09763	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	03.02	13	13	0.00236	0.00270	0.08047	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	03.03	21	18	0.00249	0.00306	0.09146	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	03.04	15	12	0.00195	0.00224	0.06700	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	04.01	23	10	0.00048	0.00071	0.02123	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	07.01	5	1	0.00210	0.00210	0.06269	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	07.02	17	1	0.00540	0.00540	0.16119	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	13	56	3	0.00020	0.00026	0.00784	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	18	8	3	0.00030	0.00052	0.01543	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	20.01	8	7	0.00816	0.01031	0.30765	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	20.02	9	8	0.02211	0.02658	0.79336	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	21	16	10	0.00629	0.00933	0.27864	0.0335	S_ACU_V
Uranium	7440-61-1	I	WHOL	22	9	9	0.00315	0.00491	0.14659	0.0335	S_ACU_V
Uranium	7440-61-1	I	FLTR	02.02	12	1	0.00310	0.00310	1.65775	0.0019	S_CHR_V
Uranium	7440-61-1	I	FLTR	03.01	13	8	0.00159	0.00180	0.96420	0.0019	S_CHR_V
Uranium	7440-61-1	I	FLTR	03.02	13	12	0.00220	0.00255	1.36130	0.0019	S_CHR_V
Uranium	7440-61-1	I	FLTR	03.03	13	10	0.00205	0.00231	1.23479	0.0019	S_CHR_V
Uranium	7440-61-1	I	FLTR	03.04	15	11	0.00178	0.00206	1.10195	0.0019	S_CHR_V
Uranium	7440-61-1	I	FLTR	04.01	15	3	0.00117	0.00126	0.67567	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	00	10	6	0.00018	0.00028	0.15059	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	01	45	17	0.00032	0.00042	0.22647	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	02.02	20	4	0.00035	0.00068	0.36448	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	02.04	9	5	0.00022	0.00038	0.20289	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	03.01	33	24	0.00270	0.00327	1.74904	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	03.02	13	13	0.00236	0.00270	1.44166	0.0019	S_CHR_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Uranium	7440-61-1	I	WHOL	03.03	21	18	0.00249	0.00306	1.63844	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	03.04	15	12	0.00195	0.00224	1.20028	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	04.01	23	10	0.00048	0.00071	0.38029	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	07.01	5	1	0.00210	0.00210	1.12299	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	07.02	17	1	0.00540	0.00540	2.88770	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	13	56	3	0.00020	0.00026	0.14037	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	18	8	3	0.00030	0.00052	0.27650	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	20.01	8	7	0.00816	0.01031	5.51139	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	20.02	9	8	0.02211	0.02658	14.21261	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	21	16	10	0.00629	0.00933	4.99173	0.0019	S_CHR_V
Uranium	7440-61-1	I	WHOL	22	9	9	0.00315	0.00491	2.62602	0.0019	S_CHR_V
Vanadium	7440-62-2	I	FLTR	07.01	5	3	0.00124	0.00130	0.01622	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	FLTR	07.02	17	1	0.00120	0.00120	0.01500	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	00	11	3	0.00456	0.00868	0.10847	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	01	48	11	0.00201	0.00281	0.03513	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	02.02	21	8	0.00149	0.00173	0.02162	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	02.04	10	2	0.00240	0.00240	0.03000	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	03.01	33	17	0.00127	0.00139	0.01734	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	03.02	13	3	0.00117	0.00127	0.01592	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	03.03	22	8	0.00154	0.00185	0.02315	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	03.04	15	5	0.00128	0.00156	0.01956	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	04.01	24	5	0.00140	0.00162	0.02021	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	04.02	6	3	0.00120	0.00120	0.01500	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	04.04	9	6	0.00121	0.00132	0.01655	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	07.01	5	4	0.00142	0.00155	0.01935	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	07.02	17	3	0.00101	0.00103	0.01286	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	13	57	25	0.00123	0.00133	0.01663	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	18	9	1	0.00660	0.00660	0.08250	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	20.01	9	1	0.00200	0.00200	0.02500	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	20.02	10	2	0.00455	0.00959	0.11990	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	21	18	6	0.00369	0.00534	0.06673	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	WHOL	22	10	9	0.00277	0.00311	0.03893	0.0800	LCV_ALLO
Vanadium	7440-62-2	I	FLTR	07.01	5	3	0.00124	0.00130	0.00138	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	FLTR	07.02	17	1	0.00120	0.00120	0.00128	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	00	11	3	0.00456	0.00868	0.00923	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	01	48	11	0.00201	0.00281	0.00299	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	02.02	21	8	0.00149	0.00173	0.00184	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	02.04	10	2	0.00240	0.00240	0.00255	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	03.01	33	17	0.00127	0.00139	0.00148	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	03.02	13	3	0.00117	0.00127	0.00136	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	03.03	22	8	0.00154	0.00185	0.00197	0.9400	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Vanadium	7440-62-2	I	WHOL	03.04	15	5	0.00128	0.00156	0.00166	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	04.01	24	5	0.00140	0.00162	0.00172	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	04.02	6	3	0.00120	0.00120	0.00128	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	04.04	9	6	0.00121	0.00132	0.00141	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	07.01	5	4	0.00142	0.00155	0.00165	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	07.02	17	3	0.00101	0.00103	0.00109	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	13	57	25	0.00123	0.00133	0.00141	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	18	9	1	0.00660	0.00660	0.00702	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	20.01	9	1	0.00200	0.00200	0.00213	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	20.02	10	2	0.00455	0.00959	0.01020	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	21	18	6	0.00369	0.00534	0.00568	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	WHOL	22	10	9	0.00277	0.00311	0.00331	0.9400	LCV_DAPH
Vanadium	7440-62-2	I	FLTR	07.01	5	3	0.00124	0.00130	0.01622	0.0800	LCV_FISH
Vanadium	7440-62-2	I	FLTR	07.02	17	1	0.00120	0.00120	0.01500	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	00	11	3	0.00456	0.00868	0.10847	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	01	48	11	0.00201	0.00281	0.03513	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	02.02	21	8	0.00149	0.00173	0.02162	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	02.04	10	2	0.00240	0.00240	0.03000	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	03.01	33	17	0.00127	0.00139	0.01734	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	03.02	13	3	0.00117	0.00127	0.01592	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	03.03	22	8	0.00154	0.00185	0.02315	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	03.04	15	5	0.00128	0.00156	0.01956	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	04.01	24	5	0.00140	0.00162	0.02021	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	04.02	6	3	0.00120	0.00120	0.01500	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	04.04	9	6	0.00121	0.00132	0.01655	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	07.01	5	4	0.00142	0.00155	0.01935	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	07.02	17	3	0.00101	0.00103	0.01286	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	13	57	25	0.00123	0.00133	0.01663	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	18	9	1	0.00660	0.00660	0.08250	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	20.01	9	1	0.00200	0.00200	0.02500	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	20.02	10	2	0.00455	0.00959	0.11990	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	21	18	6	0.00369	0.00534	0.06673	0.0800	LCV_FISH
Vanadium	7440-62-2	I	WHOL	22	10	9	0.00277	0.00311	0.03893	0.0800	LCV_FISH
Vanadium	7440-62-2	I	FLTR	07.01	5	3	0.00124	0.00130	0.00302	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	FLTR	07.02	17	1	0.00120	0.00120	0.00279	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	00	11	3	0.00456	0.00868	0.02018	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	01	48	11	0.00201	0.00281	0.00654	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	02.02	21	8	0.00149	0.00173	0.00402	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	02.04	10	2	0.00240	0.00240	0.00558	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	03.01	33	17	0.00127	0.00139	0.00323	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	03.02	13	3	0.00117	0.00127	0.00296	0.4300	LTV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Vanadium	7440-62-2	I	WHOL	03.03	22	8	0.00154	0.00185	0.00431	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	03.04	15	5	0.00128	0.00156	0.00364	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	04.01	24	5	0.00140	0.00162	0.00376	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	04.02	6	3	0.00120	0.00120	0.00279	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	04.04	9	6	0.00121	0.00132	0.00308	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	07.01	5	4	0.00142	0.00155	0.00360	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	07.02	17	3	0.00101	0.00103	0.00239	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	13	57	25	0.00123	0.00133	0.00309	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	18	9	1	0.00660	0.00660	0.01535	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	20.01	9	1	0.00200	0.00200	0.00465	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	20.02	10	2	0.00455	0.00959	0.02231	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	21	18	6	0.00369	0.00534	0.01241	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	WHOL	22	10	9	0.00277	0.00311	0.00724	0.4300	LTV_DAPH
Vanadium	7440-62-2	I	FLTR	07.01	5	3	0.00124	0.00130	0.03164	0.0410	LTV_FISH
Vanadium	7440-62-2	I	FLTR	07.02	17	1	0.00120	0.00120	0.02927	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	00	11	3	0.00456	0.00868	0.21165	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	01	48	11	0.00201	0.00281	0.06855	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	02.02	21	8	0.00149	0.00173	0.04219	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	02.04	10	2	0.00240	0.00240	0.05854	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	03.01	33	17	0.00127	0.00139	0.03383	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	03.02	13	3	0.00117	0.00127	0.03107	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	03.03	22	8	0.00154	0.00185	0.04516	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	03.04	15	5	0.00128	0.00156	0.03816	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	04.01	24	5	0.00140	0.00162	0.03942	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	04.02	6	3	0.00120	0.00120	0.02927	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	04.04	9	6	0.00121	0.00132	0.03228	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	07.01	5	4	0.00142	0.00155	0.03777	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	07.02	17	3	0.00101	0.00103	0.02508	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	13	57	25	0.00123	0.00133	0.03244	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	18	9	1	0.00660	0.00660	0.16098	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	20.01	9	1	0.00200	0.00200	0.04878	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	20.02	10	2	0.00455	0.00959	0.23394	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	21	18	6	0.00369	0.00534	0.13020	0.0410	LTV_FISH
Vanadium	7440-62-2	I	WHOL	22	10	9	0.00277	0.00311	0.07597	0.0410	LTV_FISH
Vanadium	7440-62-2	I	FLTR	07.01	5	3	0.00124	0.00130	0.00457	0.2840	S_ACU_V
Vanadium	7440-62-2	I	FLTR	07.02	17	1	0.00120	0.00120	0.00423	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	00	11	3	0.00456	0.00868	0.03055	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	01	48	11	0.00201	0.00281	0.00990	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	02.02	21	8	0.00149	0.00173	0.00609	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	02.04	10	2	0.00240	0.00240	0.00845	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	03.01	33	17	0.00127	0.00139	0.00488	0.2840	S_ACU_V

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Vanadium	7440-62-2	I	WHOL	03.02	13	3	0.00117	0.00127	0.00449	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	03.03	22	8	0.00154	0.00185	0.00652	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	03.04	15	5	0.00128	0.00156	0.00551	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	04.01	24	5	0.00140	0.00162	0.00569	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	04.02	6	3	0.00120	0.00120	0.00423	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	04.04	9	6	0.00121	0.00132	0.00466	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	07.01	5	4	0.00142	0.00155	0.00545	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	07.02	17	3	0.00101	0.00103	0.00362	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	13	57	25	0.00123	0.00133	0.00468	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	18	9	1	0.00660	0.00660	0.02324	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	20.01	9	1	0.00200	0.00200	0.00704	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	20.02	10	2	0.00455	0.00959	0.03377	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	21	18	6	0.00369	0.00534	0.01880	0.2840	S_ACU_V
Vanadium	7440-62-2	I	WHOL	22	10	9	0.00277	0.00311	0.01097	0.2840	S_ACU_V
Vanadium	7440-62-2	I	FLTR	07.01	5	3	0.00124	0.00130	0.06792	0.0191	S_CHR_V
Vanadium	7440-62-2	I	FLTR	07.02	17	1	0.00120	0.00120	0.06283	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	00	11	3	0.00456	0.00868	0.45432	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	01	48	11	0.00201	0.00281	0.14716	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	02.02	21	8	0.00149	0.00173	0.09057	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	02.04	10	2	0.00240	0.00240	0.12565	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	03.01	33	17	0.00127	0.00139	0.07261	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	03.02	13	3	0.00117	0.00127	0.06669	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	03.03	22	8	0.00154	0.00185	0.09695	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	03.04	15	5	0.00128	0.00156	0.08192	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	04.01	24	5	0.00140	0.00162	0.08463	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	04.02	6	3	0.00120	0.00120	0.06283	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	04.04	9	6	0.00121	0.00132	0.06930	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	07.01	5	4	0.00142	0.00155	0.08107	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	07.02	17	3	0.00101	0.00103	0.05385	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	13	57	25	0.00123	0.00133	0.06964	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	18	9	1	0.00660	0.00660	0.34555	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	20.01	9	1	0.00200	0.00200	0.10471	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	20.02	10	2	0.00455	0.00959	0.50218	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	21	18	6	0.00369	0.00534	0.27950	0.0191	S_CHR_V
Vanadium	7440-62-2	I	WHOL	22	10	9	0.00277	0.00311	0.16307	0.0191	S_CHR_V
Vinyl chloride	75-01-4	O	WHOL	21	18	4	0.00360	0.00498	0.00017	28.8790	LCV_ALLO
Vinyl chloride	75-01-4	O	WHOL	21	18	4	0.00360	0.00498	0.00017	28.8790	LCV_FISH
Vinyl chloride	75-01-4	O	WHOL	21	18	4	0.00360	0.00498	0.00034	14.5200	LTV_FISH
Vinyl chloride	75-01-4	O	WHOL	21	18	4	0.00360	0.00498	0.00317	1.5700	S_ACU_V
Vinyl chloride	75-01-4	O	WHOL	21	18	4	0.00360	0.00498	0.05671	0.0878	S_CHR_V
Zinc	7440-66-6	I	FLTR	00	1	1	0.00300	0.00300	0.10000	0.0300	LCV_ALLO

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Zinc	7440-66-6	I	FLTR	01	20	16	0.00741	0.00982	0.32719	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	02.01	3	3	0.00725	0.01513	0.50448	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	02.02	13	7	0.00368	0.00413	0.13752	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	02.03	6	5	0.00450	0.00524	0.17480	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	02.04	2	1	0.00941	0.00941	0.31367	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	03.01	14	13	0.00724	0.00859	0.28626	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	03.02	14	13	0.00740	0.00916	0.30527	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	03.03	14	12	0.00598	0.00813	0.27095	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	03.04	16	14	0.01366	0.02717	0.90569	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	04.01	16	14	0.01950	0.03686	1.22864	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	04.02	6	6	0.00510	0.00708	0.23604	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	04.04	10	9	0.00691	0.01071	0.35694	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	07.01	5	4	0.00463	0.00713	0.23762	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	07.02	17	12	0.00416	0.00516	0.17213	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	08	2	1	0.00600	0.00600	0.20000	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	10	2	1	0.02100	0.02100	0.70000	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	13	47	46	0.00598	0.00691	0.23047	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	22	1	1	0.02000	0.02000	0.66667	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	00	11	4	0.00965	0.01524	0.50815	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	01	51	27	0.01121	0.01750	0.58348	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	02.01	3	3	0.01020	0.01984	0.66125	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	02.02	22	13	0.01129	0.01494	0.49812	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	02.03	6	6	0.01372	0.01938	0.64591	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	02.04	11	5	0.00895	0.01731	0.57696	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	03.01	34	33	0.01467	0.01725	0.57493	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	03.02	14	13	0.00987	0.01217	0.40563	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	03.03	23	18	0.01108	0.01377	0.45887	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	03.04	16	14	0.01398	0.01818	0.60610	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	04.01	25	16	0.02340	0.04165	1.38840	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	04.02	6	6	0.00578	0.00844	0.28140	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	04.04	10	9	0.01132	0.01711	0.57045	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	07.01	5	5	0.01420	0.02273	0.75751	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	07.02	17	15	0.00993	0.01348	0.44933	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	08	2	2	0.01800	0.11776	3.92524	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	13	58	51	0.01128	0.01308	0.43599	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	18	9	3	0.00781	0.01058	0.35260	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	20.01	9	6	0.01126	0.01520	0.50658	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	20.02	10	3	0.01847	0.02970	0.99011	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	21	18	10	0.01812	0.03175	1.05820	0.0300	LCV_ALLO
Zinc	7440-66-6	I	WHOL	22	11	10	0.02288	0.02649	0.88290	0.0300	LCV_ALLO
Zinc	7440-66-6	I	FLTR	00	1	1	0.00300	0.00300	0.10000	0.0300	LCV_AQPL

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Zinc	7440-66-6	I	FLTR	01	20	16	0.00741	0.00982	0.32719	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	02.01	3	3	0.00725	0.01513	0.50448	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	02.02	13	7	0.00368	0.00413	0.13752	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	02.03	6	5	0.00450	0.00524	0.17480	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	02.04	2	1	0.00941	0.00941	0.31367	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	03.01	14	13	0.00724	0.00859	0.28626	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	03.02	14	13	0.00740	0.00916	0.30527	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	03.03	14	12	0.00598	0.00813	0.27095	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	03.04	16	14	0.01366	0.02717	0.90569	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	04.01	16	14	0.01950	0.03686	1.22864	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	04.02	6	6	0.00510	0.00708	0.23604	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	04.04	10	9	0.00691	0.01071	0.35694	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	07.01	5	4	0.00463	0.00713	0.23762	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	07.02	17	12	0.00416	0.00516	0.17213	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	08	2	1	0.00600	0.00600	0.20000	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	10	2	1	0.02100	0.02100	0.70000	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	13	47	46	0.00598	0.00691	0.23047	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	22	1	1	0.02000	0.02000	0.66667	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	00	11	4	0.00965	0.01524	0.50815	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	01	51	27	0.01121	0.01750	0.58348	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	02.01	3	3	0.01020	0.01984	0.66125	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	02.02	22	13	0.01129	0.01494	0.49812	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	02.03	6	6	0.01372	0.01938	0.64591	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	02.04	11	5	0.00895	0.01731	0.57696	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	03.01	34	33	0.01467	0.01725	0.57493	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	03.02	14	13	0.00987	0.01217	0.40563	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	03.03	23	18	0.01108	0.01377	0.45887	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	03.04	16	14	0.01398	0.01818	0.60610	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	04.01	25	16	0.02340	0.04165	1.38840	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	04.02	6	6	0.00578	0.00844	0.28140	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	04.04	10	9	0.01132	0.01711	0.57045	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	07.01	5	5	0.01420	0.02273	0.75751	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	07.02	17	15	0.00993	0.01348	0.44933	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	08	2	2	0.01800	0.11776	3.92524	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	13	58	51	0.01128	0.01308	0.43599	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	18	9	3	0.00781	0.01058	0.35260	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	20.01	9	6	0.01126	0.01520	0.50658	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	20.02	10	3	0.01847	0.02970	0.99011	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	21	18	10	0.01812	0.03175	1.05820	0.0300	LCV_AQPL
Zinc	7440-66-6	I	WHOL	22	11	10	0.02288	0.02649	0.88290	0.0300	LCV_AQPL
Zinc	7440-66-6	I	FLTR	00	1	1	0.00300	0.00300	0.06420	0.0467	LCV_DAPH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Zinc	7440-66-6	I	FLTR	01	20	16	0.00741	0.00982	0.21005	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	02.01	3	3	0.00725	0.01513	0.32387	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	02.02	13	7	0.00368	0.00413	0.08829	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	02.03	6	5	0.00450	0.00524	0.11222	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	02.04	2	1	0.00941	0.00941	0.20137	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	03.01	14	13	0.00724	0.00859	0.18377	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	03.02	14	13	0.00740	0.00916	0.19598	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	03.03	14	12	0.00598	0.00813	0.17395	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	03.04	16	14	0.01366	0.02717	0.58144	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	04.01	16	14	0.01950	0.03686	0.78877	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	04.02	6	6	0.00510	0.00708	0.15154	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	04.04	10	9	0.00691	0.01071	0.22915	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	07.01	5	4	0.00463	0.00713	0.15255	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	07.02	17	12	0.00416	0.00516	0.11050	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	08	2	1	0.00600	0.00600	0.12840	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	10	2	1	0.02100	0.02100	0.44939	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	13	47	46	0.00598	0.00691	0.14796	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	22	1	1	0.02000	0.02000	0.42799	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	00	11	4	0.00965	0.01524	0.32622	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	01	51	27	0.01121	0.01750	0.37459	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	02.01	3	3	0.01020	0.01984	0.42451	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	02.02	22	13	0.01129	0.01494	0.31978	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	02.03	6	6	0.01372	0.01938	0.41467	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	02.04	11	5	0.00895	0.01731	0.37040	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	03.01	34	33	0.01467	0.01725	0.36910	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	03.02	14	13	0.00987	0.01217	0.26041	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	03.03	23	18	0.01108	0.01377	0.29459	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	03.04	16	14	0.01398	0.01818	0.38911	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	04.01	25	16	0.02340	0.04165	0.89133	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	04.02	6	6	0.00578	0.00844	0.18066	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	04.04	10	9	0.01132	0.01711	0.36622	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	07.01	5	5	0.01420	0.02273	0.48631	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	07.02	17	15	0.00993	0.01348	0.28846	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	08	2	2	0.01800	0.11776	2.51995	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	13	58	51	0.01128	0.01308	0.27990	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	18	9	3	0.00781	0.01058	0.22636	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	20.01	9	6	0.01126	0.01520	0.32522	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	20.02	10	3	0.01847	0.02970	0.63564	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	21	18	10	0.01812	0.03175	0.67935	0.0467	LCV_DAPH
Zinc	7440-66-6	I	WHOL	22	11	10	0.02288	0.02649	0.56681	0.0467	LCV_DAPH
Zinc	7440-66-6	I	FLTR	00	1	1	0.00300	0.00300	0.08239	0.0364	LCV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Zinc	7440-66-6	I	FLTR	01	20	16	0.00741	0.00982	0.26959	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	02.01	3	3	0.00725	0.01513	0.41566	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	02.02	13	7	0.00368	0.00413	0.11331	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	02.03	6	5	0.00450	0.00524	0.14403	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	02.04	2	1	0.00941	0.00941	0.25845	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	03.01	14	13	0.00724	0.00859	0.23586	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	03.02	14	13	0.00740	0.00916	0.25153	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	03.03	14	12	0.00598	0.00813	0.22325	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	03.04	16	14	0.01366	0.02717	0.74624	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	04.01	16	14	0.01950	0.03686	1.01234	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	04.02	6	6	0.00510	0.00708	0.19449	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	04.04	10	9	0.00691	0.01071	0.29410	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	07.01	5	4	0.00463	0.00713	0.19578	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	07.02	17	12	0.00416	0.00516	0.14182	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	08	2	1	0.00600	0.00600	0.16479	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	10	2	1	0.02100	0.02100	0.57676	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	13	47	46	0.00598	0.00691	0.18990	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	22	1	1	0.02000	0.02000	0.54930	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	00	11	4	0.00965	0.01524	0.41869	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	01	51	27	0.01121	0.01750	0.48076	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	02.01	3	3	0.01020	0.01984	0.54483	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	02.02	22	13	0.01129	0.01494	0.41042	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	02.03	6	6	0.01372	0.01938	0.53220	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	02.04	11	5	0.00895	0.01731	0.47538	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	03.01	34	33	0.01467	0.01725	0.47371	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	03.02	14	13	0.00987	0.01217	0.33422	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	03.03	23	18	0.01108	0.01377	0.37809	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	03.04	16	14	0.01398	0.01818	0.49939	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	04.01	25	16	0.02340	0.04165	1.14397	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	04.02	6	6	0.00578	0.00844	0.23186	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	04.04	10	9	0.01132	0.01711	0.47002	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	07.01	5	5	0.01420	0.02273	0.62415	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	07.02	17	15	0.00993	0.01348	0.37023	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	08	2	2	0.01800	0.11776	3.23420	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	13	58	51	0.01128	0.01308	0.35923	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	18	9	3	0.00781	0.01058	0.29052	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	20.01	9	6	0.01126	0.01520	0.41739	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	20.02	10	3	0.01847	0.02970	0.81580	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	21	18	10	0.01812	0.03175	0.87190	0.0364	LCV_FISH
Zinc	7440-66-6	I	WHOL	22	11	10	0.02288	0.02649	0.72747	0.0364	LCV_FISH
Zinc	7440-66-6	I	FLTR	00	1	1	0.00300	0.00300	0.00057	5.2430	LCV_NDI

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Zinc	7440-66-6	I	FLTR	01	20	16	0.00741	0.00982	0.00187	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	02.01	3	3	0.00725	0.01513	0.00289	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	02.02	13	7	0.00368	0.00413	0.00079	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	02.03	6	5	0.00450	0.00524	0.00100	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	02.04	2	1	0.00941	0.00941	0.00179	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	03.01	14	13	0.00724	0.00859	0.00164	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	03.02	14	13	0.00740	0.00916	0.00175	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	03.03	14	12	0.00598	0.00813	0.00155	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	03.04	16	14	0.01366	0.02717	0.00518	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	04.01	16	14	0.01950	0.03686	0.00703	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	04.02	6	6	0.00510	0.00708	0.00135	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	04.04	10	9	0.00691	0.01071	0.00204	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	07.01	5	4	0.00463	0.00713	0.00136	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	07.02	17	12	0.00416	0.00516	0.00098	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	08	2	1	0.00600	0.00600	0.00114	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	10	2	1	0.02100	0.02100	0.00401	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	13	47	46	0.00598	0.00691	0.00132	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	22	1	1	0.02000	0.02000	0.00381	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	00	11	4	0.00965	0.01524	0.00291	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	01	51	27	0.01121	0.01750	0.00334	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	02.01	3	3	0.01020	0.01984	0.00378	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	02.02	22	13	0.01129	0.01494	0.00285	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	02.03	6	6	0.01372	0.01938	0.00370	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	02.04	11	5	0.00895	0.01731	0.00330	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	03.01	34	33	0.01467	0.01725	0.00329	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	03.02	14	13	0.00987	0.01217	0.00232	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	03.03	23	18	0.01108	0.01377	0.00263	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	03.04	16	14	0.01398	0.01818	0.00347	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	04.01	25	16	0.02340	0.04165	0.00794	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	04.02	6	6	0.00578	0.00844	0.00161	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	04.04	10	9	0.01132	0.01711	0.00326	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	07.01	5	5	0.01420	0.02273	0.00433	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	07.02	17	15	0.00993	0.01348	0.00257	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	08	2	2	0.01800	0.11776	0.02246	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	13	58	51	0.01128	0.01308	0.00249	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	18	9	3	0.00781	0.01058	0.00202	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	20.01	9	6	0.01126	0.01520	0.00290	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	20.02	10	3	0.01847	0.02970	0.00567	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	21	18	10	0.01812	0.03175	0.00605	5.2430	LCV_NDI
Zinc	7440-66-6	I	WHOL	22	11	10	0.02288	0.02649	0.00505	5.2430	LCV_NDI
Zinc	7440-66-6	I	FLTR	00	1	1	0.00300	0.00300	0.06383	0.0470	LTV_FISH

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Zinc	7440-66-6	I	FLTR	01	20	16	0.00741	0.00982	0.20884	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	02.01	3	3	0.00725	0.01513	0.32201	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	02.02	13	7	0.00368	0.00413	0.08778	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	02.03	6	5	0.00450	0.00524	0.11158	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	02.04	2	1	0.00941	0.00941	0.20021	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	03.01	14	13	0.00724	0.00859	0.18272	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	03.02	14	13	0.00740	0.00916	0.19485	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	03.03	14	12	0.00598	0.00813	0.17295	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	03.04	16	14	0.01366	0.02717	0.57810	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	04.01	16	14	0.01950	0.03686	0.78424	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	04.02	6	6	0.00510	0.00708	0.15067	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	04.04	10	9	0.00691	0.01071	0.22783	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	07.01	5	4	0.00463	0.00713	0.15167	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	07.02	17	12	0.00416	0.00516	0.10987	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	08	2	1	0.00600	0.00600	0.12766	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	10	2	1	0.02100	0.02100	0.44681	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	13	47	46	0.00598	0.00691	0.14711	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	22	1	1	0.02000	0.02000	0.42553	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	00	11	4	0.00965	0.01524	0.32435	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	01	51	27	0.01121	0.01750	0.37243	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	02.01	3	3	0.01020	0.01984	0.42207	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	02.02	22	13	0.01129	0.01494	0.31795	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	02.03	6	6	0.01372	0.01938	0.41228	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	02.04	11	5	0.00895	0.01731	0.36827	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	03.01	34	33	0.01467	0.01725	0.36698	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	03.02	14	13	0.00987	0.01217	0.25891	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	03.03	23	18	0.01108	0.01377	0.29290	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	03.04	16	14	0.01398	0.01818	0.38687	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	04.01	25	16	0.02340	0.04165	0.88621	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	04.02	6	6	0.00578	0.00844	0.17962	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	04.04	10	9	0.01132	0.01711	0.36412	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	07.01	5	5	0.01420	0.02273	0.48352	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	07.02	17	15	0.00993	0.01348	0.28681	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	08	2	2	0.01800	0.11776	2.50547	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	13	58	51	0.01128	0.01308	0.27829	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	18	9	3	0.00781	0.01058	0.22506	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	20.01	9	6	0.01126	0.01520	0.32335	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	20.02	10	3	0.01847	0.02970	0.63198	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	21	18	10	0.01812	0.03175	0.67544	0.0470	LTV_FISH
Zinc	7440-66-6	I	WHOL	22	11	10	0.02288	0.02649	0.56356	0.0470	LTV_FISH
Zinc	7440-66-6	I	FLTR	00	1	1	0.00300	0.00300	0.02500	0.1200	NAWQ_ACU

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Zinc	7440-66-6	I	FLTR	01	20	16	0.00741	0.00982	0.08180	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	02.01	3	3	0.00725	0.01513	0.12612	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	02.02	13	7	0.00368	0.00413	0.03438	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	02.03	6	5	0.00450	0.00524	0.04370	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	02.04	2	1	0.00941	0.00941	0.07842	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	03.01	14	13	0.00724	0.00859	0.07156	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	03.02	14	13	0.00740	0.00916	0.07632	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	03.03	14	12	0.00598	0.00813	0.06774	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	03.04	16	14	0.01366	0.02717	0.22642	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	04.01	16	14	0.01950	0.03686	0.30716	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	04.02	6	6	0.00510	0.00708	0.05901	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	04.04	10	9	0.00691	0.01071	0.08923	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	07.01	5	4	0.00463	0.00713	0.05940	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	07.02	17	12	0.00416	0.00516	0.04303	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	08	2	1	0.00600	0.00600	0.05000	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	10	2	1	0.02100	0.02100	0.17500	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	13	47	46	0.00598	0.00691	0.05762	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	22	1	1	0.02000	0.02000	0.16667	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	00	11	4	0.00965	0.01524	0.12704	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	01	51	27	0.01121	0.01750	0.14587	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	02.01	3	3	0.01020	0.01984	0.16531	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	02.02	22	13	0.01129	0.01494	0.12453	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	02.03	6	6	0.01372	0.01938	0.16148	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	02.04	11	5	0.00895	0.01731	0.14424	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	03.01	34	33	0.01467	0.01725	0.14373	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	03.02	14	13	0.00987	0.01217	0.10141	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	03.03	23	18	0.01108	0.01377	0.11472	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	03.04	16	14	0.01398	0.01818	0.15152	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	04.01	25	16	0.02340	0.04165	0.34710	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	04.02	6	6	0.00578	0.00844	0.07035	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	04.04	10	9	0.01132	0.01711	0.14261	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	07.01	5	5	0.01420	0.02273	0.18938	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	07.02	17	15	0.00993	0.01348	0.11233	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	08	2	2	0.01800	0.11776	0.98131	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	13	58	51	0.01128	0.01308	0.10900	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	18	9	3	0.00781	0.01058	0.08815	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	20.01	9	6	0.01126	0.01520	0.12664	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	20.02	10	3	0.01847	0.02970	0.24753	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	21	18	10	0.01812	0.03175	0.26455	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	WHOL	22	11	10	0.02288	0.02649	0.22073	0.1200	NAWQ_ACU
Zinc	7440-66-6	I	FLTR	00	1	1	0.00300	0.00300	0.02727	0.1100	NAWQ_CHR

Table F2.1 (continued)

Parameter	CAS No.	Type	Media	Sub reach	Total obs.	Detects	Mean	UCB concentration	UCB quotient	Benchmark value	Benchmark type
Zinc	7440-66-6	I	FLTR	01	20	16	0.00741	0.00982	0.08923	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	02.01	3	3	0.00725	0.01513	0.13758	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	02.02	13	7	0.00368	0.00413	0.03751	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	02.03	6	5	0.00450	0.00524	0.04767	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	02.04	2	1	0.00941	0.00941	0.08555	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	03.01	14	13	0.00724	0.00859	0.07807	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	03.02	14	13	0.00740	0.00916	0.08326	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	03.03	14	12	0.00598	0.00813	0.07390	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	03.04	16	14	0.01366	0.02717	0.24701	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	04.01	16	14	0.01950	0.03686	0.33508	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	04.02	6	6	0.00510	0.00708	0.06438	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	04.04	10	9	0.00691	0.01071	0.09735	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	07.01	5	4	0.00463	0.00713	0.06480	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	07.02	17	12	0.00416	0.00516	0.04694	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	08	2	1	0.00600	0.00600	0.05455	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	10	2	1	0.02100	0.02100	0.19091	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	13	47	46	0.00598	0.00691	0.06286	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	FLTR	22	1	1	0.02000	0.02000	0.18182	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	00	11	4	0.00965	0.01524	0.13859	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	01	51	27	0.01121	0.01750	0.15913	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	02.01	3	3	0.01020	0.01984	0.18034	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	02.02	22	13	0.01129	0.01494	0.13585	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	02.03	6	6	0.01372	0.01938	0.17616	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	02.04	11	5	0.00895	0.01731	0.15735	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	03.01	34	33	0.01467	0.01725	0.15680	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	03.02	14	13	0.00987	0.01217	0.11063	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	03.03	23	18	0.01108	0.01377	0.12515	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	03.04	16	14	0.01398	0.01818	0.16530	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	04.01	25	16	0.02340	0.04165	0.37865	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	04.02	6	6	0.00578	0.00844	0.07675	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	04.04	10	9	0.01132	0.01711	0.15558	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	07.01	5	5	0.01420	0.02273	0.20659	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	07.02	17	15	0.00993	0.01348	0.12255	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	08	2	2	0.01800	0.11776	1.07052	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	13	58	51	0.01128	0.01308	0.11891	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	18	9	3	0.00781	0.01058	0.09616	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	20.01	9	6	0.01126	0.01520	0.13816	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	20.02	10	3	0.01847	0.02970	0.27003	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	21	18	10	0.01812	0.03175	0.28860	0.1100	NAWQ_CHR
Zinc	7440-66-6	I	WHOL	22	11	10	0.02288	0.02649	0.24079	0.1100	NAWQ_CHR

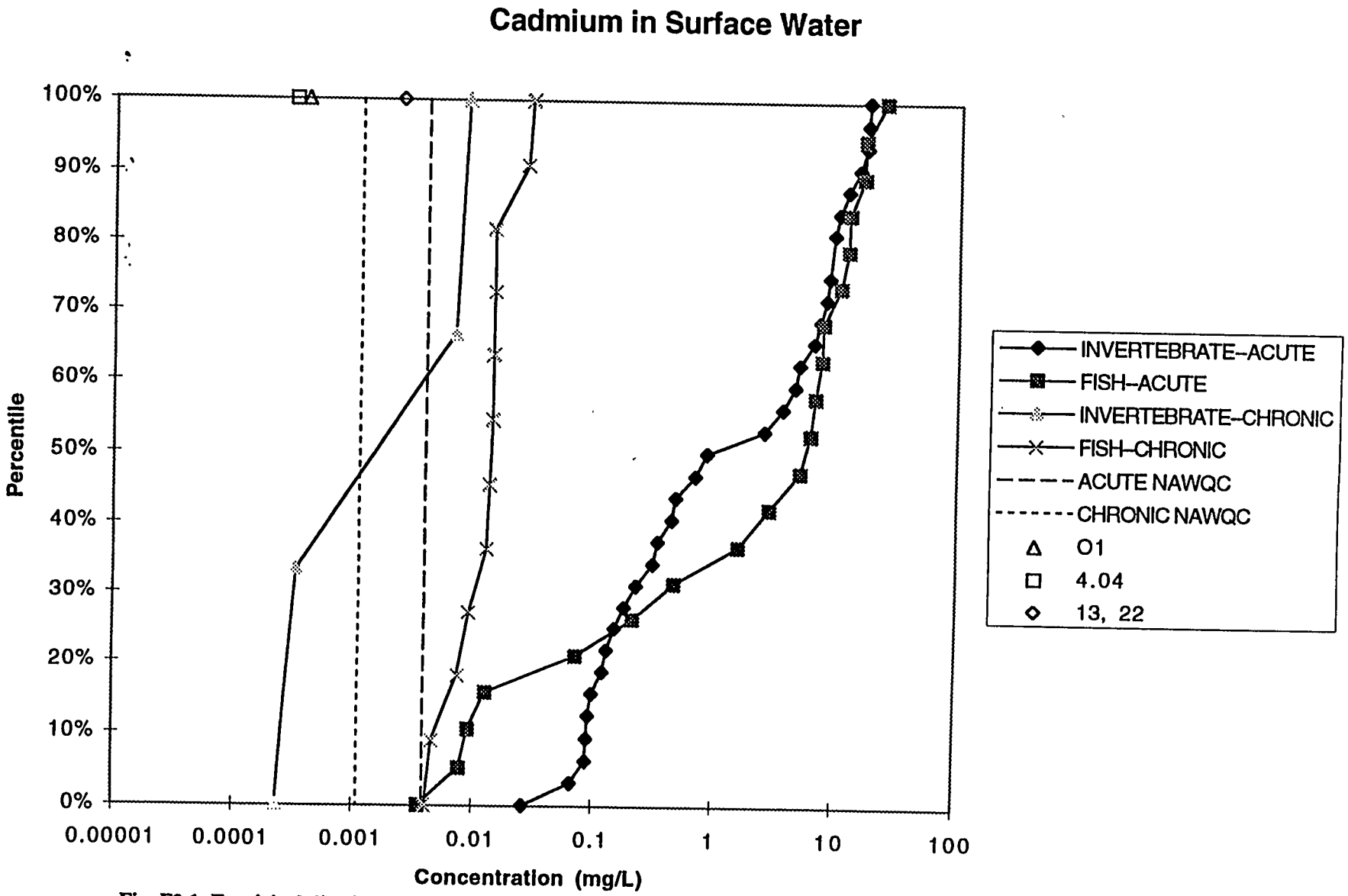

Fig. F2.1. Empirical distribution functions for acute toxicity and chronic toxicity of cadmium to fish and invertebrates and individual measurements of cadmium in reaches for which potentially significant concentrations were reported.

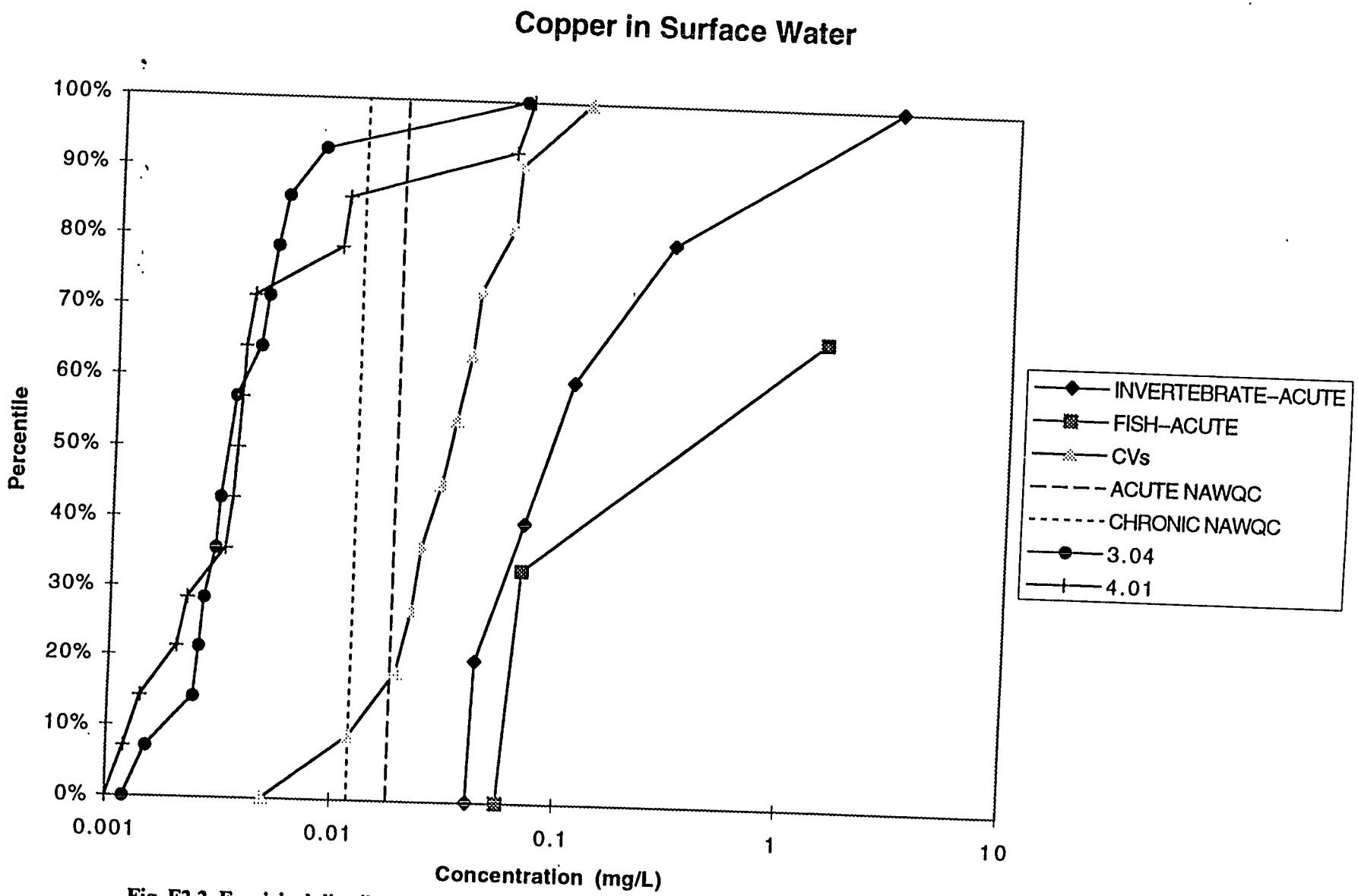

Fig. F2.2. Empirical distribution functions for acute toxicity and chronic toxicity of copper to fish and invertebrates and individual measurements of copper in reaches for which potentially significant concentrations were reported.

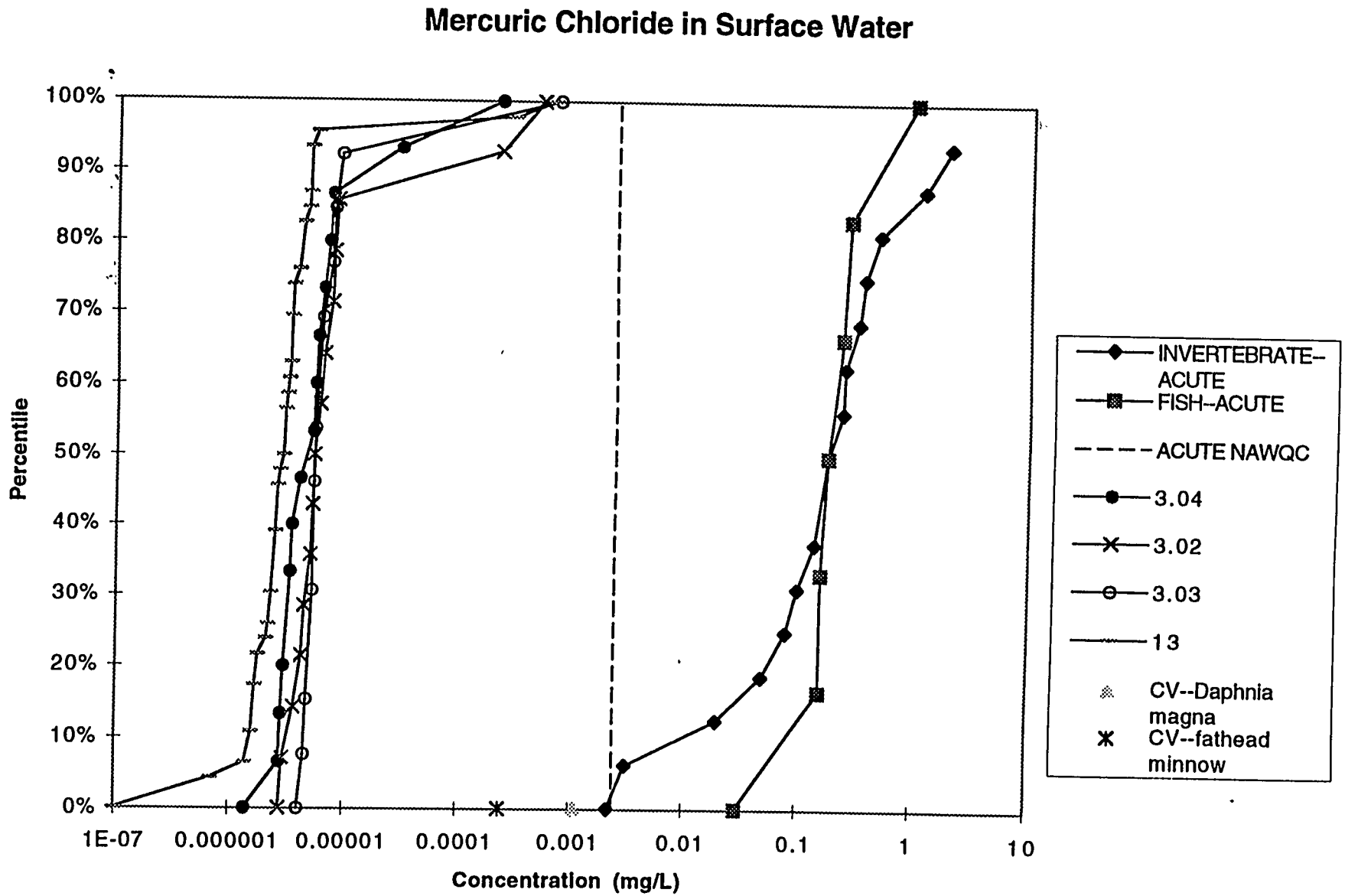

Fig. F2.3. Empirical distribution functions for acute toxicity and chronic toxicity of inorganic mercury to fish and invertebrates and individual measurements of mercury in reaches for which potentially significant concentrations were reported.

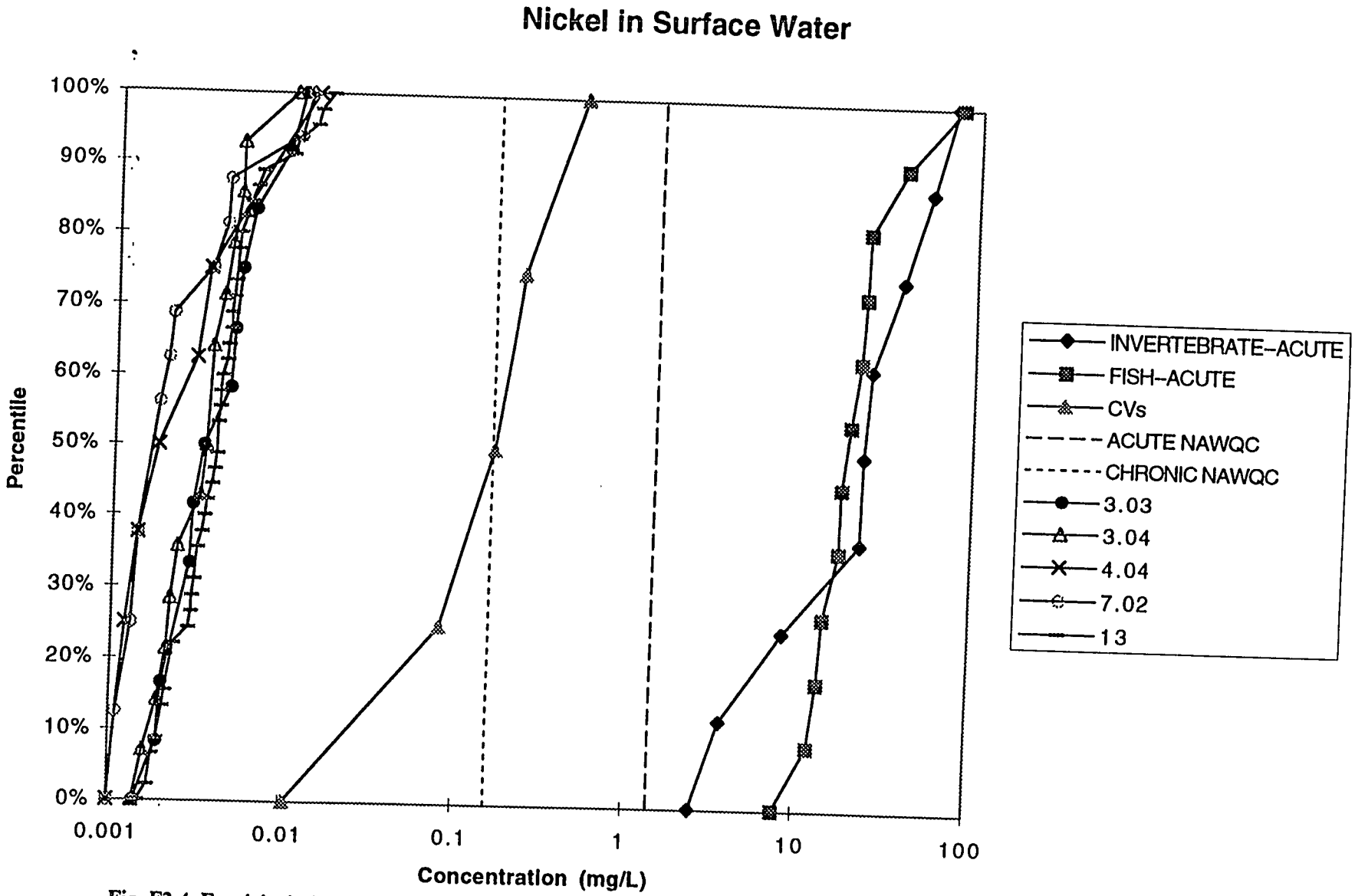

Fig. F2.4. Empirical distribution functions for acute toxicity and chronic toxicity of nickel to fish and invertebrates and individual measurements of nickel in reaches for which potentially significant concentrations were reported.

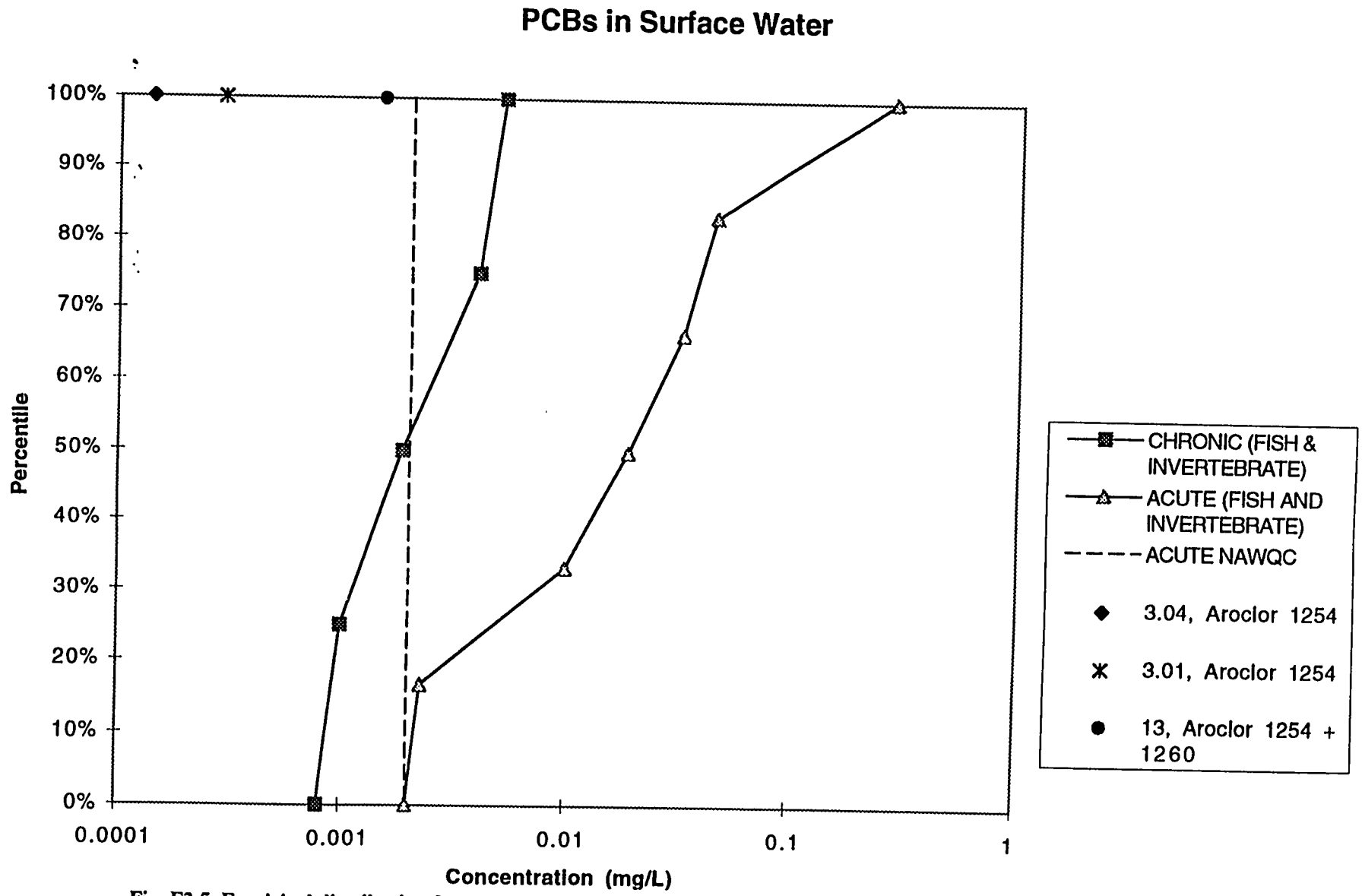

Fig. F2.5. Empirical distribution functions for acute toxicity and chronic toxicity of PCBs to fish and invertebrates and individual measurements of PCBs in reaches for which potentially significant concentrations were reported.

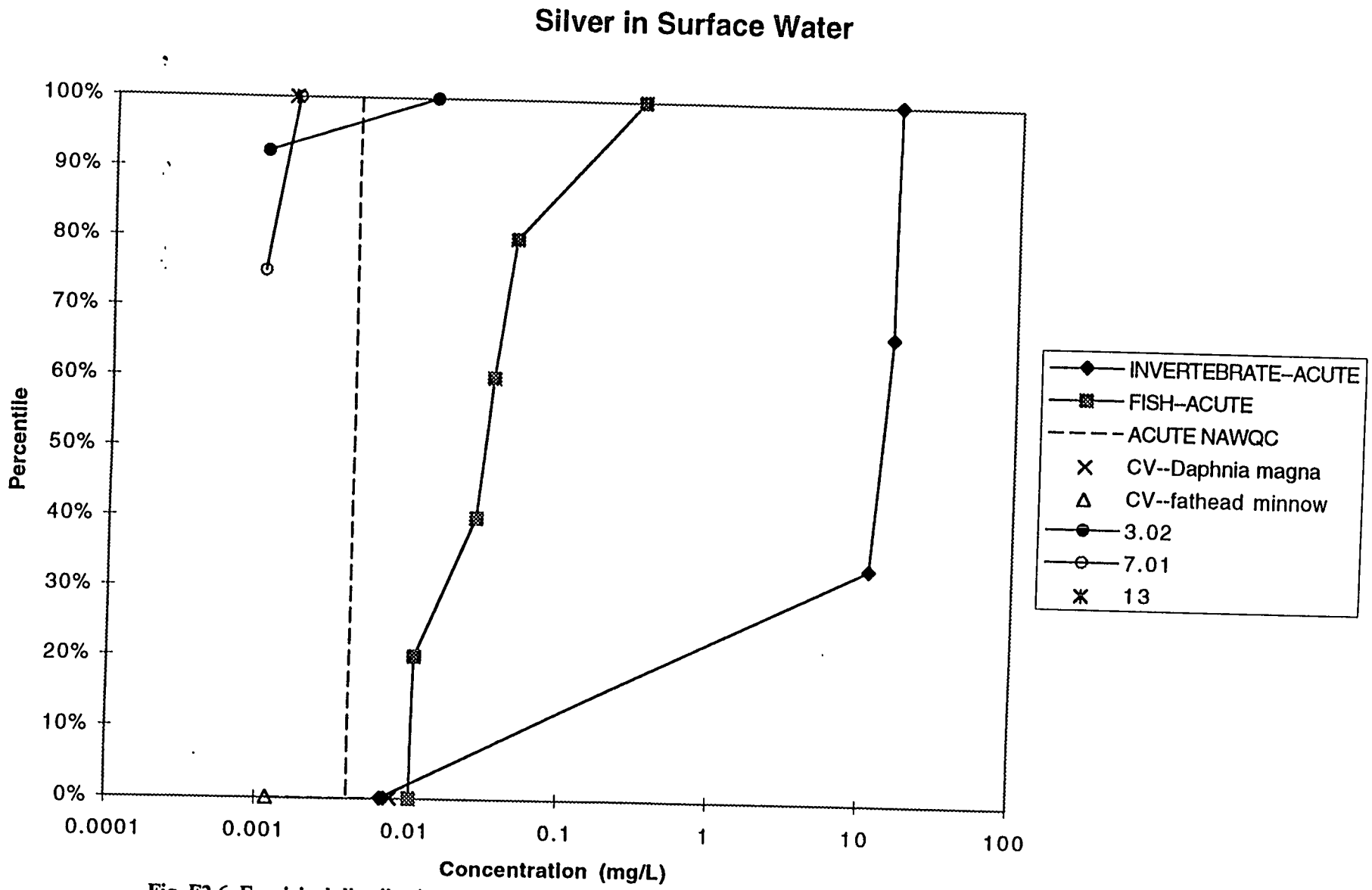

Fig. F2.6. Empirical distribution functions for acute toxicity and chronic toxicity of silver to fish and invertebrates and individual measurements of silver in reaches for which potentially significant concentrations were reported.

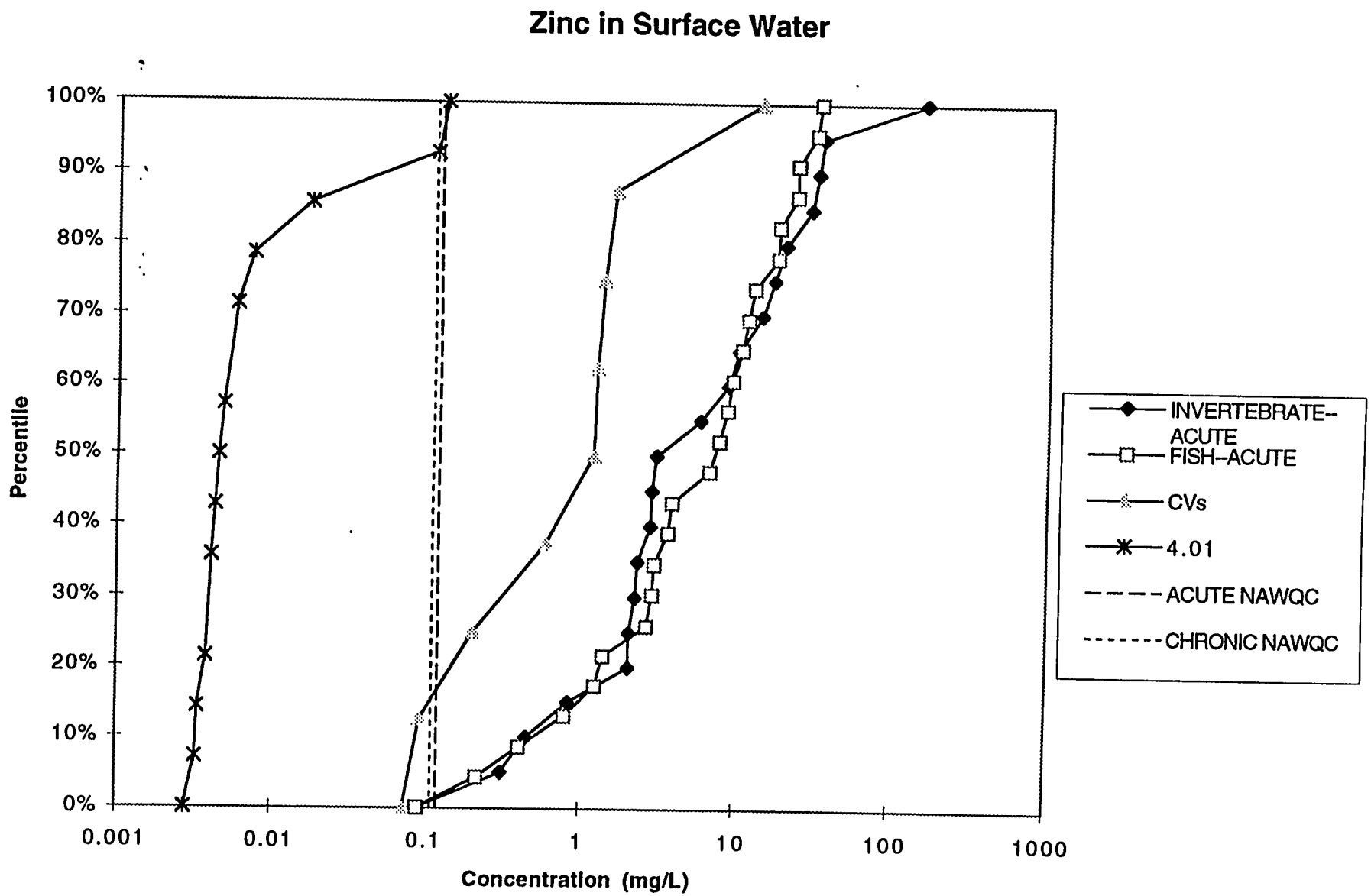

Fig. F2.7. Empirical distribution functions for acute toxicity and chronic toxicity of zinc to fish and invertebrates and individual measurements of zinc in reaches for which potentially significant concentrations were reported.

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Appendix F3

BENTHIC MACROINVERTEBRATES

Table F3.1. Median and maximum concentrations[a] of the contaminants of potential ecological concern in whole sediment, sediment ecotoxicological benchmarks (BMK name) and their values (BMK value) for each chemical, and the quotients (HQ max) of maximum/BMK value

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Arsenic	0	5	5	3.81E+00	5.10E+00	LEL_MOE	6.00E+00	0.85
Arsenic	0	5	5	3.81E+00	5.10E+00	REG_IV	8.00E+00	0.64
Arsenic	0	5	5	3.81E+00	5.10E+00	ER_L	8.20E+00	0.62
Arsenic	0	5	5	3.81E+00	5.10E+00	ER_M	7.00E+01	0.07
Arsenic	**1**	**2**	**2**	**7.44E+00**	**1.04E+01**	**LEL_MOE**	**6.00E+00**	**1.73**
Arsenic	**1**	**2**	**2**	**7.44E+00**	**1.04E+01**	**REG_IV**	**8.00E+00**	**1.29**
Arsenic	**1**	**2**	**2**	**7.44E+00**	**1.04E+01**	**ER_L**	**8.20E+00**	**1.26**
Arsenic	1	2	2	7.44E+00	1.04E+01	ER_M	7.00E+01	0.15
Arsenic	2.01	1	1	1.80E+00	1.80E+00	LEL_MOE	6.00E+00	0.30
Arsenic	2.01	1	1	1.80E+00	1.80E+00	REG_IV	8.00E+00	0.23
Arsenic	2.01	1	1	1.80E+00	1.80E+00	ER_L	8.20E+00	0.22
Arsenic	2.01	1	1	1.80E+00	1.80E+00	ER_M	7.00E+01	0.03
Arsenic	2.02	1	1	3.09E+00	3.09E+00	LEL_MOE	6.00E+00	0.52
Arsenic	2.02	1	1	3.09E+00	3.09E+00	REG_IV	8.00E+00	0.39
Arsenic	2.02	1	1	3.09E+00	3.09E+00	ER_L	8.20E+00	0.38
Arsenic	2.02	1	1	3.09E+00	3.09E+00	ER_M	7.00E+01	0.04
Arsenic	2.03	1	1	2.04E+00	2.04E+00	LEL_MOE	6.00E+00	0.34
Arsenic	2.03	1	1	2.04E+00	2.04E+00	REG_IV	8.00E+00	0.25
Arsenic	2.03	1	1	2.04E+00	2.04E+00	ER_L	8.20E+00	0.25
Arsenic	2.03	1	1	2.04E+00	2.04E+00	ER_M	7.00E+01	0.03
Arsenic	**2.04**	**8**	**8**	**5.22E+00**	**1.02E+01**	**LEL_MOE**	**6.00E+00**	**1.70**
Arsenic	**2.04**	**8**	**8**	**5.22E+00**	**1.02E+01**	**REG_IV**	**8.00E+00**	**1.28**
Arsenic	**2.04**	**8**	**8**	**5.22E+00**	**1.02E+01**	**ER_L**	**8.20E+00**	**1.25**
Arsenic	2.04	8	8	5.22E+00	1.02E+01	ER_M	7.00E+01	0.15

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Arsenic	3.01	2	2	2.85E+00	4.10E+00	LEL_MOE	6.00E+00	0.68
Arsenic	3.01	2	2	2.85E+00	4.10E+00	REG_IV	8.00E+00	0.51
Arsenic	3.01	2	2	2.85E+00	4.10E+00	ER_L	8.20E+00	0.50
Arsenic	3.01	2	2	2.85E+00	4.10E+00	ER_M	7.00E+01	0.06
Arsenic	**3.02**	**9**	**9**	**3.60E+00**	**1.78E+01**	**LEL_MOE**	**6.00E+00**	**2.97**
Arsenic	**3.02**	**9**	**9**	**3.60E+00**	**1.78E+01**	**REG_IV**	**8.00E+00**	**2.23**
Arsenic	**3.02**	**9**	**9**	**3.60E+00**	**1.78E+01**	**ER_L**	**8.20E+00**	**2.17**
Arsenic	3.02	9	9	3.60E+00	1.78E+01	ER_M	7.00E+01	0.25
Arsenic	**3.03**	**9**	**9**	**4.30E+00**	**1.07E+01**	**LEL_MOE**	**6.00E+00**	**1.78**
Arsenic	**3.03**	**9**	**9**	**4.30E+00**	**1.07E+01**	**REG_IV**	**8.00E+00**	**1.34**
Arsenic	**3.03**	**9**	**9**	**4.30E+00**	**1.07E+01**	**ER_L**	**8.20E+00**	**1.30**
Arsenic	3.03	9	9	4.30E+00	1.07E+01	ER_M	7.00E+01	0.15
Arsenic	**3.04**	**7**	**7**	**1.21E+01**	**6.43E+01**	**LEL_MOE**	**6.00E+00**	**10.72**
Arsenic	**3.04**	**7**	**7**	**1.21E+01**	**6.43E+01**	**REG_IV**	**8.00E+00**	**8.04**
Arsenic	**3.04**	**7**	**7**	**1.21E+01**	**6.43E+01**	**ER_L**	**8.20E+00**	**7.84**
Arsenic	3.04	7	7	1.21E+01	6.43E+01	ER_M	7.00E+01	0.92
Arsenic	**4.01**	**10**	**10**	**3.39E+00**	**6.20E+00**	**LEL_MOE**	**6.00E+00**	**1.03**
Arsenic	4.01	10	10	3.39E+00	6.20E+00	REG_IV	8.00E+00	0.78
Arsenic	4.01	10	10	3.39E+00	6.20E+00	ER_L	8.20E+00	0.76
Arsenic	4.01	10	10	3.39E+00	6.20E+00	ER_M	7.00E+01	0.09
Arsenic	**4.02**	**6**	**6**	**3.76E+00**	**1.12E+01**	**LEL_MOE**	**6.00E+00**	**1.87**
Arsenic	**4.02**	**6**	**6**	**3.76E+00**	**1.12E+01**	**REG_IV**	**8.00E+00**	**1.40**
Arsenic	**4.02**	**6**	**6**	**3.76E+00**	**1.12E+01**	**ER_L**	**8.20E+00**	**1.37**
Arsenic	4.02	6	6	3.76E+00	1.12E+01	ER_M	7.00E+01	0.16
Arsenic	**4.03**	**7**	**7**	**8.19E+00**	**1.30E+01**	**LEL_MOE**	**6.00E+00**	**2.17**
Arsenic	**4.03**	**7**	**7**	**8.19E+00**	**1.30E+01**	**REG_IV**	**8.00E+00**	**1.63**
Arsenic	**4.03**	**7**	**7**	**8.19E+00**	**1.30E+01**	**ER_L**	**8.20E+00**	**1.59**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Arsenic	4.03	7	7	8.19E+00	1.30E+01	ER_M	7.00E+01	0.19
Arsenic	**4.04**	**12**	**12**	**8.20E+00**	**1.68E+01**	**LEL_MOE**	**6.00E+00**	**2.80**
Arsenic	**4.04**	**12**	**12**	**8.20E+00**	**1.68E+01**	**REG_IV**	**8.00E+00**	**2.10**
Arsenic	**4.04**	**12**	**12**	**8.20E+00**	**1.68E+01**	**ER_L**	**8.20E+00**	**2.05**
Arsenic	4.04	12	12	8.20E+00	1.68E+01	ER_M	7.00E+01	0.24
Arsenic	**5**	**4**	**4**	**1.02E+01**	**1.14E+01**	**LEL_MOE**	**6.00E+00**	**1.89**
Arsenic	**5**	**4**	**4**	**1.02E+01**	**1.14E+01**	**REG_IV**	**8.00E+00**	**1.42**
Arsenic	**5**	**4**	**4**	**1.02E+01**	**1.14E+01**	**ER_L**	**8.20E+00**	**1.38**
Arsenic	5	4	4	1.02E+01	1.14E+01	ER_M	7.00E+01	0.16
Arsenic	**7.01**	**1**	**1**	**9.71E+01**	**9.71E+01**	**LEL_MOE**	**6.00E+00**	**16.19**
Arsenic	**7.01**	**1**	**1**	**9.71E+01**	**9.71E+01**	**REG_IV**	**8.00E+00**	**12.14**
Arsenic	**7.01**	**1**	**1**	**9.71E+01**	**9.71E+01**	**ER_L**	**8.20E+00**	**11.84**
Arsenic	**7.01**	**1**	**1**	**9.71E+01**	**9.71E+01**	**ER_M**	**7.00E+01**	**1.39**
Arsenic	**7.02**	**9**	**9**	**1.27E+01**	**2.14E+01**	**LEL_MOE**	**6.00E+00**	**3.57**
Arsenic	**7.02**	**9**	**9**	**1.27E+01**	**2.14E+01**	**REG_IV**	**8.00E+00**	**2.68**
Arsenic	**7.02**	**9**	**9**	**1.27E+01**	**2.14E+01**	**ER_L**	**8.20E+00**	**2.61**
Arsenic	7.02	9	9	1.27E+01	2.14E+01	ER_M	7.00E+01	0.31
Arsenic	**8**	**1**	**1**	**7.90E+00**	**7.90E+00**	**LEL_MOE**	**6.00E+00**	**1.32**
Arsenic	8	1	1	7.90E+00	7.90E+00	REG_IV	8.00E+00	0.99
Arsenic	8	1	1	7.90E+00	7.90E+00	ER_L	8.20E+00	0.96
Arsenic	8	1	1	7.90E+00	7.90E+00	ER_M	7.00E+01	0.11
Arsenic	**10**	**1**	**1**	**6.87E+00**	**6.87E+00**	**LEL_MOE**	**6.00E+00**	**1.15**
Arsenic	10	1	1	6.87E+00	6.87E+00	REG_IV	8.00E+00	0.86
Arsenic	10	1	1	6.87E+00	6.87E+00	ER_L	8.20E+00	0.84
Arsenic	10	1	1	6.87E+00	6.87E+00	ER_M	7.00E+01	0.10
Arsenic	13	5	5	3.80E+00	4.10E+00	LEL_MOE	6.00E+00	0.68
Arsenic	13	5	5	3.80E+00	4.10E+00	REG_IV	8.00E+00	0.51

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Arsenic	13	5	5	3.80E+00	4.10E+00	ER_L	8.20E+00	0.50
Arsenic	13	5	5	3.80E+00	4.10E+00	ER_M	7.00E+01	0.06
Arsenic	18	3	3	4.92E+00	5.36E+00	LEL_MOE	6.00E+00	0.89
Arsenic	18	3	3	4.92E+00	5.36E+00	REG_IV	8.00E+00	0.67
Arsenic	18	3	3	4.92E+00	5.36E+00	ER_L	8.20E+00	0.65
Arsenic	18	3	3	4.92E+00	5.36E+00	ER_M	7.00E+01	0.08
Arsenic	22	1	1	3.86E+00	3.86E+00	LEL_MOE	6.00E+00	0.64
Arsenic	22	1	1	3.86E+00	3.86E+00	REG_IV	8.00E+00	0.48
Arsenic	22	1	1	3.86E+00	3.86E+00	ER_L	8.20E+00	0.47
Arsenic	22	1	1	3.86E+00	3.86E+00	ER_M	7.00E+01	0.06
Barium	**0**	**5**	**5**	**6.55E+01**	**7.36E+01**	**EPA_REGV**	**2.00E+01**	**3.68**
Barium	**2.01**	**1**	**1**	**4.26E+01**	**4.26E+01**	**EPA_REGV**	**2.00E+01**	**2.13**
Barium	**2.03**	**1**	**1**	**8.86E+01**	**8.86E+01**	**EPA_REGV**	**2.00E+01**	**4.43**
Barium	**2.04**	**7**	**7**	**1.25E+02**	**1.92E+02**	**EPA_REGV**	**2.00E+01**	**9.59**
Barium	**3.01**	**2**	**2**	**8.19E+01**	**8.60E+01**	**EPA_REGV**	**2.00E+01**	**4.30**
Barium	**3.02**	**8**	**8**	**9.93E+01**	**1.92E+02**	**EPA_REGV**	**2.00E+01**	**9.60**
Barium	**3.03**	**9**	**9**	**9.34E+01**	**1.29E+02**	**EPA_REGV**	**2.00E+01**	**6.45**
Barium	**3.04**	**6**	**6**	**1.06E+02**	**2.08E+02**	**EPA_REGV**	**2.00E+01**	**10.40**
Barium	**4.01**	**9**	**9**	**5.40E+01**	**1.16E+02**	**EPA_REGV**	**2.00E+01**	**5.80**
Barium	**4.02**	**6**	**6**	**6.74E+01**	**1.07E+02**	**EPA_REGV**	**2.00E+01**	**5.35**
Barium	**4.03**	**7**	**7**	**6.45E+01**	**1.23E+02**	**EPA_REGV**	**2.00E+01**	**6.13**
Barium	**4.04**	**11**	**11**	**1.03E+02**	**1.68E+02**	**EPA_REGV**	**2.00E+01**	**8.40**
Barium	**7.01**	**1**	**1**	**1.60E+02**	**1.60E+02**	**EPA_REGV**	**2.00E+01**	**7.99**
Barium	**7.02**	**1**	**1**	**1.57E+02**	**1.57E+02**	**EPA_REGV**	**2.00E+01**	**7.85**
Barium	**8**	**1**	**1**	**1.23E+02**	**1.23E+02**	**EPA_REGV**	**2.00E+01**	**6.15**
Barium	**13**	**5**	**5**	**8.49E+01**	**1.22E+02**	**EPA_REGV**	**2.00E+01**	**6.10**
Barium	**18**	**3**	**3**	**1.17E+02**	**1.24E+02**	**EPA_REGV**	**2.00E+01**	**6.19**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Cadmium	0	5	5	2.66E-01	2.90E-01	LEL_MOE	6.00E-01	0.48
Cadmium	0	5	5	2.66E-01	2.90E-01	REG_IV	1.00E+00	0.29
Cadmium	0	5	5	2.66E-01	2.90E-01	ER_L	1.20E+00	0.24
Cadmium	0	5	5	2.66E-01	2.90E-01	ER_M	9.60E+00	0.03
Cadmium	**1**	**2**	**2**	**6.99E-01**	**8.12E-01**	**LEL_MOE**	**6.00E-01**	**1.35**
Cadmium	1	2	2	6.99E-01	8.12E-01	REG_IV	1.00E+00	0.81
Cadmium	1	2	2	6.99E-01	8.12E-01	ER_L	1.20E+00	0.68
Cadmium	1	2	2	6.99E-01	8.12E-01	ER_M	9.60E+00	0.08
Cadmium	2.01	1	1	1.10E-01	1.10E-01	LEL_MOE	6.00E-01	0.18
Cadmium	2.01	1	1	1.10E-01	1.10E-01	REG_IV	1.00E+00	0.11
Cadmium	2.01	1	1	1.10E-01	1.10E-01	ER_L	1.20E+00	0.09
Cadmium	2.01	1	1	1.10E-01	1.10E-01	ER_M	9.60E+00	0.01
Cadmium	2.03	1	1	1.88E-01	1.88E-01	LEL_MOE	6.00E-01	0.31
Cadmium	2.03	1	1	1.88E-01	1.88E-01	REG_IV	1.00E+00	0.19
Cadmium	2.03	1	1	1.88E-01	1.88E-01	ER_L	1.20E+00	0.16
Cadmium	2.03	1	1	1.88E-01	1.88E-01	ER_M	9.60E+00	0.02
Cadmium	2.04	8	8	2.91E-01	5.07E-01	LEL_MOE	6.00E-01	0.84
Cadmium	2.04	8	8	2.91E-01	5.07E-01	REG_IV	1.00E+00	0.51
Cadmium	2.04	8	8	2.91E-01	5.07E-01	ER_L	1.20E+00	0.42
Cadmium	2.04	8	8	2.91E-01	5.07E-01	ER_M	9.60E+00	0.05
Cadmium	**3.01**	**2**	**2**	**1.12E+00**	**2.10E+00**	**LEL_MOE**	**6.00E-01**	**3.50**
Cadmium	**3.01**	**2**	**2**	**1.12E+00**	**2.10E+00**	**REG_IV**	**1.00E+00**	**2.10**
Cadmium	**3.01**	**2**	**2**	**1.12E+00**	**2.10E+00**	**ER_L**	**1.20E+00**	**1.75**
Cadmium	3.01	2	2	1.12E+00	2.10E+00	ER_M	9.60E+00	0.22
Cadmium	**3.02**	**9**	**9**	**7.84E-01**	**5.30E+00**	**LEL_MOE**	**6.00E-01**	**8.83**
Cadmium	**3.02**	**9**	**9**	**7.84E-01**	**5.30E+00**	**REG_IV**	**1.00E+00**	**5.30**
Cadmium	**3.02**	**9**	**9**	**7.84E-01**	**5.30E+00**	**ER_L**	**1.20E+00**	**4.42**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[a]	HQ max[b]
Cadmium	3.02	9	9	7.84E-01	5.30E+00	ER_M	9.60E+00	0.55
Cadmium	**3.03**	**9**	**9**	**1.00E+00**	**3.50E+00**	**LEL_MOE**	**6.00E-01**	**5.83**
Cadmium	**3.03**	**9**	**9**	**1.00E+00**	**3.50E+00**	**REG_IV**	**1.00E+00**	**3.50**
Cadmium	**3.03**	**9**	**9**	**1.00E+00**	**3.50E+00**	**ER_L**	**1.20E+00**	**2.91**
Cadmium	3.03	9	9	1.00E+00	3.50E+00	ER_M	9.60E+00	0.36
Cadmium	**3.04**	**7**	**7**	**1.20E+00**	**5.63E+00**	**LEL_MOE**	**6.00E-01**	**9.39**
Cadmium	**3.04**	**7**	**7**	**1.20E+00**	**5.63E+00**	**REG_IV**	**1.00E+00**	**5.63**
Cadmium	**3.04**	**7**	**7**	**1.20E+00**	**5.63E+00**	**ER_L**	**1.20E+00**	**4.70**
Cadmium	3.04	7	7	1.20E+00	5.63E+00	ER_M	9.60E+00	0.59
Cadmium	4.01	10	10	2.50E-01	5.48E-01	LEL_MOE	6.00E-01	0.91
Cadmium	4.01	10	10	2.50E-01	5.48E-01	REG_IV	1.00E+00	0.55
Cadmium	4.01	10	10	2.50E-01	5.48E-01	ER_L	1.20E+00	0.46
Cadmium	4.01	10	10	2.50E-01	5.48E-01	ER_M	9.60E+00	0.06
Cadmium	4.02	6	6	1.75E-01	5.10E-01	LEL_MOE	6.00E-01	0.85
Cadmium	4.02	6	6	1.75E-01	5.10E-01	REG_IV	1.00E+00	0.51
Cadmium	4.02	6	6	1.75E-01	5.10E-01	ER_L	1.20E+00	0.43
Cadmium	4.02	6	6	1.75E-01	5.10E-01	ER_M	9.60E+00	0.05
Cadmium	4.03	7	7	4.40E-01	5.56E-01	LEL_MOE	6.00E-01	0.93
Cadmium	4.03	7	7	4.40E-01	5.56E-01	REG_IV	1.00E+00	0.56
Cadmium	4.03	7	7	4.40E-01	5.56E-01	ER_L	1.20E+00	0.46
Cadmium	4.03	7	7	4.40E-01	5.56E-01	ER_M	9.60E+00	0.06
Cadmium	**4.04**	**12**	**12**	**4.60E-01**	**1.28E+00**	**LEL_MOE**	**6.00E-01**	**2.14**
Cadmium	**4.04**	**12**	**12**	**4.60E-01**	**1.28E+00**	**REG_IV**	**1.00E+00**	**1.28**
Cadmium	**4.04**	**12**	**12**	**4.60E-01**	**1.28E+00**	**ER_L**	**1.20E+00**	**1.07**
Cadmium	4.04	12	12	4.60E-01	1.28E+00	ER_M	9.60E+00	0.13
Cadmium	**5**	**4**	**4**	**1.29E+00**	**7.04E+00**	**LEL_MOE**	**6.00E-01**	**11.74**
Cadmium	**5**	**4**	**4**	**1.29E+00**	**7.04E+00**	**REG_IV**	**1.00E+00**	**7.04**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Cadmium	**5**	**4**	**4**	**1.29E+00**	**7.04E+00**	**ER_L**	**1.20E+00**	**5.87**
Cadmium	5	4	4	1.29E+00	7.04E+00	ER_M	9.60E+00	0.73
Cadmium	7.01	1	1	4.98E-01	4.98E-01	LEL_MOE	6.00E-01	0.83
Cadmium	7.01	1	1	4.98E-01	4.98E-01	REG_IV	1.00E+00	0.50
Cadmium	7.01	1	1	4.98E-01	4.98E-01	ER_L	1.20E+00	0.42
Cadmium	7.01	1	1	4.98E-01	4.98E-01	ER_M	9.60E+00	0.05
Cadmium	**7.02**	**2**	**9**	**3.60E-01**	**9.36E-01**	**LEL_MOE**	**6.00E-01**	**1.56**
Cadmium	7.02	2	9	3.60E-01	9.36E-01	REG_IV	1.00E+00	0.94
Cadmium	7.02	2	9	3.60E-01	9.36E-01	ER_L	1.20E+00	0.78
Cadmium	7.02	2	9	3.60E-01	9.36E-01	ER_M	9.60E+00	0.10
Cadmium	8	1	1	2.80E-01	2.80E-01	LEL_MOE	6.00E-01	0.47
Cadmium	8	1	1	2.80E-01	2.80E-01	REG_IV	1.00E+00	0.28
Cadmium	8	1	1	2.80E-01	2.80E-01	ER_L	1.20E+00	0.23
Cadmium	8	1	1	2.80E-01	2.80E-01	ER_M	9.60E+00	0.03
Cadmium	13	5	5	1.80E-01	4.30E-01	LEL_MOE	6.00E-01	0.72
Cadmium	13	5	5	1.80E-01	4.30E-01	REG_IV	1.00E+00	0.43
Cadmium	13	5	5	1.80E-01	4.30E-01	ER_L	1.20E+00	0.36
Cadmium	13	5	5	1.80E-01	4.30E-01	ER_M	9.60E+00	0.04
Cadmium	18	3	3	4.48E-01	4.53E-01	LEL_MOE	6.00E-01	0.75
Cadmium	18	3	3	4.48E-01	4.53E-01	REG_IV	1.00E+00	0.45
Cadmium	18	3	3	4.48E-01	4.53E-01	ER_L	1.20E+00	0.38
Cadmium	18	3	3	4.48E-01	4.53E-01	ER_M	9.60E+00	0.05
Cadmium	**22**	**1**	**1**	**3.54E+00**	**3.54E+00**	**LEL_MOE**	**6.00E-01**	**5.89**
Cadmium	**22**	**1**	**1**	**3.54E+00**	**3.54E+00**	**REG_IV**	**1.00E+00**	**3.54**
Cadmium	**22**	**1**	**1**	**3.54E+00**	**3.54E+00**	**ER_L**	**1.20E+00**	**2.95**
Cadmium	22	1	1	3.54E+00	3.54E+00	ER_M	9.60E+00	0.37
Chromium	0	5	5	1.03E+01	1.28E+01	REG_IV	3.30E+01	0.39

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Chromium	0	5	5	1.03E+01	1.28E+01	ER_L	8.10E+01	0.16
Chromium	0	5	5	1.03E+01	1.28E+01	ER_M	3.70E+02	0.03
Chromium	1	2	2	1.26E+01	1.63E+01	REG_IV	3.30E+01	0.49
Chromium	1	2	2	1.26E+01	1.63E+01	ER_L	8.10E+01	0.20
Chromium	1	2	2	1.26E+01	1.63E+01	ER_M	3.70E+02	0.04
Chromium	2.01	1	1	7.80E+00	7.80E+00	REG_IV	3.30E+01	0.24
Chromium	2.01	1	1	7.80E+00	7.80E+00	ER_L	8.10E+01	0.10
Chromium	2.01	1	1	7.80E+00	7.80E+00	ER_M	3.70E+02	0.02
Chromium	2.02	1	1	6.94E+00	6.94E+00	REG_IV	3.30E+01	0.21
Chromium	2.02	1	1	6.94E+00	6.94E+00	ER_L	8.10E+01	0.09
Chromium	2.02	1	1	6.94E+00	6.94E+00	ER_M	3.70E+02	0.02
Chromium	2.03	1	1	1.26E+01	1.26E+01	REG_IV	3.30E+01	0.38
Chromium	2.03	1	1	1.26E+01	1.26E+01	ER_L	8.10E+01	0.16
Chromium	2.03	1	1	1.26E+01	1.26E+01	ER_M	3.70E+02	0.03
Chromium	2.04	8	8	1.38E+01	2.07E+01	REG_IV	3.30E+01	0.63
Chromium	2.04	8	8	1.38E+01	2.07E+01	ER_L	8.10E+01	0.26
Chromium	2.04	8	8	1.38E+01	2.07E+01	ER_M	3.70E+02	0.06
Chromium	3.01	2	2	1.63E+01	2.06E+01	REG_IV	3.30E+01	0.62
Chromium	3.01	2	2	1.63E+01	2.06E+01	ER_L	8.10E+01	0.25
Chromium	3.01	2	2	1.63E+01	2.06E+01	ER_M	3.70E+02	0.06
Chromium	**3.02**	**9**	**9**	**2.57E+01**	**2.33E+02**	**REG_IV**	**3.30E+01**	**7.06**
Chromium	**3.02**	**9**	**9**	**2.57E+01**	**2.33E+02**	**ER_L**	**8.10E+01**	**2.88**
Chromium	3.02	9	9	2.57E+01	2.33E+02	ER_M	3.70E+02	0.63
Chromium	**3.03**	**9**	**9**	**3.04E+01**	**1.17E+02**	**REG_IV**	**3.30E+01**	**3.56**
Chromium	**3.03**	**9**	**9**	**3.04E+01**	**1.17E+02**	**ER_L**	**8.10E+01**	**1.45**
Chromium	3.03	9	9	3.04E+01	1.17E+02	ER_M	3.70E+02	0.32
Chromium	**3.04**	**7**	**7**	**2.56E+01**	**5.65E+01**	**REG_IV**	**3.30E+01**	**1.71**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Chromium	3.04	7	7	2.56E+01	5.65E+01	ER_L	8.10E+01	0.70
Chromium	3.04	7	7	2.56E+01	5.65E+01	ER_M	3.70E+02	0.15
Chromium	4.01	10	10	1.68E+01	2.06E+01	REG_IV	3.30E+01	0.62
Chromium	4.01	10	10	1.68E+01	2.06E+01	ER_L	8.10E+01	0.25
Chromium	4.01	10	10	1.68E+01	2.06E+01	ER_M	3.70E+02	0.06
Chromium	4.02	6	6	1.49E+01	1.93E+01	REG_IV	3.30E+01	0.58
Chromium	4.02	6	6	1.49E+01	1.93E+01	ER_L	8.10E+01	0.24
Chromium	4.02	6	6	1.49E+01	1.93E+01	ER_M	3.70E+02	0.05
Chromium	**4.03**	**7**	**7**	**2.91E+01**	**5.14E+01**	**REG_IV**	**3.30E+01**	**1.56**
Chromium	4.03	7	7	2.91E+01	5.14E+01	ER_L	8.10E+01	0.63
Chromium	4.03	7	7	2.91E+01	5.14E+01	ER_M	3.70E+02	0.14
Chromium	4.04	12	12	1.79E+01	3.05E+01	REG_IV	3.30E+01	0.92
Chromium	4.04	12	12	1.79E+01	3.05E+01	ER_L	8.10E+01	0.38
Chromium	4.04	12	12	1.79E+01	3.05E+01	ER_M	3.70E+02	0.08
Chromium	5	4	4	3.02E+01	3.18E+01	REG_IV	3.30E+01	0.96
Chromium	5	4	4	3.02E+01	3.18E+01	ER_L	8.10E+01	0.39
Chromium	5	4	4	3.02E+01	3.18E+01	ER_M	3.70E+02	0.09
Chromium	7.01	1	1	2.54E+01	2.54E+01	REG_IV	3.30E+01	0.77
Chromium	7.01	1	1	2.54E+01	2.54E+01	ER_L	8.10E+01	0.31
Chromium	7.01	1	1	2.54E+01	2.54E+01	ER_M	3.70E+02	0.07
Chromium	**7.02**	**9**	**9**	**2.31E+01**	**5.86E+01**	**REG_IV**	**3.30E+01**	**1.78**
Chromium	7.02	9	9	2.31E+01	5.86E+01	ER_L	8.10E+01	0.72
Chromium	7.02	9	9	2.31E+01	5.86E+01	ER_M	3.70E+02	0.16
Chromium	8	1	1	2.13E+01	2.13E+01	REG_IV	3.30E+01	0.65
Chromium	8	1	1	2.13E+01	2.13E+01	ER_L	8.10E+01	0.26
Chromium	8	1	1	2.13E+01	2.13E+01	ER_M	3.70E+02	0.06
Chromium	10	1	1	2.58E+01	2.58E+01	REG_IV	3.30E+01	0.78

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Chromium	10	1	1	2.58E+01	2.58E+01	ER_L	8.10E+01	0.32
Chromium	10	1	1	2.58E+01	2.58E+01	ER_M	3.70E+02	0.07
Chromium	13	5	5	1.51E+01	1.67E+01	REG_IV	3.30E+01	0.51
Chromium	13	5	5	1.51E+01	1.67E+01	ER_L	8.10E+01	0.21
Chromium	13	5	5	1.51E+01	1.67E+01	ER_M	3.70E+02	0.05
Chromium	18	3	3	1.73E+01	1.77E+01	REG_IV	3.30E+01	0.54
Chromium	18	3	3	1.73E+01	1.77E+01	ER_L	8.10E+01	0.22
Chromium	18	3	3	1.73E+01	1.77E+01	ER_M	3.70E+02	0.05
Chromium	**22**	**1**	**1**	**9.76E+01**	**9.76E+01**	**REG_IV**	**3.30E+01**	**2.96**
Chromium	**22**	**1**	**1**	**9.76E+01**	**9.76E+01**	**ER_L**	**8.10E+01**	**1.20**
Chromium	22	1	1	9.76E+01	9.76E+01	ER_M	3.70E+02	0.26
Copper	0	5	5	9.00E+00	1.04E+01	REG_IV	2.80E+01	0.37
Copper	0	5	5	9.00E+00	1.04E+01	ER_L	3.40E+01	0.31
Copper	0	5	5	9.00E+00	1.04E+01	ER_M	2.70E+02	0.04
Copper	**1**	**2**	**2**	**3.45E+01**	**3.48E+01**	**REG_IV**	**2.80E+01**	**1.24**
Copper	**1**	**2**	**2**	**3.45E+01**	**3.48E+01**	**ER_L**	**3.40E+01**	**1.02**
Copper	1	2	2	3.45E+01	3.48E+01	ER_M	2.70E+02	0.13
Copper	2.01	1	1	4.20E+00	4.20E+00	REG_IV	2.80E+01	0.15
Copper	2.01	1	1	4.20E+00	4.20E+00	ER_L	3.40E+01	0.12
Copper	2.01	1	1	4.20E+00	4.20E+00	ER_M	2.70E+02	0.02
Copper	2.02	1	1	9.07E+00	9.07E+00	REG_IV	2.80E+01	0.32
Copper	2.02	1	1	9.07E+00	9.07E+00	ER_L	3.40E+01	0.27
Copper	2.02	1	1	9.07E+00	9.07E+00	ER_M	2.70E+02	0.03
Copper	2.03	1	1	7.67E+00	7.67E+00	REG_IV	2.80E+01	0.27
Copper	2.03	1	1	7.67E+00	7.67E+00	ER_L	3.40E+01	0.23
Copper	2.03	1	1	7.67E+00	7.67E+00	ER_M	2.70E+02	0.03
Copper	2.04	8	8	1.07E+01	1.24E+01	REG_IV	2.80E+01	0.44

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Copper	2.04	8	8	1.07E+01	1.24E+01	ER_L	3.40E+01	0.37
Copper	2.04	8	8	1.07E+01	1.24E+01	ER_M	2.70E+02	0.05
Copper	3.01	2	2	1.64E+01	2.64E+01	REG_IV	2.80E+01	0.94
Copper	3.01	2	2	1.64E+01	2.64E+01	ER_L	3.40E+01	0.78
Copper	3.01	2	2	1.64E+01	2.64E+01	ER_M	2.70E+02	0.10
Copper	**3.02**	**9**	**9**	**2.86E+01**	**1.42E+02**	**REG_IV**	**2.80E+01**	**5.07**
Copper	**3.02**	**9**	**9**	**2.86E+01**	**1.42E+02**	**ER_L**	**3.40E+01**	**4.18**
Copper	3.02	9	9	2.86E+01	1.42E+02	ER_M	2.70E+02	0.53
Copper	**3.03**	**9**	**9**	**2.44E+01**	**5.89E+01**	**REG_IV**	**2.80E+01**	**2.10**
Copper	**3.03**	**9**	**9**	**2.44E+01**	**5.89E+01**	**ER_L**	**3.40E+01**	**1.73**
Copper	3.03	9	9	2.44E+01	5.89E+01	ER_M	2.70E+02	0.22
Copper	**3.04**	**7**	**7**	**3.83E+01**	**9.03E+01**	**REG_IV**	**2.80E+01**	**3.23**
Copper	**3.04**	**7**	**7**	**3.83E+01**	**9.03E+01**	**ER_L**	**3.40E+01**	**2.66**
Copper	3.04	7	7	3.83E+01	9.03E+01	ER_M	2.70E+02	0.33
Copper	4.01	10	10	7.75E+00	1.77E+01	REG_IV	2.80E+01	0.63
Copper	4.01	10	10	7.75E+00	1.77E+01	ER_L	3.40E+01	0.52
Copper	4.01	10	10	7.75E+00	1.77E+01	ER_M	2.70E+02	0.07
Copper	4.02	6	6	7.46E+00	1.66E+01	REG_IV	2.80E+01	0.59
Copper	4.02	6	6	7.46E+00	1.66E+01	ER_L	3.40E+01	0.49
Copper	4.02	6	6	7.46E+00	1.66E+01	ER_M	2.70E+02	0.06
Copper	**4.03**	**7**	**7**	**2.27E+01**	**3.88E+01**	**REG_IV**	**2.80E+01**	**1.39**
Copper	**4.03**	**7**	**7**	**2.27E+01**	**3.88E+01**	**ER_L**	**3.40E+01**	**1.14**
Copper	4.03	7	7	2.27E+01	3.88E+01	ER_M	2.70E+02	0.14
Copper	**4.04**	**12**	**12**	**2.98E+01**	**6.09E+01**	**REG_IV**	**2.80E+01**	**2.18**
Copper	**4.04**	**12**	**12**	**2.98E+01**	**6.09E+01**	**ER_L**	**3.40E+01**	**1.79**
Copper	4.04	12	12	2.98E+01	6.09E+01	ER_M	2.70E+02	0.23
Copper	**5**	**4**	**4**	**3.85E+01**	**4.32E+01**	**REG_IV**	**2.80E+01**	**1.54**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Copper	**5**	**4**	**4**	**3.85E+01**	**4.32E+01**	**ER_L**	**3.40E+01**	**1.27**
Copper	5	4	4	3.85E+01	4.32E+01	ER_M	2.70E+02	0.16
Copper	7.01	1	1	2.60E+01	2.60E+01	REG_IV	2.80E+01	0.93
Copper	7.01	1	1	2.60E+01	2.60E+01	ER_L	3.40E+01	0.76
Copper	7.01	1	1	2.60E+01	2.60E+01	ER_M	2.70E+02	0.10
Copper	**7.02**	**9**	**9**	**2.77E+01**	**4.34E+01**	**REG_IV**	**2.80E+01**	**1.55**
Copper	**7.02**	**9**	**9**	**2.77E+01**	**4.34E+01**	**ER_L**	**3.40E+01**	**1.28**
Copper	7.02	9	9	2.77E+01	4.34E+01	ER_M	2.70E+02	0.16
Copper	8	1	1	2.26E+01	2.26E+01	REG_IV	2.80E+01	0.81
Copper	8	1	1	2.26E+01	2.26E+01	ER_L	3.40E+01	0.66
Copper	8	1	1	2.26E+01	2.26E+01	ER_M	2.70E+02	0.08
Copper	**10**	**1**	**1**	**4.55E+01**	**4.55E+01**	**REG_IV**	**2.80E+01**	**1.62**
Copper	**10**	**1**	**1**	**4.55E+01**	**4.55E+01**	**ER_L**	**3.40E+01**	**1.34**
Copper	10	1	1	4.55E+01	4.55E+01	ER_M	2.70E+02	0.17
Copper	13	5	5	1.04E+01	1.50E+01	REG_IV	2.80E+01	0.54
Copper	13	5	5	1.04E+01	1.50E+01	ER_L	3.40E+01	0.44
Copper	13	5	5	1.04E+01	1.50E+01	ER_M	2.70E+02	0.06
Copper	18	3	3	1.74E+01	1.98E+01	REG_IV	2.80E+01	0.71
Copper	18	3	3	1.74E+01	1.98E+01	ER_L	3.40E+01	0.58
Copper	18	3	3	1.74E+01	1.98E+01	ER_M	2.70E+02	0.07
Copper	**22**	**1**	**1**	**4.12E+01**	**4.12E+01**	**REG_IV**	**2.80E+01**	**1.47**
Copper	**22**	**1**	**1**	**4.12E+01**	**4.12E+01**	**ER_L**	**3.40E+01**	**1.21**
Copper	22	1	1	4.12E+01	4.12E+01	ER_M	2.70E+02	0.15
Iron	0	5	5	1.40E+04	1.48E+04	LEL_MOE	3.00E+04	0.49
Iron	2.01	1	1	8.40E+03	8.40E+03	LEL_MOE	3.00E+04	0.28
Iron	2.03	1	1	1.54E+04	1.54E+04	LEL_MOE	3.00E+04	0.51
Iron	2.04	7	7	1.76E+04	2.64E+04	LEL_MOE	3.00E+04	0.88

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Iron	3.01	2	2	1.56E+04	1.77E+04	LEL_MOE	3.00E+04	0.59
Iron	3.02	8	8	1.93E+04	2.42E+04	LEL_MOE	3.00E+04	0.81
Iron	**3.03**	**9**	**9**	**1.92E+04**	**3.29E+04**	**LEL_MOE**	**3.00E+04**	**1.10**
Iron	3.04	6	6	1.96E+04	2.41E+04	LEL_MOE	3.00E+04	0.80
Iron	4.01	9	9	1.09E+04	1.95E+04	LEL_MOE	3.00E+04	0.65
Iron	4.02	6	6	1.27E+04	1.65E+04	LEL_MOE	3.00E+04	0.55
Iron	4.03	7	7	1.82E+04	2.39E+04	LEL_MOE	3.00E+04	0.80
Iron	**4.04**	**11**	**11**	**2.06E+04**	**3.24E+04**	**LEL_MOE**	**3.00E+04**	**1.08**
Iron	**7.01**	**1**	**1**	**3.08E+04**	**3.08E+04**	**LEL_MOE**	**3.00E+04**	**1.03**
Iron	**7.02**	**1**	**1**	**3.04E+04**	**3.04E+04**	**LEL_MOE**	**3.00E+04**	**1.01**
Iron	8	1	1	2.89E+04	2.89E+04	LEL_MOE	3.00E+04	0.96
Iron	13	5	5	1.58E+04	1.84E+04	LEL_MOE	3.00E+04	0.61
Iron	18	3	3	1.91E+04	2.02E+04	LEL_MOE	3.00E+04	0.67
Lead	**0**	**5**	**5**	**2.16E+01**	**2.60E+01**	**REG_IV**	**2.10E+01**	**1.24**
Lead	0	5	5	2.16E+01	2.60E+01	ER_L	4.70E+01	0.55
Lead	0	5	5	2.16E+01	2.60E+01	ER_M	2.18E+02	0.12
Lead	**1**	**2**	**2**	**3.14E+01**	**3.80E+01**	**REG_IV**	**2.10E+01**	**1.81**
Lead	1	2	2	3.14E+01	3.80E+01	ER_L	4.70E+01	0.81
Lead	1	2	2	3.14E+01	3.80E+01	ER_M	2.18E+02	0.17
Lead	2.01	1	1	5.40E+00	5.40E+00	REG_IV	2.10E+01	0.26
Lead	2.01	1	1	5.40E+00	5.40E+00	ER_L	4.70E+01	0.11
Lead	2.01	1	1	5.40E+00	5.40E+00	ER_M	2.18E+02	0.02
Lead	2.02	1	1	9.73E+00	9.73E+00	REG_IV	2.10E+01	0.46
Lead	2.02	1	1	9.73E+00	9.73E+00	ER_L	4.70E+01	0.21
Lead	2.02	1	1	9.73E+00	9.73E+00	ER_M	2.18E+02	0.04
Lead	2.03	1	1	8.57E+00	8.57E+00	REG_IV	2.10E+01	0.41
Lead	2.03	1	1	8.57E+00	8.57E+00	ER_L	4.70E+01	0.18

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Lead	2.03	1	1	8.57E+00	8.57E+00	ER_M	2.18E+02	0.04
Lead	**2.04**	**8**	**8**	**2.02E+01**	**6.47E+01**	**REG_IV**	**2.10E+01**	**3.08**
Lead	**2.04**	**8**	**8**	**2.02E+01**	**6.47E+01**	**ER_L**	**4.70E+01**	**1.38**
Lead	2.04	8	8	2.02E+01	6.47E+01	ER_M	2.18E+02	0.30
Lead	3.01	2	2	1.42E+01	1.89E+01	REG_IV	2.10E+01	0.90
Lead	3.01	2	2	1.42E+01	1.89E+01	ER_L	4.70E+01	0.40
Lead	3.01	2	2	1.42E+01	1.89E+01	ER_M	2.18E+02	0.09
Lead	**3.02**	**9**	**9**	**1.75E+01**	**5.33E+01**	**REG_IV**	**2.10E+01**	**2.54**
Lead	**3.02**	**9**	**9**	**1.75E+01**	**5.33E+01**	**ER_L**	**4.70E+01**	**1.13**
Lead	3.02	9	9	1.75E+01	5.33E+01	ER_M	2.18E+02	0.24
Lead	**3.03**	**9**	**9**	**2.26E+01**	**3.76E+01**	**REG_IV**	**2.10E+01**	**1.79**
Lead	3.03	9	9	2.26E+01	3.76E+01	ER_L	4.70E+01	0.80
Lead	3.03	9	9	2.26E+01	3.76E+01	ER_M	2.18E+02	0.17
Lead	**3.04**	**7**	**7**	**2.03E+01**	**3.09E+01**	**REG_IV**	**2.10E+01**	**1.47**
Lead	3.04	7	7	2.03E+01	3.09E+01	ER_L	4.70E+01	0.66
Lead	3.04	7	7	2.03E+01	3.09E+01	ER_M	2.18E+02	0.14
Lead	**4.01**	**10**	**10**	**1.29E+01**	**4.79E+01**	**REG_IV**	**2.10E+01**	**2.28**
Lead	**4.01**	**10**	**10**	**1.29E+01**	**4.79E+01**	**ER_L**	**4.70E+01**	**1.02**
Lead	4.01	10	10	1.29E+01	4.79E+01	ER_M	2.18E+02	0.22
Lead	**4.02**	**6**	**6**	**1.85E+01**	**3.29E+01**	**REG_IV**	**2.10E+01**	**1.57**
Lead	4.02	6	6	1.85E+01	3.29E+01	ER_L	4.70E+01	0.70
Lead	4.02	6	6	1.85E+01	3.29E+01	ER_M	2.18E+02	0.15
Lead	**4.03**	**7**	**7**	**3.09E+01**	**7.07E+01**	**REG_IV**	**2.10E+01**	**3.37**
Lead	**4.03**	**7**	**7**	**3.09E+01**	**7.07E+01**	**ER_L**	**4.70E+01**	**1.50**
Lead	4.03	7	7	3.09E+01	7.07E+01	ER_M	2.18E+02	0.32
Lead	**4.04**	**12**	**12**	**2.50E+01**	**5.99E+01**	**REG_IV**	**2.10E+01**	**2.85**
Lead	**4.04**	**12**	**12**	**2.50E+01**	**5.99E+01**	**ER_L**	**4.70E+01**	**1.27**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Lead	4.04	12	12	2.50E+01	5.99E+01	ER_M	2.18E+02	0.27
Lead	**5**	**4**	**4**	**4.09E+01**	**4.75E+01**	**REG_IV**	**2.10E+01**	**2.26**
Lead	**5**	**4**	**4**	**4.09E+01**	**4.75E+01**	**ER_L**	**4.70E+01**	**1.01**
Lead	5	4	4	4.09E+01	4.75E+01	ER_M	2.18E+02	0.22
Lead	7.01	1	1	1.64E+01	1.64E+01	REG_IV	2.10E+01	0.78
Lead	7.01	1	1	1.64E+01	1.64E+01	ER_L	4.70E+01	0.35
Lead	7.01	1	1	1.64E+01	1.64E+01	ER_M	2.18E+02	0.08
Lead	**7.02**	**9**	**9**	**1.90E+01**	**3.34E+01**	**REG_IV**	**2.10E+01**	**1.59**
Lead	7.02	9	9	1.90E+01	3.34E+01	ER_L	4.70E+01	0.71
Lead	7.02	9	9	1.90E+01	3.34E+01	ER_M	2.18E+02	0.15
Lead	**8**	**1**	**1**	**2.77E+01**	**2.77E+01**	**REG_IV**	**2.10E+01**	**1.32**
Lead	8	1	1	2.77E+01	2.77E+01	ER_L	4.70E+01	0.59
Lead	8	1	1	2.77E+01	2.77E+01	ER_M	2.18E+02	0.13
Lead	**10**	**1**	**1**	**3.80E+01**	**3.80E+01**	**REG_IV**	**2.10E+01**	**1.81**
Lead	10	1	1	3.80E+01	3.80E+01	ER_L	4.70E+01	0.81
Lead	10	1	1	3.80E+01	3.80E+01	ER_M	2.18E+02	0.17
Lead	13	5	5	1.54E+01	1.82E+01	REG_IV	2.10E+01	0.87
Lead	13	5	5	1.54E+01	1.82E+01	ER_L	4.70E+01	0.39
Lead	13	5	5	1.54E+01	1.82E+01	ER_M	2.18E+02	0.08
Lead	**18**	**3**	**3**	**2.31E+01**	**2.67E+01**	**REG_IV**	**2.10E+01**	**1.27**
Lead	18	3	3	2.31E+01	2.67E+01	ER_L	4.70E+01	0.57
Lead	18	3	3	2.31E+01	2.67E+01	ER_M	2.18E+02	0.12
Lead	**22**	**1**	**1**	**1.20E+02**	**1.20E+02**	**REG_IV**	**2.10E+01**	**5.72**
Lead	**22**	**1**	**1**	**1.20E+02**	**1.20E+02**	**ER_L**	**4.70E+01**	**2.56**
Lead	22	1	1	1.20E+02	1.20E+02	ER_M	2.18E+02	0.55
Manganese	**0**	**5**	**5**	**1.09E+03**	**2.12E+03**	**LEL_MOE**	**4.60E+02**	**4.61**
Manganese	2.01	1	1	2.72E+02	2.72E+02	LEL_MOE	4.60E+02	0.59

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Manganese	**2.03**	**1**	**1**	**5.51E+02**	**5.51E+02**	**LEL_MOE**	**4.60E+02**	**1.20**
Manganese	**2.04**	**7**	**7**	**1.27E+03**	**4.48E+03**	**LEL_MOE**	**4.60E+02**	**9.75**
Manganese	**3.01**	**2**	**2**	**4.98E+02**	**6.12E+02**	**LEL_MOE**	**4.60E+02**	**1.33**
Manganese	**3.02**	**8**	**8**	**5.82E+02**	**1.08E+03**	**LEL_MOE**	**4.60E+02**	**2.35**
Manganese	**3.03**	**9**	**9**	**6.22E+02**	**1.40E+03**	**LEL_MOE**	**4.60E+02**	**3.04**
Manganese	**3.04**	**6**	**6**	**6.19E+02**	**8.44E+02**	**LEL_MOE**	**4.60E+02**	**1.83**
Manganese	**4.01**	**9**	**9**	**5.51E+02**	**8.02E+02**	**LEL_MOE**	**4.60E+02**	**1.74**
Manganese	**4.02**	**6**	**6**	**3.99E+02**	**1.24E+03**	**LEL_MOE**	**4.60E+02**	**2.70**
Manganese	**4.03**	**7**	**7**	**8.34E+02**	**1.97E+03**	**LEL_MOE**	**4.60E+02**	**4.29**
Manganese	**4.04**	**11**	**11**	**1.34E+03**	**1.97E+03**	**LEL_MOE**	**4.60E+02**	**4.28**
Manganese	**7.01**	**1**	**1**	**1.64E+03**	**1.64E+03**	**LEL_MOE**	**4.60E+02**	**3.57**
Manganese	**7.02**	**1**	**1**	**2.94E+03**	**2.94E+03**	**LEL_MOE**	**4.60E+02**	**6.39**
Manganese	**8**	**1**	**1**	**2.01E+03**	**2.01E+03**	**LEL_MOE**	**4.60E+02**	**4.37**
Manganese	**13**	**5**	**5**	**4.22E+02**	**8.08E+02**	**LEL_MOE**	**4.60E+02**	**1.76**
Manganese	**18**	**3**	**3**	**1.85E+03**	**2.02E+03**	**LEL_MOE**	**4.60E+02**	**4.40**
Mercury	0	5	5	4.94E-02	6.86E-02	REG_IV	1.00E-01	0.69
Mercury	0	5	5	4.94E-02	6.86E-02	ER_L	1.50E-01	0.46
Mercury	0	5	5	4.94E-02	6.86E-02	ER_M	7.10E-01	0.10
Mercury	**1**	**2**	**2**	**1.03E-01**	**1.54E-01**	**REG_IV**	**1.00E-01**	**1.54**
Mercury	**1**	**2**	**2**	**1.03E-01**	**1.54E-01**	**ER_L**	**1.50E-01**	**1.03**
Mercury	1	2	2	1.03E-01	1.54E-01	ER_M	7.10E-01	0.22
Mercury	**2.01**	**1**	**1**	**2.37E-01**	**2.37E-01**	**REG_IV**	**1.00E-01**	**2.37**
Mercury	**2.01**	**1**	**1**	**2.37E-01**	**2.37E-01**	**ER_L**	**1.50E-01**	**1.58**
Mercury	2.01	1	1	2.37E-01	2.37E-01	ER_M	7.10E-01	0.33
Mercury	2.03	1	1	2.59E-02	2.59E-02	REG_IV	1.00E-01	0.26
Mercury	2.03	1	1	2.59E-02	2.59E-02	ER_L	1.50E-01	0.17
Mercury	2.03	1	1	2.59E-02	2.59E-02	ER_M	7.10E-01	0.04

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Mercury	2.04	9	9	9.31E-02	6.19E-01	REG_IV	1.00E-01	6.19
Mercury	2.04	9	9	9.31E-02	6.19E-01	ER_L	1.50E-01	4.13
Mercury	2.04	9	9	9.31E-02	6.19E-01	ER_M	7.10E-01	0.87
Mercury	3.01	2	2	2.32E+00	4.61E+00	REG_IV	1.00E-01	46.06
Mercury	3.01	2	2	2.32E+00	4.61E+00	ER_L	1.50E-01	30.71
Mercury	3.01	2	2	2.32E+00	4.61E+00	ER_M	7.10E-01	6.49
Mercury	3.02	9	9	8.36E+00	3.70E+01	REG_IV	1.00E-01	369.56
Mercury	3.02	9	9	8.36E+00	3.70E+01	ER_L	1.50E-01	246.37
Mercury	3.02	9	9	8.36E+00	3.70E+01	ER_M	7.10E-01	52.05
Mercury	3.03	9	9	4.98E+00	1.21E+01	REG_IV	1.00E-01	121.35
Mercury	3.03	9	9	4.98E+00	1.21E+01	ER_L	1.50E-01	80.90
Mercury	3.03	9	9	4.98E+00	1.21E+01	ER_M	7.10E-01	17.09
Mercury	3.04	8	8	5.07E+00	1.39E+02	REG_IV	1.00E-01	1394.09
Mercury	3.04	8	8	5.07E+00	1.39E+02	ER_L	1.50E-01	929.39
Mercury	3.04	8	8	5.07E+00	1.39E+02	ER_M	7.10E-01	196.35
Mercury	4.01	10	10	8.48E-01	6.95E+00	REG_IV	1.00E-01	69.46
Mercury	4.01	10	10	8.48E-01	6.95E+00	ER_L	1.50E-01	46.31
Mercury	4.01	10	10	8.48E-01	6.95E+00	ER_M	7.10E-01	9.78
Mercury	4.02	6	6	9.48E-01	2.94E+00	REG_IV	1.00E-01	29.39
Mercury	4.02	6	6	9.48E-01	2.94E+00	ER_L	1.50E-01	19.59
Mercury	4.02	6	6	9.48E-01	2.94E+00	ER_M	7.10E-01	4.14
Mercury	4.03	7	7	1.79E+00	5.28E+00	REG_IV	1.00E-01	52.84
Mercury	4.03	7	7	1.79E+00	5.28E+00	ER_L	1.50E-01	35.22
Mercury	4.03	7	7	1.79E+00	5.28E+00	ER_M	7.10E-01	7.44
Mercury	4.04	12	12	1.67E+00	2.20E+00	REG_IV	1.00E-01	22.00
Mercury	4.04	12	12	1.67E+00	2.20E+00	ER_L	1.50E-01	14.67
Mercury	4.04	12	12	1.67E+00	2.20E+00	ER_M	7.10E-01	3.10

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Mercury	**5**	**4**	**4**	**5.33E-01**	**1.26E+00**	**REG_IV**	**1.00E-01**	**12.60**
Mercury	**5**	**4**	**4**	**5.33E-01**	**1.26E+00**	**ER_L**	**1.50E-01**	**8.40**
Mercury	**5**	**4**	**4**	**5.33E-01**	**1.26E+00**	**ER_M**	**7.10E-01**	**1.77**
Mercury	**7.01**	**1**	**1**	**1.60E-01**	**1.60E-01**	**REG_IV**	**1.00E-01**	**1.60**
Mercury	**7.01**	**1**	**1**	**1.60E-01**	**1.60E-01**	**ER_L**	**1.50E-01**	**1.07**
Mercury	7.01	1	1	1.60E-01	1.60E-01	ER_M	7.10E-01	0.23
Mercury	**7.02**	**1**	**9**	**1.09E-01**	**1.09E-01**	**REG_IV**	**1.00E-01**	**1.09**
Mercury	7.02	1	9	1.09E-01	1.09E-01	ER_L	1.50E-01	0.73
Mercury	7.02	1	9	1.09E-01	1.09E-01	ER_M	7.10E-01	0.15
Mercury	**8**	**1**	**1**	**7.64E-01**	**7.64E-01**	**REG_IV**	**1.00E-01**	**7.64**
Mercury	**8**	**1**	**1**	**7.64E-01**	**7.64E-01**	**ER_L**	**1.50E-01**	**5.09**
Mercury	**8**	**1**	**1**	**7.64E-01**	**7.64E-01**	**ER_M**	**7.10E-01**	**1.08**
Mercury	10	1	1	6.97E-02	6.97E-02	REG_IV	1.00E-01	0.70
Mercury	10	1	1	6.97E-02	6.97E-02	ER_L	1.50E-01	0.46
Mercury	10	1	1	6.97E-02	6.97E-02	ER_M	7.10E-01	0.10
Mercury	**13**	**5**	**5**	**1.85E-01**	**1.22E+00**	**REG_IV**	**1.00E-01**	**12.19**
Mercury	**13**	**5**	**5**	**1.85E-01**	**1.22E+00**	**ER_L**	**1.50E-01**	**8.13**
Mercury	**13**	**5**	**5**	**1.85E-01**	**1.22E+00**	**ER_M**	**7.10E-01**	**1.72**
Mercury	**18**	**3**	**3**	**9.83E-02**	**1.11E-01**	**REG_IV**	**1.00E-01**	**1.11**
Mercury	18	3	3	9.83E-02	1.11E-01	ER_L	1.50E-01	0.74
Mercury	18	3	3	9.83E-02	1.11E-01	ER_M	7.10E-01	0.16
Mercury	**22**	**1**	**1**	**1.14E+02**	**1.14E+02**	**REG_IV**	**1.00E-01**	**1140.73**
Mercury	**22**	**1**	**1**	**1.14E+02**	**1.14E+02**	**ER_L**	**1.50E-01**	**760.49**
Mercury	**22**	**1**	**1**	**1.14E+02**	**1.14E+02**	**ER_M**	**7.10E-01**	**160.67**
Nickel	0	5	5	1.35E+01	1.49E+01	REG_IV	2.09E+01	0.71
Nickel	0	5	5	1.35E+01	1.49E+01	ER_L	2.10E+01	0.71
Nickel	0	5	5	1.35E+01	1.49E+01	ER_M	5.16E+01	0.29

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Nickel	1	2	2	1.60E+01	2.01E+01	REG_IV	2.09E+01	0.96
Nickel	1	2	2	1.60E+01	2.01E+01	ER_L	2.10E+01	0.96
Nickel	1	2	2	1.60E+01	2.01E+01	ER_M	5.16E+01	0.39
Nickel	2.01	1	1	9.70E+00	9.70E+00	REG_IV	2.09E+01	0.46
Nickel	2.01	1	1	9.70E+00	9.70E+00	ER_L	2.10E+01	0.46
Nickel	2.01	1	1	9.70E+00	9.70E+00	ER_M	5.16E+01	0.19
Nickel	2.02	1	1	4.69E+00	4.69E+00	REG_IV	2.09E+01	0.22
Nickel	2.02	1	1	4.69E+00	4.69E+00	ER_L	2.10E+01	0.22
Nickel	2.02	1	1	4.69E+00	4.69E+00	ER_M	5.16E+01	0.09
Nickel	2.03	1	1	1.75E+01	1.75E+01	REG_IV	2.09E+01	0.84
Nickel	2.03	1	1	1.75E+01	1.75E+01	ER_L	2.10E+01	0.83
Nickel	2.03	1	1	1.75E+01	1.75E+01	ER_M	5.16E+01	0.34
Nickel	**2.04**	**8**	**8**	**1.41E+01**	**2.53E+01**	**REG_IV**	**2.09E+01**	**1.21**
Nickel	**2.04**	**8**	**8**	**1.41E+01**	**2.53E+01**	**ER_L**	**2.10E+01**	**1.20**
Nickel	2.04	8	8	1.41E+01	2.53E+01	ER_M	5.16E+01	0.49
Nickel	**3.01**	**2**	**2**	**2.04E+01**	**2.88E+01**	**REG_IV**	**2.09E+01**	**1.38**
Nickel	**3.01**	**2**	**2**	**2.04E+01**	**2.88E+01**	**ER_L**	**2.10E+01**	**1.37**
Nickel	3.01	2	2	2.04E+01	2.88E+01	ER_M	5.16E+01	0.56
Nickel	**3.02**	**9**	**9**	**4.80E+01**	**2.28E+02**	**REG_IV**	**2.09E+01**	**10.91**
Nickel	**3.02**	**9**	**9**	**4.80E+01**	**2.28E+02**	**ER_L**	**2.10E+01**	**10.86**
Nickel	**3.02**	**9**	**9**	**4.80E+01**	**2.28E+02**	**ER_M**	**5.16E+01**	**4.42**
Nickel	**3.03**	**9**	**9**	**4.42E+01**	**8.57E+01**	**REG_IV**	**2.09E+01**	**4.10**
Nickel	**3.03**	**9**	**9**	**4.42E+01**	**8.57E+01**	**ER_L**	**2.10E+01**	**4.08**
Nickel	**3.03**	**9**	**9**	**4.42E+01**	**8.57E+01**	**ER_M**	**5.16E+01**	**1.66**
Nickel	**3.04**	**7**	**7**	**3.67E+01**	**6.96E+01**	**REG_IV**	**2.09E+01**	**3.33**
Nickel	**3.04**	**7**	**7**	**3.67E+01**	**6.96E+01**	**ER_L**	**2.10E+01**	**3.31**
Nickel	**3.04**	**7**	**7**	**3.67E+01**	**6.96E+01**	**ER_M**	**5.16E+01**	**1.35**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Nickel	**4.01**	**10**	**10**	**1.33E+01**	**2.58E+01**	**REG_IV**	**2.09E+01**	**1.23**
Nickel	**4.01**	**10**	**10**	**1.33E+01**	**2.58E+01**	**ER_L**	**2.10E+01**	**1.23**
Nickel	4.01	10	10	1.33E+01	2.58E+01	ER_M	5.16E+01	0.50
Nickel	**4.02**	**6**	**6**	**1.27E+01**	**2.11E+01**	**REG_IV**	**2.09E+01**	**1.01**
Nickel	**4.02**	**6**	**6**	**1.27E+01**	**2.11E+01**	**ER_L**	**2.10E+01**	**1.00**
Nickel	4.02	6	6	1.27E+01	2.11E+01	ER_M	5.16E+01	0.41
Nickel	**4.03**	**7**	**7**	**2.82E+01**	**4.39E+01**	**REG_IV**	**2.09E+01**	**2.10**
Nickel	**4.03**	**7**	**7**	**2.82E+01**	**4.39E+01**	**ER_L**	**2.10E+01**	**2.09**
Nickel	4.03	7	7	2.82E+01	4.39E+01	ER_M	5.16E+01	0.85
Nickel	**4.04**	**12**	**12**	**2.55E+01**	**4.22E+01**	**REG_IV**	**2.09E+01**	**2.02**
Nickel	**4.04**	**12**	**12**	**2.55E+01**	**4.22E+01**	**ER_L**	**2.10E+01**	**2.01**
Nickel	4.04	12	12	2.55E+01	4.22E+01	ER_M	5.16E+01	0.82
Nickel	**5**	**4**	**4**	**2.29E+01**	**3.19E+01**	**REG_IV**	**2.09E+01**	**1.52**
Nickel	**5**	**4**	**4**	**2.29E+01**	**3.19E+01**	**ER_L**	**2.10E+01**	**1.52**
Nickel	5	4	4	2.29E+01	3.19E+01	ER_M	5.16E+01	0.62
Nickel	**7.01**	**1**	**1**	**2.67E+01**	**2.67E+01**	**REG_IV**	**2.09E+01**	**1.28**
Nickel	**7.01**	**1**	**1**	**2.67E+01**	**2.67E+01**	**ER_L**	**2.10E+01**	**1.27**
Nickel	7.01	1	1	2.67E+01	2.67E+01	ER_M	5.16E+01	0.52
Nickel	**7.02**	**9**	**9**	**2.54E+01**	**4.10E+01**	**REG_IV**	**2.09E+01**	**1.96**
Nickel	**7.02**	**9**	**9**	**2.54E+01**	**4.10E+01**	**ER_L**	**2.10E+01**	**1.95**
Nickel	7.02	9	9	2.54E+01	4.10E+01	ER_M	5.16E+01	0.80
Nickel	**8**	**1**	**1**	**2.44E+01**	**2.44E+01**	**REG_IV**	**2.09E+01**	**1.17**
Nickel	**8**	**1**	**1**	**2.44E+01**	**2.44E+01**	**ER_L**	**2.10E+01**	**1.16**
Nickel	8	1	1	2.44E+01	2.44E+01	ER_M	5.16E+01	0.47
Nickel	**10**	**1**	**1**	**2.30E+01**	**2.30E+01**	**REG_IV**	**2.09E+01**	**1.10**
Nickel	**10**	**1**	**1**	**2.30E+01**	**2.30E+01**	**ER_L**	**2.10E+01**	**1.09**
Nickel	10	1	1	2.30E+01	2.30E+01	ER_M	5.16E+01	0.44

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Nickel	**13**	**5**	**5**	**1.91E+01**	**2.92E+01**	**REG_IV**	**2.09E+01**	**1.40**
Nickel	**13**	**5**	**5**	**1.91E+01**	**2.92E+01**	**ER_L**	**2.10E+01**	**1.39**
Nickel	13	5	5	1.91E+01	2.92E+01	ER_M	5.16E+01	0.57
Nickel	18	3	3	1.26E+01	1.40E+01	REG_IV	2.09E+01	0.67
Nickel	18	3	3	1.26E+01	1.40E+01	ER_L	2.10E+01	0.67
Nickel	18	3	3	1.26E+01	1.40E+01	ER_M	5.16E+01	0.27
Nickel	**22**	**1**	**1**	**2.38E+01**	**2.38E+01**	**REG_IV**	**2.09E+01**	**1.14**
Nickel	**22**	**1**	**1**	**2.38E+01**	**2.38E+01**	**ER_L**	**2.10E+01**	**1.13**
Nickel	22	1	1	2.38E+01	2.38E+01	ER_M	5.16E+01	0.46
Silver	0	4	5	5.18E-02	7.41E-01	ER_L	1.00E+00	0.74
Silver	0	4	5	5.18E-02	7.41E-01	REG_IV	2.00E+00	0.37
Silver	0	4	5	5.18E-02	7.41E-01	ER_M	3.70E+00	0.20
Silver	1	2	2	2.78E-01	3.29E-01	ER_L	1.00E+00	0.33
Silver	1	2	2	2.78E-01	3.29E-01	REG_IV	2.00E+00	0.16
Silver	1	2	2	2.78E-01	3.29E-01	ER_M	3.70E+00	0.09
Silver	2.01	1	1	3.00E-02	3.00E-02	ER_L	1.00E+00	0.03
Silver	2.01	1	1	3.00E-02	3.00E-02	REG_IV	2.00E+00	0.02
Silver	2.01	1	1	3.00E-02	3.00E-02	ER_M	3.70E+00	0.01
Silver	2.03	1	1	5.35E-02	5.35E-02	ER_L	1.00E+00	0.05
Silver	2.03	1	1	5.35E-02	5.35E-02	REG_IV	2.00E+00	0.03
Silver	2.03	1	1	5.35E-02	5.35E-02	ER_M	3.70E+00	0.01
Silver	2.04	7	8	6.64E-02	5.97E-01	ER_L	1.00E+00	0.60
Silver	2.04	7	8	6.64E-02	5.97E-01	REG_IV	2.00E+00	0.30
Silver	2.04	7	8	6.64E-02	5.97E-01	ER_M	3.70E+00	0.16
Silver	3.01	2	2	2.70E-01	5.00E-01	ER_L	1.00E+00	0.50
Silver	3.01	2	2	2.70E-01	5.00E-01	REG_IV	2.00E+00	0.25
Silver	3.01	2	2	2.70E-01	5.00E-01	ER_M	3.70E+00	0.14

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Silver	**3.02**	**9**	**9**	**4.30E-01**	**5.60E+00**	**ER_L**	**1.00E+00**	**5.60**
Silver	**3.02**	**9**	**9**	**4.30E-01**	**5.60E+00**	**REG_IV**	**2.00E+00**	**2.80**
Silver	**3.02**	**9**	**9**	**4.30E-01**	**5.60E+00**	**ER_M**	**3.70E+00**	**1.51**
Silver	**3.03**	**9**	**9**	**5.80E-01**	**4.90E+00**	**ER_L**	**1.00E+00**	**4.90**
Silver	**3.03**	**9**	**9**	**5.80E-01**	**4.90E+00**	**REG_IV**	**2.00E+00**	**2.45**
Silver	**3.03**	**9**	**9**	**5.80E-01**	**4.90E+00**	**ER_M**	**3.70E+00**	**1.32**
Silver	**3.04**	**6**	**6**	**9.50E-01**	**1.55E+00**	**ER_L**	**1.00E+00**	**1.55**
Silver	3.04	6	6	9.50E-01	1.55E+00	REG_IV	2.00E+00	0.78
Silver	3.04	6	6	9.50E-01	1.55E+00	ER_M	3.70E+00	0.42
Silver	4.01	9	9	9.00E-02	3.10E-01	ER_L	1.00E+00	0.31
Silver	4.01	9	9	9.00E-02	3.10E-01	REG_IV	2.00E+00	0.16
Silver	4.01	9	9	9.00E-02	3.10E-01	ER_M	3.70E+00	0.08
Silver	4.02	6	6	5.30E-02	1.80E-01	ER_L	1.00E+00	0.18
Silver	4.02	6	6	5.30E-02	1.80E-01	REG_IV	2.00E+00	0.09
Silver	4.02	6	6	5.30E-02	1.80E-01	ER_M	3.70E+00	0.05
Silver	4.03	7	7	2.10E-01	3.58E-01	ER_L	1.00E+00	0.36
Silver	4.03	7	7	2.10E-01	3.58E-01	REG_IV	2.00E+00	0.18
Silver	4.03	7	7	2.10E-01	3.58E-01	ER_M	3.70E+00	0.10
Silver	**4.04**	**11**	**11**	**2.30E-01**	**2.70E+00**	**ER_L**	**1.00E+00**	**2.70**
Silver	**4.04**	**11**	**11**	**2.30E-01**	**2.70E+00**	**REG_IV**	**2.00E+00**	**1.35**
Silver	4.04	11	11	2.30E-01	2.70E+00	ER_M	3.70E+00	0.73
Silver	5	4	4	2.81E-01	9.11E-01	ER_L	1.00E+00	0.91
Silver	5	4	4	2.81E-01	9.11E-01	REG_IV	2.00E+00	0.46
Silver	5	4	4	2.81E-01	9.11E-01	ER_M	3.70E+00	0.25
Silver	7.02	6	9	7.65E-02	2.61E-01	ER_L	1.00E+00	0.26
Silver	7.02	6	9	7.65E-02	2.61E-01	REG_IV	2.00E+00	0.13
Silver	7.02	6	9	7.65E-02	2.61E-01	ER_M	3.70E+00	0.07

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Silver	8	1	1	8.00E-02	8.00E-02	ER_L	1.00E+00	0.08
Silver	8	1	1	8.00E-02	8.00E-02	REG_IV	2.00E+00	0.04
Silver	8	1	1	8.00E-02	8.00E-02	ER_M	3.70E+00	0.02
Silver	13	4	5	5.00E-02	1.60E-01	ER_L	1.00E+00	0.16
Silver	13	4	5	5.00E-02	1.60E-01	REG_IV	2.00E+00	0.08
Silver	13	4	5	5.00E-02	1.60E-01	ER_M	3.70E+00	0.04
Silver	18	3	3	1.41E-01	1.88E-01	ER_L	1.00E+00	0.19
Silver	18	3	3	1.41E-01	1.88E-01	REG_IV	2.00E+00	0.09
Silver	18	3	3	1.41E-01	1.88E-01	ER_M	3.70E+00	0.05
Silver	**22**	**1**	**1**	**1.67E+01**	**1.67E+01**	**ER_L**	**1.00E+00**	**16.72**
Silver	**22**	**1**	**1**	**1.67E+01**	**1.67E+01**	**REG_IV**	**2.00E+00**	**8.36**
Silver	**22**	**1**	**1**	**1.67E+01**	**1.67E+01**	**ER_M**	**3.70E+00**	**4.52**
Zinc	**0**	**5**	**5**	**6.41E+01**	**8.89E+01**	**REG_IV**	**6.80E+01**	**1.31**
Zinc	0	5	5	6.41E+01	8.89E+01	ER_L	1.50E+02	0.59
Zinc	0	5	5	6.41E+01	8.89E+01	ER_M	4.10E+02	0.22
Zinc	**1**	**2**	**2**	**8.42E+01**	**1.08E+02**	**REG_IV**	**6.80E+01**	**1.58**
Zinc	1	2	2	8.42E+01	1.08E+02	ER_L	1.50E+02	0.72
Zinc	1	2	2	8.42E+01	1.08E+02	ER_M	4.10E+02	0.26
Zinc	2.01	1	1	2.99E+01	2.99E+01	REG_IV	6.80E+01	0.44
Zinc	2.01	1	1	2.99E+01	2.99E+01	ER_L	1.50E+02	0.20
Zinc	2.01	1	1	2.99E+01	2.99E+01	ER_M	4.10E+02	0.07
Zinc	2.02	1	1	4.02E+01	4.02E+01	REG_IV	6.80E+01	0.59
Zinc	2.02	1	1	4.02E+01	4.02E+01	ER_L	1.50E+02	0.27
Zinc	2.02	1	1	4.02E+01	4.02E+01	ER_M	4.10E+02	0.10
Zinc	2.03	1	1	5.28E+01	5.28E+01	REG_IV	6.80E+01	0.78
Zinc	2.03	1	1	5.28E+01	5.28E+01	ER_L	1.50E+02	0.35
Zinc	2.03	1	1	5.28E+01	5.28E+01	ER_M	4.10E+02	0.13

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Zinc	**2.04**	**8**	**8**	**5.95E+01**	**8.24E+01**	**REG_IV**	**6.80E+01**	**1.21**
Zinc	2.04	8	8	5.95E+01	8.24E+01	ER_L	1.50E+02	0.55
Zinc	2.04	8	8	5.95E+01	8.24E+01	ER_M	4.10E+02	0.20
Zinc	**3.01**	**2**	**2**	**5.54E+01**	**7.70E+01**	**REG_IV**	**6.80E+01**	**1.13**
Zinc	3.01	2	2	5.54E+01	7.70E+01	ER_L	1.50E+02	0.51
Zinc	3.01	2	2	5.54E+01	7.70E+01	ER_M	4.10E+02	0.19
Zinc	**3.02**	**9**	**9**	**8.11E+01**	**2.43E+02**	**REG_IV**	**6.80E+01**	**3.57**
Zinc	**3.02**	**9**	**9**	**8.11E+01**	**2.43E+02**	**ER_L**	**1.50E+02**	**1.62**
Zinc	3.02	9	9	8.11E+01	2.43E+02	ER_M	4.10E+02	0.59
Zinc	**3.03**	**9**	**9**	**8.26E+01**	**1.49E+02**	**REG_IV**	**6.80E+01**	**2.19**
Zinc	3.03	9	9	8.26E+01	1.49E+02	ER_L	1.50E+02	0.99
Zinc	3.03	9	9	8.26E+01	1.49E+02	ER_M	4.10E+02	0.36
Zinc	**3.04**	**7**	**7**	**8.53E+01**	**1.13E+02**	**REG_IV**	**6.80E+01**	**1.66**
Zinc	3.04	7	7	8.53E+01	1.13E+02	ER_L	1.50E+02	0.75
Zinc	3.04	7	7	8.53E+01	1.13E+02	ER_M	4.10E+02	0.28
Zinc	4.01	10	10	4.47E+01	6.65E+01	REG_IV	6.80E+01	0.98
Zinc	4.01	10	10	4.47E+01	6.65E+01	ER_L	1.50E+02	0.44
Zinc	4.01	10	10	4.47E+01	6.65E+01	ER_M	4.10E+02	0.16
Zinc	**4.02**	**6**	**6**	**4.77E+01**	**7.99E+01**	**REG_IV**	**6.80E+01**	**1.18**
Zinc	4.02	6	6	4.77E+01	7.99E+01	ER_L	1.50E+02	0.53
Zinc	4.02	6	6	4.77E+01	7.99E+01	ER_M	4.10E+02	0.19
Zinc	**4.03**	**7**	**7**	**7.69E+01**	**1.09E+02**	**REG_IV**	**6.80E+01**	**1.60**
Zinc	4.03	7	7	7.69E+01	1.09E+02	ER_L	1.50E+02	0.73
Zinc	4.03	7	7	7.69E+01	1.09E+02	ER_M	4.10E+02	0.27
Zinc	**4.04**	**12**	**12**	**1.18E+02**	**1.72E+02**	**REG_IV**	**6.80E+01**	**2.53**
Zinc	**4.04**	**12**	**12**	**1.18E+02**	**1.72E+02**	**ER_L**	**1.50E+02**	**1.15**
Zinc	4.04	12	12	1.18E+02	1.72E+02	ER_M	4.10E+02	0.42

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Zinc	**5**	**4**	**4**	**2.13E+02**	**2.67E+02**	**REG_IV**	**6.80E+01**	**3.92**
Zinc	**5**	**4**	**4**	**2.13E+02**	**2.67E+02**	**ER_L**	**1.50E+02**	**1.78**
Zinc	5	4	4	2.13E+02	2.67E+02	ER_M	4.10E+02	0.65
Zinc	**7.01**	**1**	**1**	**9.75E+01**	**9.75E+01**	**REG_IV**	**6.80E+01**	**1.43**
Zinc	7.01	1	1	9.75E+01	9.75E+01	ER_L	1.50E+02	0.65
Zinc	7.01	1	1	9.75E+01	9.75E+01	ER_M	4.10E+02	0.24
Zinc	**7.02**	**9**	**9**	**7.24E+01**	**1.09E+02**	**REG_IV**	**6.80E+01**	**1.60**
Zinc	7.02	9	9	7.24E+01	1.09E+02	ER_L	1.50E+02	0.73
Zinc	7.02	9	9	7.24E+01	1.09E+02	ER_M	4.10E+02	0.27
Zinc	**8**	**1**	**1**	**9.17E+01**	**9.17E+01**	**REG_IV**	**6.80E+01**	**1.35**
Zinc	8	1	1	9.17E+01	9.17E+01	ER_L	1.50E+02	0.61
Zinc	8	1	1	9.17E+01	9.17E+01	ER_M	4.10E+02	0.22
Zinc	**10**	**1**	**1**	**9.88E+01**	**9.88E+01**	**REG_IV**	**6.80E+01**	**1.45**
Zinc	10	1	1	9.88E+01	9.88E+01	ER_L	1.50E+02	0.66
Zinc	10	1	1	9.88E+01	9.88E+01	ER_M	4.10E+02	0.24
Zinc	**13**	**5**	**5**	**5.72E+01**	**9.21E+01**	**REG_IV**	**6.80E+01**	**1.35**
Zinc	13	5	5	5.72E+01	9.21E+01	ER_L	1.50E+02	0.61
Zinc	13	5	5	5.72E+01	9.21E+01	ER_M	4.10E+02	0.22
Zinc	**18**	**3**	**3**	**1.29E+02**	**1.32E+02**	**REG_IV**	**6.80E+01**	**1.94**
Zinc	18	3	3	1.29E+02	1.32E+02	ER_L	1.50E+02	0.88
Zinc	18	3	3	1.29E+02	1.32E+02	ER_M	4.10E+02	0.32
Zinc	**22**	**1**	**1**	**1.13E+02**	**1.13E+02**	**REG_IV**	**6.80E+01**	**1.66**
Zinc	22	1	1	1.13E+02	1.13E+02	ER_L	1.50E+02	0.75
Zinc	22	1	1	1.13E+02	1.13E+02	ER_M	4.10E+02	0.28
2-Methylnaphthalene	**0**	**5**	**5**	**5.40E-02**	**6.70E-01**	**ER_L**	**7.00E-02**	**9.57**
2-Methylnaphthalene	**0**	**5**	**5**	**5.40E-02**	**6.70E-01**	**REG_IV**	**3.30E-01**	**2.03**
2-Methylnaphthalene	**0**	**5**	**5**	**5.40E-02**	**6.70E-01**	**ER_M**	**6.70E-01**	**1.00**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
2-Methylnaphthalene	**2.04**	**5**	**8**	**4.00E-02**	**6.50E-01**	**ER_L**	**7.00E-02**	**9.29**
2-Methylnaphthalene	**2.04**	**5**	**8**	**4.00E-02**	**6.50E-01**	**REG_IV**	**3.30E-01**	**1.97**
2-Methylnaphthalene	2.04	5	8	4.00E-02	6.50E-01	ER_M	6.70E-01	0.97
2-Methylnaphthalene	3.01	1	2	1.80E-02	1.80E-02	ER_L	7.00E-02	0.26
2-Methylnaphthalene	3.01	1	2	1.80E-02	1.80E-02	REG_IV	3.30E-01	0.05
2-Methylnaphthalene	3.01	1	2	1.80E-02	1.80E-02	ER_M	6.70E-01	0.03
2-Methylnaphthalene	**3.02**	**8**	**9**	**1.45E-01**	**3.40E-01**	**ER_L**	**7.00E-02**	**4.86**
2-Methylnaphthalene	**3.02**	**8**	**9**	**1.45E-01**	**3.40E-01**	**REG_IV**	**3.30E-01**	**1.03**
2-Methylnaphthalene	3.02	8	9	1.45E-01	3.40E-01	ER_M	6.70E-01	0.51
2-Methylnaphthalene	**3.03**	**9**	**9**	**1.20E-01**	**5.10E-01**	**ER_L**	**7.00E-02**	**7.29**
2-Methylnaphthalene	**3.03**	**9**	**9**	**1.20E-01**	**5.10E-01**	**REG_IV**	**3.30E-01**	**1.55**
2-Methylnaphthalene	3.03	9	9	1.20E-01	5.10E-01	ER_M	6.70E-01	0.76
2-Methylnaphthalene	**3.04**	**7**	**7**	**1.20E-01**	**2.75E-01**	**ER_L**	**7.00E-02**	**3.93**
2-Methylnaphthalene	3.04	7	7	1.20E-01	2.75E-01	REG_IV	3.30E-01	0.83
2-Methylnaphthalene	3.04	7	7	1.20E-01	2.75E-01	ER_M	6.70E-01	0.41
2-Methylnaphthalene	**4.01**	**7**	**10**	**5.50E-02**	**7.20E-02**	**ER_L**	**7.00E-02**	**1.03**
2-Methylnaphthalene	4.01	7	10	5.50E-02	7.20E-02	REG_IV	3.30E-01	0.22
2-Methylnaphthalene	4.01	7	10	5.50E-02	7.20E-02	ER_M	6.70E-01	0.11
2-Methylnaphthalene	**4.02**	**4**	**5**	**5.80E-02**	**2.50E-01**	**ER_L**	**7.00E-02**	**3.57**
2-Methylnaphthalene	4.02	4	5	5.80E-02	2.50E-01	REG_IV	3.30E-01	0.76
2-Methylnaphthalene	4.02	4	5	5.80E-02	2.50E-01	ER_M	6.70E-01	0.37
2-Methylnaphthalene	**4.03**	**7**	**7**	**1.10E-01**	**2.40E-01**	**ER_L**	**7.00E-02**	**3.43**
2-Methylnaphthalene	4.03	7	7	1.10E-01	2.40E-01	REG_IV	3.30E-01	0.73
2-Methylnaphthalene	4.03	7	7	1.10E-01	2.40E-01	ER_M	6.70E-01	0.36
2-Methylnaphthalene	**4.04**	**10**	**12**	**1.30E-01**	**1.60E-01**	**ER_L**	**7.00E-02**	**2.29**
2-Methylnaphthalene	4.04	10	12	1.30E-01	1.60E-01	REG_IV	3.30E-01	0.48
2-Methylnaphthalene	4.04	10	12	1.30E-01	1.60E-01	ER_M	6.70E-01	0.24

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
2-Methylnaphthalene	**7.02**	**1**	**1**	**1.10E-01**	**1.10E-01**	**ER_L**	**7.00E-02**	**1.57**
2-Methylnaphthalene	7.02	1	1	1.10E-01	1.10E-01	REG_IV	3.30E-01	0.33
2-Methylnaphthalene	7.02	1	1	1.10E-01	1.10E-01	ER_M	6.70E-01	0.16
2-Methylnaphthalene	8	1	1	4.00E-02	4.00E-02	ER_L	7.00E-02	0.57
2-Methylnaphthalene	8	1	1	4.00E-02	4.00E-02	REG_IV	3.30E-01	0.12
2-Methylnaphthalene	8	1	1	4.00E-02	4.00E-02	ER_M	6.70E-01	0.06
2-Methylnaphthalene	**13**	**5**	**5**	**2.50E-01**	**1.10E+01**	**ER_L**	**7.00E-02**	**157.14**
2-Methylnaphthalene	**13**	**5**	**5**	**2.50E-01**	**1.10E+01**	**REG_IV**	**3.30E-01**	**33.33**
2-Methylnaphthalene	**13**	**5**	**5**	**2.50E-01**	**1.10E+01**	**ER_M**	**6.70E-01**	**16.42**
4,4'-DDD	**1**	**1**	**2**	**2.84E-01**	**2.84E-01**	**EQ_PART**	**1.10E-01**	**2.58**
4,4'-DDD	**1**	**1**	**2**	**2.84E-01**	**2.84E-01**	**ER_L**	**2.00E-03**	**141.84**
4,4'-DDD	**1**	**1**	**2**	**2.84E-01**	**2.84E-01**	**ER_M**	**2.00E-02**	**14.18**
4,4'-DDT	1	1	2	2.84E-01	2.84E-01	EQ_PART	1.30E-00	0.22
4,4'-DDT	**1**	**1**	**2**	**2.84E-01**	**2.84E-01**	**ER_L**	**1.60E-03**	**177.30**
4,4'-DDT	**1**	**1**	**2**	**2.84E-01**	**2.84E-01**	**REG_IV**	**3.30E-03**	**85.96**
4,4'-DDT	**1**	**1**	**2**	**2.84E-01**	**2.84E-01**	**ER_M**	**4.61E-02**	**6.15**
Acenaphthene	**0**	**1**	**5**	**2.00E-02**	**2.00E-02**	**ER_L**	**1.60E-02**	**1.25**
Acenaphthene	0	1	5	2.00E-02	2.00E-02	REG_IV	3.30E-01	0.06
Acenaphthene	0	1	5	2.00E-02	2.00E-02	ER_M	5.00E-01	0.04
Acenaphthene	0	1	5	2.00E-02	2.00E-02	EPASQC	1.86E+00	0.01
Acenaphthene	**3.02**	**5**	**9**	**4.90E-02**	**7.60E-02**	**ER_L**	**1.60E-02**	**4.75**
Acenaphthene	3.02	5	9	4.90E-02	7.60E-02	REG_IV	3.30E-01	0.23
Acenaphthene	3.02	5	9	4.90E-02	7.60E-02	ER_M	5.00E-01	0.15
Acenaphthene	3.02	5	9	4.90E-02	7.60E-02	EPASQC	8.14E+00	0.01
Acenaphthene	**3.03**	**7**	**9**	**2.70E-02**	**1.39E-01**	**ER_L**	**1.60E-02**	**8.66**
Acenaphthene	3.03	7	9	2.70E-02	1.39E-01	REG_IV	3.30E-01	0.42
Acenaphthene	3.03	7	9	2.70E-02	1.39E-01	ER_M	5.00E-01	0.28

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Acenaphthene	3.03	7	9	2.70E-02	1.39E-01	EPASQC	2.39E+00	0.06
Acenaphthene	**3.04**	**2**	**7**	**8.43E-02**	**1.52E-01**	**ER_L**	**1.60E-02**	**9.47**
Acenaphthene	3.04	2	7	8.43E-02	1.52E-01	REG_IV	3.30E-01	0.46
Acenaphthene	3.04	2	7	8.43E-02	1.52E-01	ER_M	5.00E-01	0.30
Acenaphthene	3.04	2	7	8.43E-02	1.52E-01	EPASQC	1.18E+00	0.13
Acenaphthene	**4.01**	**1**	**10**	**1.14E-01**	**1.14E-01**	**ER_L**	**1.60E-02**	**7.10**
Acenaphthene	4.01	1	10	1.14E-01	1.14E-01	REG_IV	3.30E-01	0.34
Acenaphthene	4.01	1	10	1.14E-01	1.14E-01	ER_M	5.00E-01	0.23
Acenaphthene	4.01	1	10	1.14E-01	1.14E-01	EPASQC	1.09E+00	0.10
Acenaphthene	**13**	**1**	**5**	**1.90E-01**	**1.90E-01**	**ER_L**	**1.60E-02**	**11.88**
Acenaphthene	13	1	5	1.90E-01	1.90E-01	REG_IV	3.30E-01	0.58
Acenaphthene	13	1	5	1.90E-01	1.90E-01	ER_M	5.00E-01	0.38
Acenaphthene	13	1	5	1.90E-01	1.90E-01	EPASQC	4.13E+00	0.05
Anthracene	**3.02**	**5**	**9**	**5.60E-02**	**1.00E-01**	**EQ_PART**	**1.88E-03**	**53.21**
Anthracene	**3.02**	**5**	**9**	**5.60E-02**	**1.00E-01**	**ER_L**	**8.50E-02**	**1.18**
Anthracene	3.02	5	9	5.60E-02	1.00E-01	REG_IV	3.30E-01	0.30
Anthracene	3.02	5	9	5.60E-02	1.00E-01	ER_M	1.10E+00	0.09
Anthracene	**3.03**	**7**	**9**	**4.00E-02**	**2.10E-01**	**EQ_PART**	**5.51E-04**	**381.47**
Anthracene	**3.03**	**7**	**9**	**4.00E-02**	**2.10E-01**	**ER_L**	**8.50E-02**	**2.47**
Anthracene	3.03	7	9	4.00E-02	2.10E-01	REG_IV	3.30E-01	0.64
Anthracene	3.03	7	9	4.00E-02	2.10E-01	ER_M	1.10E+00	0.19
Anthracene	**3.04**	**3**	**7**	**1.24E-01**	**1.51E-01**	**EQ_PART**	**2.73E-04**	**551.13**
Anthracene	**3.04**	**3**	**7**	**1.24E-01**	**1.51E-01**	**ER_L**	**8.50E-02**	**1.77**
Anthracene	3.04	3	7	1.24E-01	1.51E-01	REG_IV	3.30E-01	0.46
Anthracene	3.04	3	7	1.24E-01	1.51E-01	ER_M	1.10E+00	0.14
Anthracene	**4.01**	**1**	**10**	**1.13E-01**	**1.13E-01**	**EQ_PART**	**2.51E-04**	**450.76**
Anthracene	**4.01**	**1**	**10**	**1.13E-01**	**1.13E-01**	**ER_L**	**8.50E-02**	**1.33**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Anthracene	4.01	1	10	1.13E-01	1.13E-01	REG_IV	3.30E-01	0.34
Anthracene	4.01	1	10	1.13E-01	1.13E-01	ER_M	1.10E+00	0.10
Anthracene	**4.02**	**1**	**5**	**2.00E-02**	**2.00E-02**	**EQ_PART**	**3.38E-04**	**59.15**
Anthracene	4.02	1	5	2.00E-02	2.00E-02	ER_L	8.50E-02	0.24
Anthracene	4.02	1	5	2.00E-02	2.00E-02	REG_IV	3.30E-01	0.06
Anthracene	4.02	1	5	2.00E-02	2.00E-02	ER_M	1.10E+00	0.02
Anthracene	**13**	**1**	**5**	**1.80E-02**	**1.80E-02**	**EQ_PART**	**9.53E-04**	**18.89**
Anthracene	13	1	5	1.80E-02	1.80E-02	ER_L	8.50E-02	0.21
Anthracene	13	1	5	1.80E-02	1.80E-02	REG_IV	3.30E-01	0.05
Anthracene	13	1	5	1.80E-02	1.80E-02	ER_M	1.10E+00	0.02
Benzo(a)anthracene	0	2	5	9.10E-02	1.10E-01	EQ_PART	1.54E-01	0.71
Benzo(a)anthracene	0	2	5	9.10E-02	1.10E-01	ER_L	2.60E-01	0.42
Benzo(a)anthracene	0	2	5	9.10E-02	1.10E-01	REG_IV	3.30E-01	0.33
Benzo(a)anthracene	0	2	5	9.10E-02	1.10E-01	ER_M	1.60E+00	0.07
Benzo(a)anthracene	2.04	2	8	8.85E-02	1.10E-01	EQ_PART	1.64E-01	0.65
Benzo(a)anthracene	2.04	2	8	8.85E-02	1.07E-01	ER_L	2.60E-01	0.41
Benzo(a)anthracene	2.04	2	8	8.85E-02	1.07E-01	REG_IV	3.30E-01	0.32
Benzo(a)anthracene	2.04	2	8	8.85E-02	1.07E-01	ER_M	1.60E+00	0.07
Benzo(a)anthracene	**3.01**	**1**	**2**	**1.00E-01**	**1.00E-01**	**EQ_PART**	**9.64E-02**	**1.04**
Benzo(a)anthracene	3.01	1	2	1.00E-01	1.00E-01	ER_L	2.60E-01	0.38
Benzo(a)anthracene	3.01	1	2	1.00E-01	1.00E-01	REG_IV	3.30E-01	0.30
Benzo(a)anthracene	3.01	1	2	1.00E-01	1.00E-01	ER_M	1.60E+00	0.06
Benzo(a)anthracene	3.02	7	9	1.80E-01	5.00E-01	EQ_PART	6.77E-01	0.74
Benzo(a)anthracene	**3.02**	**7**	**9**	**1.80E-01**	**5.00E-01**	**ER_L**	**2.60E-01**	**1.92**
Benzo(a)anthracene	**3.02**	**7**	**9**	**1.80E-01**	**5.00E-01**	**REG_IV**	**3.30E-01**	**1.52**
Benzo(a)anthracene	3.02	7	9	1.80E-01	5.00E-01	ER_M	1.60E+00	0.31
Benzo(a)anthracene	**3.03**	**9**	**9**	**1.70E-01**	**8.70E-01**	**EQ_PART**	**1.98E-01**	**4.39**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Benzo(a)anthracene	**3.03**	**9**	**9**	**1.70E-01**	**8.70E-01**	**ER_L**	**2.60E-01**	**3.35**
Benzo(a)anthracene	**3.03**	**9**	**9**	**1.70E-01**	**8.70E-01**	**REG_IV**	**3.30E-01**	**2.64**
Benzo(a)anthracene	3.03	9	9	1.70E-01	8.70E-01	ER_M	1.60E+00	0.54
Benzo(a)anthracene	**3.04**	**5**	**7**	**1.30E-01**	**1.80E-01**	**EQ_PART**	**9.83E-02**	**1.83**
Benzo(a)anthracene	3.04	5	7	1.30E-01	1.80E-01	ER_L	2.60E-01	0.69
Benzo(a)anthracene	3.04	5	7	1.30E-01	1.80E-01	REG_IV	3.30E-01	0.55
Benzo(a)anthracene	3.04	5	7	1.30E-01	1.80E-01	ER_M	1.60E+00	0.11
Benzo(a)anthracene	**4.01**	**5**	**10**	**4.90E-02**	**9.70E-02**	**EQ_PART**	**9.02E-02**	**1.07**
Benzo(a)anthracene	4.01	5	10	4.90E-02	9.70E-02	ER_L	2.60E-01	0.37
Benzo(a)anthracene	4.01	5	10	4.90E-02	9.70E-02	REG_IV	3.30E-01	0.29
Benzo(a)anthracene	4.01	5	10	4.90E-02	9.70E-02	ER_M	1.60E+00	0.06
Benzo(a)anthracene	**4.02**	**4**	**5**	**7.75E-02**	**1.40E-01**	**EQ_PART**	**1.22E-01**	**1.15**
Benzo(a)anthracene	4.02	4	5	7.75E-02	1.40E-01	ER_L	2.60E-01	0.54
Benzo(a)anthracene	4.02	4	5	7.75E-02	1.40E-01	REG_IV	3.30E-01	0.42
Benzo(a)anthracene	4.02	4	5	7.75E-02	1.40E-01	ER_M	1.60E+00	0.09
Benzo(a)anthracene	4.03	7	7	5.70E-02	9.30E-02	EQ_PART	1.72E-01	0.54
Benzo(a)anthracene	4.03	7	7	5.70E-02	9.30E-02	ER_L	2.60E-01	0.36
Benzo(a)anthracene	4.03	7	7	5.70E-02	9.30E-02	REG_IV	3.30E-01	0.28
Benzo(a)anthracene	4.03	7	7	5.70E-02	9.30E-02	ER_M	1.60E+00	0.06
Benzo(a)anthracene	4.04	10	12	8.75E-02	2.00E-01	EQ_PART	2.66E-01	0.75
Benzo(a)anthracene	4.04	10	12	8.75E-02	2.00E-01	ER_L	2.60E-01	0.77
Benzo(a)anthracene	4.04	10	12	8.75E-02	2.00E-01	REG_IV	3.30E-01	0.61
Benzo(a)anthracene	4.04	10	12	8.75E-02	2.00E-01	ER_M	1.60E+00	0.13
Benzo(a)anthracene	7.01	1	1	3.30E-02	3.30E-02	EQ_PART	1.89E-01	0.17
Benzo(a)anthracene	7.01	1	1	3.30E-02	3.30E-02	ER_L	2.60E-01	0.13
Benzo(a)anthracene	7.01	1	1	3.30E-02	3.30E-02	REG_IV	3.30E-01	0.10
Benzo(a)anthracene	7.01	1	1	3.30E-02	3.30E-02	ER_M	1.60E+00	0.02

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Benzo(a)anthracene	7.02	1	1	2.90E-02	2.90E-02	EQ_PART	1.89E-01	0.15
Benzo(a)anthracene	7.02	1	1	2.90E-02	2.90E-02	ER_L	2.60E-01	0.11
Benzo(a)anthracene	7.02	1	1	2.90E-02	2.90E-02	REG_IV	3.30E-01	0.09
Benzo(a)anthracene	7.02	1	1	2.90E-02	2.90E-02	ER_M	1.60E+00	0.02
Benzo(a)anthracene	13	3	5	1.00E-01	1.70E-01	EQ_PART	3.43E-01	0.50
Benzo(a)anthracene	13	3	5	1.00E-01	1.70E-01	ER_L	2.60E-01	0.65
Benzo(a)anthracene	13	3	5	1.00E-01	1.70E-01	REG_IV	3.30E-01	0.52
Benzo(a)anthracene	13	3	5	1.00E-01	1.70E-01	ER_M	1.60E+00	0.11
Benzo(a)anthracene	**18**	**3**	**3**	**2.10E-01**	**6.75E-01**	**EQ_PART**	**1.78E-01**	**3.80**
Benzo(a)anthracene	**18**	**3**	**3**	**2.10E-01**	**6.75E-01**	**ER_L**	**2.60E-01**	**2.60**
Benzo(a)anthracene	**18**	**3**	**3**	**2.10E-01**	**6.75E-01**	**REG_IV**	**3.30E-01**	**2.05**
Benzo(a)anthracene	18	3	3	2.10E-01	6.75E-01	ER_M	1.60E+00	0.42
Benzo(a)pyrene	0	2	5	8.05E-02	8.80E-02	EQ_PART	2.00E-01	0.44
Benzo(a)pyrene	0	2	5	8.05E-02	8.80E-02	REG_IV	3.30E-01	0.27
Benzo(a)pyrene	0	2	5	8.05E-02	8.80E-02	ER_L	4.30E-01	0.20
Benzo(a)pyrene	0	2	5	8.05E-02	8.80E-02	ER_M	1.60E+00	0.06
Benzo(a)pyrene	**2.04**	**4**	**8**	**2.10E-02**	**3.70E-01**	**EQ_PART**	**2.13E-01**	**1.74**
Benzo(a)pyrene	**2.04**	**4**	**8**	**2.10E-02**	**3.70E-01**	**REG_IV**	**3.30E-01**	**1.12**
Benzo(a)pyrene	2.04	4	8	2.10E-02	3.70E-01	ER_L	4.30E-01	0.86
Benzo(a)pyrene	2.04	4	8	2.10E-02	3.70E-01	ER_M	1.60E+00	0.23
Benzo(a)pyrene	3.01	1	2	6.50E-02	6.50E-02	EQ_PART	1.25E-01	0.52
Benzo(a)pyrene	3.01	1	2	6.50E-02	6.50E-02	REG_IV	3.30E-01	0.20
Benzo(a)pyrene	3.01	1	2	6.50E-02	6.50E-02	ER_L	4.30E-01	0.15
Benzo(a)pyrene	3.01	1	2	6.50E-02	6.50E-02	ER_M	1.60E+00	0.04
Benzo(a)pyrene	3.02	8	9	1.70E-01	3.80E-01	EQ_PART	8.77E-01	0.43
Benzo(a)pyrene	**3.02**	**8**	**9**	**1.70E-01**	**3.80E-01**	**REG_IV**	**3.30E-01**	**1.15**
Benzo(a)pyrene	3.02	8	9	1.70E-01	3.80E-01	ER_L	4.30E-01	0.88

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Benzo(a)pyrene	3.02	8	9	1.70E-01	3.80E-01	ER_M	1.60E+00	0.24
Benzo(a)pyrene	**3.03**	**9**	**9**	**1.25E-01**	**6.70E-01**	**EQ_PART**	**2.57E-01**	**2.61**
Benzo(a)pyrene	**3.03**	**9**	**9**	**1.25E-01**	**6.70E-01**	**REG_IV**	**3.30E-01**	**2.03**
Benzo(a)pyrene	**3.03**	**9**	**9**	**1.25E-01**	**6.70E-01**	**ER_L**	**4.30E-01**	**1.56**
Benzo(a)pyrene	3.03	9	9	1.25E-01	6.70E-01	ER_M	1.60E+00	0.42
Benzo(a)pyrene	**3.04**	**6**	**7**	**1.00E-01**	**1.80E-01**	**EQ_PART**	**1.27E-01**	**1.41**
Benzo(a)pyrene	3.04	6	7	1.00E-01	1.80E-01	REG_IV	3.30E-01	0.55
Benzo(a)pyrene	3.04	6	7	1.00E-01	1.80E-01	ER_L	4.30E-01	0.42
Benzo(a)pyrene	3.04	6	7	1.00E-01	1.80E-01	ER_M	1.60E+00	0.11
Benzo(a)pyrene	4.01	6	10	3.45E-02	7.60E-01	EQ_PART	1.17E-01	0.65
Benzo(a)pyrene	4.01	6	10	3.45E-02	7.60E-02	REG_IV	3.30E-01	0.23
Benzo(a)pyrene	4.01	6	10	3.45E-02	7.60E-02	ER_L	4.30E-01	0.18
Benzo(a)pyrene	4.01	6	10	3.45E-02	7.60E-02	ER_M	1.60E+00	0.05
Benzo(a)pyrene	**4.02**	**4**	**5**	**3.00E-02**	**3.10E-01**	**EQ_PART**	**1.58E-01**	**1.96**
Benzo(a)pyrene	4.02	4	5	3.00E-02	3.10E-01	REG_IV	3.30E-01	0.94
Benzo(a)pyrene	4.02	4	5	3.00E-02	3.10E-01	ER_L	4.30E-01	0.72
Benzo(a)pyrene	4.02	4	5	3.00E-02	3.10E-01	ER_M	1.60E+00	0.19
Benzo(a)pyrene	**4.03**	**7**	**7**	**1.80E-01**	**1.10E-00**	**EQ_PART**	**2.23E-01**	**4.93**
Benzo(a)pyrene	**4.03**	**7**	**7**	**1.80E-01**	**1.10E+00**	**REG_IV**	**3.30E-01**	**3.33**
Benzo(a)pyrene	**4.03**	**7**	**7**	**1.80E-01**	**1.10E+00**	**ER_L**	**4.30E-01**	**2.56**
Benzo(a)pyrene	4.03	7	7	1.80E-01	1.10E+00	ER_M	1.60E+00	0.69
Benzo(a)pyrene	**4.04**	**8**	**12**	**5.85E-01**	**8.60E-01**	**EQ_PART**	**3.44E-01**	**2.50**
Benzo(a)pyrene	**4.04**	**8**	**12**	**5.85E-01**	**8.60E-01**	**REG_IV**	**3.30E-01**	**2.61**
Benzo(a)pyrene	**4.04**	**8**	**12**	**5.85E-01**	**8.60E-01**	**ER_L**	**4.30E-01**	**2.00**
Benzo(a)pyrene	4.04	8	12	5.85E-01	8.60E-01	ER_M	1.60E+00	0.54
Benzo(a)pyrene	**7.01**	**1**	**1**	**3.90E-01**	**3.90E-01**	**EQ_PART**	**2.45E-01**	**1.59**
Benzo(a)pyrene	**7.01**	**1**	**1**	**3.90E-01**	**3.90E-01**	**REG_IV**	**3.30E-01**	**1.18**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Benzo(a)pyrene	7.01	1	1	3.90E-01	3.90E-01	ER_L	4.30E-01	0.91
Benzo(a)pyrene	7.01	1	1	3.90E-01	3.90E-01	ER_M	1.60E+00	0.24
Benzo(a)pyrene	**7.02**	**1**	**1**	**6.40E-01**	**6.40E-01**	**EQ_PART**	**2.45E-01**	**2.62**
Benzo(a)pyrene	**7.02**	**1**	**1**	**6.40E-01**	**6.40E-01**	**REG_IV**	**3.30E-01**	**1.94**
Benzo(a)pyrene	**7.02**	**1**	**1**	**6.40E-01**	**6.40E-01**	**ER_L**	**4.30E-01**	**1.49**
Benzo(a)pyrene	7.02	1	1	6.40E-01	6.40E-01	ER_M	1.60E+00	0.40
Benzo(a)pyrene	**8**	**1**	**1**	**5.50E-01**	**5.50E-01**	**EQ_PART**	**2.45E-01**	**2.25**
Benzo(a)pyrene	**8**	**1**	**1**	**5.50E-01**	**5.50E-01**	**REG_IV**	**3.30E-01**	**1.67**
Benzo(a)pyrene	**8**	**1**	**1**	**5.50E-01**	**5.50E-01**	**ER_L**	**4.30E-01**	**1.28**
Benzo(a)pyrene	8	1	1	5.50E-01	5.50E-01	ER_M	1.60E+00	0.34
Benzo(a)pyrene	13	4	5	1.37E-01	3.30E-01	EQ_PART	4.45E-01	0.74
Benzo(a)pyrene	**13**	**4**	**5**	**1.37E-01**	**3.30E-01**	**REG_IV**	**3.30E-01**	**1.00**
Benzo(a)pyrene	13	4	5	1.37E-01	3.30E-01	ER_L	4.30E-01	0.77
Benzo(a)pyrene	13	4	5	1.37E-01	3.30E-01	ER_M	1.60E+00	0.21
Benzo(a)pyrene	18	3	3	1.50E-01	1.60E-01	EQ_PART	2.30E-01	0.69
Benzo(a)pyrene	18	3	3	1.50E-01	1.60E-01	REG_IV	3.30E-01	0.48
Benzo(a)pyrene	18	3	3	1.50E-01	1.60E-01	ER_L	4.30E-01	0.37
Benzo(a)pyrene	18	3	3	1.50E-01	1.60E-01	ER_M	1.60E+00	0.10
Chrysene	0	4	5	6.55E-02	1.30E-01	REG_IV	3.30E-01	0.39
Chrysene	0	4	5	6.55E-02	1.30E-01	ER_L	3.80E-01	0.34
Chrysene	0	4	5	6.55E-02	1.30E-01	ER_M	2.80E+00	0.05
Chrysene	2.04	6	8	5.05E-02	1.06E-01	REG_IV	3.30E-01	0.32
Chrysene	2.04	6	8	5.05E-02	1.06E-01	ER_L	3.80E-01	0.28
Chrysene	2.04	6	8	5.05E-02	1.06E-01	ER_M	2.80E+00	0.04
Chrysene	3.01	2	2	5.05E-02	8.80E-02	REG_IV	3.30E-01	0.27
Chrysene	3.01	2	2	5.05E-02	8.80E-02	ER_L	3.80E-01	0.23
Chrysene	3.01	2	2	5.05E-02	8.80E-02	ER_M	2.80E+00	0.03

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[a]	HQ max[b]
Chrysene	**3.02**	**7**	**9**	**1.70E-01**	**4.00E-01**	**REG_IV**	**3.30E-01**	**1.21**
Chrysene	**3.02**	**7**	**9**	**1.70E-01**	**4.00E-01**	**ER_L**	**3.80E-01**	**1.05**
Chrysene	3.02	7	9	1.70E-01	4.00E-01	ER_M	2.80E+00	0.14
Chrysene	**3.03**	**9**	**9**	**1.80E-01**	**7.30E-01**	**REG_IV**	**3.30E-01**	**2.21**
Chrysene	**3.03**	**9**	**9**	**1.80E-01**	**7.30E-01**	**ER_L**	**3.80E-01**	**1.92**
Chrysene	3.03	9	9	1.80E-01	7.30E-01	ER_M	2.80E+00	0.26
Chrysene	3.04	5	7	1.20E-01	1.85E-01	REG_IV	3.30E-01	0.56
Chrysene	3.04	5	7	1.20E-01	1.85E-01	ER_L	3.80E-01	0.49
Chrysene	3.04	5	7	1.20E-01	1.85E-01	ER_M	2.80E+00	0.07
Chrysene	4.01	6	10	4.70E-02	8.65E-02	REG_IV	3.30E-01	0.26
Chrysene	4.01	6	10	4.70E-02	8.65E-02	ER_L	3.80E-01	0.23
Chrysene	4.01	6	10	4.70E-02	8.65E-02	ER_M	2.80E+00	0.03
Chrysene	4.02	4	5	9.00E-02	1.50E-01	REG_IV	3.30E-01	0.45
Chrysene	4.02	4	5	9.00E-02	1.50E-01	ER_L	3.80E-01	0.39
Chrysene	4.02	4	5	9.00E-02	1.50E-01	ER_M	2.80E+00	0.05
Chrysene	4.03	7	7	6.70E-02	1.20E-01	REG_IV	3.30E-01	0.36
Chrysene	4.03	7	7	6.70E-02	1.20E-01	ER_L	3.80E-01	0.32
Chrysene	4.03	7	7	6.70E-02	1.20E-01	ER_M	2.80E+00	0.04
Chrysene	4.04	8	12	1.10E-01	2.10E-01	REG_IV	3.30E-01	0.64
Chrysene	4.04	8	12	1.10E-01	2.10E-01	ER_L	3.80E-01	0.55
Chrysene	4.04	8	12	1.10E-01	2.10E-01	ER_M	2.80E+00	0.08
Chrysene	7.01	1	1	3.30E-02	3.30E-02	REG_IV	3.30E-01	0.10
Chrysene	7.01	1	1	3.30E-02	3.30E-02	ER_L	3.80E-01	0.09
Chrysene	7.01	1	1	3.30E-02	3.30E-02	ER_M	2.80E+00	0.01
Chrysene	7.02	1	1	4.80E-02	4.80E-02	REG_IV	3.30E-01	0.15
Chrysene	7.02	1	1	4.80E-02	4.80E-02	ER_L	3.80E-01	0.13
Chrysene	7.02	1	1	4.80E-02	4.80E-02	ER_M	2.80E+00	0.02

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Chrysene	8	1	1	4.10E-02	4.10E-02	REG_IV	3.30E-01	0.12
Chrysene	8	1	1	4.10E-02	4.10E-02	ER_L	3.80E-01	0.11
Chrysene	8	1	1	4.10E-02	4.10E-02	ER_M	2.80E+00	0.01
Chrysene	**13**	**4**	**5**	**9.80E-02**	**5.50E-01**	**REG_IV**	**3.30E-01**	**1.67**
Chrysene	**13**	**4**	**5**	**9.80E-02**	**5.50E-01**	**ER_L**	**3.80E-01**	**1.45**
Chrysene	13	4	5	9.80E-02	5.50E-01	ER_M	2.80E+00	0.20
Chrysene	18	3	3	2.00E-01	2.30E-01	REG_IV	3.30E-01	0.70
Chrysene	18	3	3	2.00E-01	2.30E-01	ER_L	3.80E-01	0.61
Chrysene	18	3	3	2.00E-01	2.30E-01	ER_M	2.80E+00	0.08
Dibenz(a,h)anthracene	3.02	3	9	3.40E-02	5.50E-02	ER_L	6.30E-02	0.87
Dibenz(a,h)anthracene	3.02	3	9	3.40E-02	5.50E-02	ER_M	2.60E-01	0.21
Dibenz(a,h)anthracene	3.02	3	9	3.40E-02	5.50E-02	REG_IV	3.30E-01	0.17
Dibenz(a,h)anthracene	**3.03**	**7**	**9**	**2.40E-02**	**1.20E-01**	**ER_L**	**6.30E-02**	**1.90**
Dibenz(a,h)anthracene	3.03	7	9	2.40E-02	1.20E-01	ER_M	2.60E-01	0.46
Dibenz(a,h)anthracene	3.03	7	9	2.40E-02	1.20E-01	REG_IV	3.30E-01	0.36
Dibenz(a,h)anthracene	**3.04**	**3**	**7**	**2.90E-02**	**1.28E-01**	**ER_L**	**6.30E-02**	**2.02**
Dibenz(a,h)anthracene	3.04	3	7	2.90E-02	1.28E-01	ER_M	2.60E-01	0.49
Dibenz(a,h)anthracene	3.04	3	7	2.90E-02	1.28E-01	REG_IV	3.30E-01	0.39
Dibenz(a,h)anthracene	**4.01**	**1**	**10**	**1.15E-01**	**1.15E-01**	**ER_L**	**6.30E-02**	**1.82**
Dibenz(a,h)anthracene	4.01	1	10	1.15E-01	1.15E-01	ER_M	2.60E-01	0.44
Dibenz(a,h)anthracene	4.01	1	10	1.15E-01	1.15E-01	REG_IV	3.30E-01	0.35
Dibenz(a,h)anthracene	4.02	2	5	1.90E-02	2.00E-02	ER_L	6.30E-02	0.32
Dibenz(a,h)anthracene	4.02	2	5	1.90E-02	2.00E-02	ER_M	2.60E-01	0.08
Dibenz(a,h)anthracene	4.02	2	5	1.90E-02	2.00E-02	REG_IV	3.30E-01	0.06
Dibenz(a,h)anthracene	4.03	2	7	1.90E-02	2.40E-02	ER_L	6.30E-02	0.38
Dibenz(a,h)anthracene	4.03	2	7	1.90E-02	2.40E-02	ER_M	2.60E-01	0.09
Dibenz(a,h)anthracene	4.03	2	7	1.90E-02	2.40E-02	REG_IV	3.30E-01	0.07

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Dibenz(a,h)anthracene	13	1	5	2.30E-02	2.30E-02	ER_L	6.30E-02	0.37
Dibenz(a,h)anthracene	13	1	5	2.30E-02	2.30E-02	ER_M	2.60E-01	0.09
Dibenz(a,h)anthracene	13	1	5	2.30E-02	2.30E-02	REG_IV	3.30E-01	0.07
Fluoranthene	0	3	5	8.60E-02	1.10E-01	REG_IV	3.80E-01	0.29
Fluoranthene	0	3	5	8.60E-02	1.10E-01	ER_L	6.00E-01	0.18
Fluoranthene	0	3	5	8.60E-02	1.10E-01	ER_M	5.10E+00	0.02
Fluoranthene	0	3	5	8.60E-02	1.10E-01	EPASQC	8.85E+00	0.01
Fluoranthene	**2.04**	**7**	**8**	**9.50E-02**	**4.96E-01**	**REG_IV**	**3.80E-01**	**1.30**
Fluoranthene	2.04	7	8	9.50E-02	4.96E-01	ER_L	6.00E-01	0.83
Fluoranthene	2.04	7	8	9.50E-02	4.96E-01	ER_M	5.10E+00	0.10
Fluoranthene	2.04	7	8	9.50E-02	4.96E-01	EPASQC	9.42E+00	0.05
Fluoranthene	3.01	2	2	8.25E-02	1.40E-01	REG_IV	3.80E-01	0.37
Fluoranthene	3.01	2	2	8.25E-02	1.40E-01	ER_L	6.00E-01	0.23
Fluoranthene	3.01	2	2	8.25E-02	1.40E-01	ER_M	5.10E+00	0.03
Fluoranthene	3.01	2	2	8.25E-02	1.40E-01	EPASQC	5.53E+00	0.03
Fluoranthene	**3.02**	**8**	**9**	**4.40E-01**	**7.10E-01**	**REG_IV**	**3.80E-01**	**1.87**
Fluoranthene	**3.02**	**8**	**9**	**4.40E-01**	**7.10E-01**	**ER_L**	**6.00E-01**	**1.18**
Fluoranthene	3.02	8	9	4.40E-01	7.10E-01	ER_M	5.10E+00	0.14
Fluoranthene	3.02	8	9	4.40E-01	7.10E-01	EPASQC	3.88E+01	0.02
Fluoranthene	**3.03**	**9**	**9**	**3.30E-01**	**1.40E+00**	**REG_IV**	**3.80E-01**	**3.68**
Fluoranthene	**3.03**	**9**	**9**	**3.30E-01**	**1.40E+00**	**ER_L**	**6.00E-01**	**2.33**
Fluoranthene	3.03	9	9	3.30E-01	1.40E+00	ER_M	5.10E+00	0.27
Fluoranthene	3.03	9	9	3.30E-01	1.40E+00	EPASQC	1.14E+01	0.12
Fluoranthene	3.04	7	7	1.68E-01	2.70E-01	REG_IV	3.80E-01	0.71
Fluoranthene	3.04	7	7	1.68E-01	2.70E-01	ER_L	6.00E-01	0.45
Fluoranthene	3.04	7	7	1.68E-01	2.70E-01	ER_M	5.10E+00	0.05
Fluoranthene	3.04	7	7	1.68E-01	2.70E-01	EPASQC	5.64E+00	0.05

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Fluoranthene	4.01	7	10	7.80E-02	1.75E-01	REG_IV	3.80E-01	0.46
Fluoranthene	4.01	7	10	7.80E-02	1.75E-01	ER_L	6.00E-01	0.29
Fluoranthene	4.01	7	10	7.80E-02	1.75E-01	ER_M	5.10E+00	0.03
Fluoranthene	4.01	7	10	7.80E-02	1.75E-01	EPASQC	5.18E+00	0.03
Fluoranthene	4.02	4	5	7.60E-02	2.60E-01	REG_IV	3.80E-01	0.68
Fluoranthene	4.02	4	5	7.60E-02	2.60E-01	ER_L	6.00E-01	0.43
Fluoranthene	4.02	4	5	7.60E-02	2.60E-01	ER_M	5.10E+00	0.05
Fluoranthene	4.02	4	5	7.60E-02	2.60E-01	EPASQC	6.99E+00	0.04
Fluoranthene	4.03	7	7	9.55E-02	1.40E-01	REG_IV	3.80E-01	0.37
Fluoranthene	4.03	7	7	9.55E-02	1.40E-01	ER_L	6.00E-01	0.23
Fluoranthene	4.03	7	7	9.55E-02	1.40E-01	ER_M	5.10E+00	0.03
Fluoranthene	4.03	7	7	9.55E-02	1.40E-01	EPASQC	9.88E+00	0.01
Fluoranthene	4.04	11	12	1.60E-01	2.20E-01	REG_IV	3.80E-01	0.58
Fluoranthene	4.04	11	12	1.60E-01	2.20E-01	ER_L	6.00E-01	0.37
Fluoranthene	4.04	11	12	1.60E-01	2.20E-01	ER_M	5.10E+00	0.04
Fluoranthene	4.04	11	12	1.60E-01	2.20E-01	EPASQC	1.52E+01	0.01
Fluoranthene	8	1	1	4.90E-02	4.90E-02	REG_IV	3.80E-01	0.13
Fluoranthene	8	1	1	4.90E-02	4.90E-02	ER_L	6.00E-01	0.08
Fluoranthene	8	1	1	4.90E-02	4.90E-02	ER_M	5.10E+00	0.01
Fluoranthene	8	1	1	4.90E-02	4.90E-02	EPASQC	1.08E+01	0.00
Fluoranthene	13	4	5	1.20E-01	2.70E-01	REG_IV	3.80E-01	0.71
Fluoranthene	13	4	5	1.20E-01	2.70E-01	ER_L	6.00E-01	0.45
Fluoranthene	13	4	5	1.20E-01	2.70E-01	ER_M	5.10E+00	0.05
Fluoranthene	13	4	5	1.20E-01	2.70E-01	EPASQC	1.97E+01	0.01
Fluoranthene	**18**	**3**	**3**	**3.70E-01**	**4.10E-01**	**REG_IV**	**3.80E-01**	**1.08**
Fluoranthene	18	3	3	3.70E-01	4.10E-01	ER_L	6.00E-01	0.68
Fluoranthene	18	3	3	3.70E-01	4.10E-01	ER_M	5.10E+00	0.08

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Fluoranthene	18	3	3	3.70E-01	4.10E-01	EPASQC	1.02E+01	0.04
Fluorene	**0**	**2**	**5**	**4.10E-02**	**4.10E-02**	**ER_L**	**1.90E-02**	**2.16**
Fluorene	0	2	5	4.10E-02	4.10E-02	REG_IV	3.30E-01	0.12
Fluorene	0	2	5	4.10E-02	4.10E-02	ER_M	5.40E-01	0.08
Fluorene	**3.02**	**4**	**9**	**6.00E-02**	**9.40E-02**	**ER_L**	**1.90E-02**	**4.95**
Fluorene	3.02	4	9	6.00E-02	9.40E-02	REG_IV	3.30E-01	0.28
Fluorene	3.02	4	9	6.00E-02	9.40E-02	ER_M	5.40E-01	0.17
Fluorene	**3.03**	**6**	**9**	**4.40E-02**	**1.39E-01**	**ER_L**	**1.90E-02**	**7.29**
Fluorene	3.03	6	9	4.40E-02	1.39E-01	REG_IV	3.30E-01	0.42
Fluorene	3.03	6	9	4.40E-02	1.39E-01	ER_M	5.40E-01	0.26
Fluorene	**3.04**	**4**	**7**	**7.68E-02**	**1.37E-01**	**ER_L**	**1.90E-02**	**7.18**
Fluorene	3.04	4	7	7.68E-02	1.37E-01	REG_IV	3.30E-01	0.41
Fluorene	3.04	4	7	7.68E-02	1.37E-01	ER_M	5.40E-01	0.25
Fluorene	4.02	1	5	1.80E-02	1.80E-02	ER_L	1.90E-02	0.95
Fluorene	4.02	1	5	1.80E-02	1.80E-02	REG_IV	3.30E-01	0.05
Fluorene	4.02	1	5	1.80E-02	1.80E-02	ER_M	5.40E-01	0.03
Fluorene	**4.03**	**1**	**7**	**2.70E-02**	**2.70E-02**	**ER_L**	**1.90E-02**	**1.42**
Fluorene	4.03	1	7	2.70E-02	2.70E-02	REG_IV	3.30E-01	0.08
Fluorene	4.03	1	7	2.70E-02	2.70E-02	ER_M	5.40E-01	0.05
Fluorene	**13**	**2**	**5**	**1.90E-02**	**2.60E-01**	**ER_L**	**1.90E-02**	**13.68**
Fluorene	13	2	5	1.90E-02	2.60E-01	REG_IV	3.30E-01	0.79
Fluorene	13	2	5	1.90E-02	2.60E-01	ER_M	5.40E-01	0.48
Naphthalene	0	5	5	3.50E-02	3.80E-01	EQ_PART	5.81E-01	0.65
Naphthalene	**0**	**5**	**5**	**3.50E-02**	**3.80E-01**	**ER_L**	**1.60E-01**	**2.38**
Naphthalene	**0**	**5**	**5**	**3.50E-02**	**3.80E-01**	**REG_IV**	**3.30E-01**	**1.15**
Naphthalene	0	5	5	3.50E-02	3.80E-01	ER_M	2.10E+00	0.18
Naphthalene	2.04	5	8	2.60E-02	3.60E-01	EQ_PART	6.18E-01	0.58

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Naphthalene	**2.04**	**5**	**8**	**2.60E-02**	**3.60E-01**	**ER_L**	**1.60E-01**	**2.25**
Naphthalene	**2.04**	**5**	**8**	**2.60E-02**	**3.60E-01**	**REG_IV**	**3.30E-01**	**1.09**
Naphthalene	2.04	5	8	2.60E-02	3.60E-01	ER_M	2.10E+00	0.17
Naphthalene	3.02	7	9	9.80E-02	2.40E-01	EQ_PART	2.55E-02	0.09
Naphthalene	**3.02**	**7**	**9**	**9.80E-02**	**2.40E-01**	**ER_L**	**1.60E-01**	**1.50**
Naphthalene	3.02	7	9	9.80E-02	2.40E-01	REG_IV	3.30E-01	0.73
Naphthalene	3.02	7	9	9.80E-02	2.40E-01	ER_M	2.10E+00	0.11
Naphthalene	3.03	9	9	8.00E-02	3.90E-01	EQ_PART	7.47E-01	0.52
Naphthalene	**3.03**	**9**	**9**	**8.00E-02**	**3.90E-01**	**ER_L**	**1.60E-01**	**2.44**
Naphthalene	**3.03**	**9**	**9**	**8.00E-02**	**3.90E-01**	**REG_IV**	**3.30E-01**	**1.18**
Naphthalene	3.03	9	9	8.00E-02	3.90E-01	ER_M	2.10E+00	0.19
Naphthalene	3.04	7	7	7.30E-02	3.31E-01	EQ_PART	3.70E-01	0.89
Naphthalene	**3.04**	**7**	**7**	**7.30E-02**	**3.31E-01**	**ER_L**	**1.60E-01**	**2.07**
Naphthalene	**3.04**	**7**	**7**	**7.30E-02**	**3.31E-01**	**REG_IV**	**3.30E-01**	**1.00**
Naphthalene	3.04	7	7	7.30E-02	3.31E-01	ER_M	2.10E+00	0.16
Naphthalene	4.01	7	10	3.60E-02	4.65E-02	EQ_PART	3.40E-01	0.14
Naphthalene	4.01	7	10	3.60E-02	4.65E-02	ER_L	1.60E-01	0.29
Naphthalene	4.01	7	10	3.60E-02	4.65E-02	REG_IV	3.30E-01	0.14
Naphthalene	4.01	7	10	3.60E-02	4.65E-02	ER_M	2.10E+00	0.02
Naphthalene	4.02	4	5	3.30E-02	1.50E-01	EQ_PART	4.59E-01	0.33
Naphthalene	4.02	4	5	3.30E-02	1.50E-01	ER_L	1.60E-01	0.94
Naphthalene	4.02	4	5	3.30E-02	1.50E-01	REG_IV	3.30E-01	0.45
Naphthalene	4.02	4	5	3.30E-02	1.50E-01	ER_M	2.10E+00	0.07
Naphthalene	4.03	7	7	6.00E-02	1.20E-01	EQ_PART	6.49E-01	0.19
Naphthalene	4.03	7	7	6.00E-02	1.20E-01	ER_L	1.60E-01	0.75
Naphthalene	4.03	7	7	6.00E-02	1.20E-01	REG_IV	3.30E-01	0.36
Naphthalene	4.03	7	7	6.00E-02	1.20E-01	ER_M	2.10E+00	0.06

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Naphthalene	4.04	7	12	9.60E-02	1.20E-01	EQ_PART	1.00E-00	0.12
Naphthalene	4.04	7	12	9.60E-02	1.20E-01	ER_L	1.60E-01	0.75
Naphthalene	4.04	7	12	9.60E-02	1.20E-01	REG_IV	3.30E-01	0.36
Naphthalene	4.04	7	12	9.60E-02	1.20E-01	ER_M	2.10E+00	0.06
Naphthalene	7.02	1	1	5.80E-02	5.80E-02	EQ_PART	7.11E-01	0.08
Naphthalene	7.02	1	1	5.80E-02	5.80E-02	ER_L	1.60E-01	0.36
Naphthalene	7.02	1	1	5.80E-02	5.80E-02	REG_IV	3.30E-01	0.18
Naphthalene	7.02	1	1	5.80E-02	5.80E-02	ER_M	2.10E+00	0.03
Naphthalene	8	1	1	2.50E-02	2.50E-02	EQ_PART	7.11E-01	0.04
Naphthalene	8	1	1	2.50E-02	2.50E-02	ER_L	1.60E-01	0.16
Naphthalene	8	1	1	2.50E-02	2.50E-02	REG_IV	3.30E-01	0.08
Naphthalene	8	1	1	2.50E-02	2.50E-02	ER_M	2.10E+00	0.01
Naphthalene	**13**	**5**	**5**	**1.60E-01**	**8.30E+00**	**EQ_PART**	**1.29E-00**	**6.42**
Naphthalene	**13**	**5**	**5**	**1.60E-01**	**8.30E+00**	**ER_L**	**1.60E-01**	**51.88**
Naphthalene	**13**	**5**	**5**	**1.60E-01**	**8.30E+00**	**REG_IV**	**3.30E-01**	**25.15**
Naphthalene	**13**	**5**	**5**	**1.60E-01**	**8.30E+00**	**ER_M**	**2.10E+00**	**3.95**
PAH, total	**0**	**5**	**5**	**2.94E+00**	**4.09E+00**	**REG_IV**	**2.90E+00**	**1.41**
PAH, total	**0**	**5**	**5**	**2.94E+00**	**4.09E+00**	**ER_L**	**4.03E+00**	**1.02**
PAH, total	0	5	5	2.94E+00	4.09E+00	ER_M	4.48E+01	0.09
PAH, total	**2.04**	**7**	**8**	**3.15E+00**	**8.92E+00**	**REG_IV**	**2.90E+00**	**3.08**
PAH, total	**2.04**	**7**	**8**	**3.15E+00**	**8.92E+00**	**ER_L**	**4.03E+00**	**2.22**
PAH, total	2.04	7	8	3.15E+00	8.92E+00	ER_M	4.48E+01	0.20
PAH, total	**3.01**	**2**	**2**	**2.88E+00**	**3.05E+00**	**REG_IV**	**2.90E+00**	**1.05**
PAH, total	3.01	2	2	2.88E+00	3.05E+00	ER_L	4.03E+00	0.76
PAH, total	3.01	2	2	2.88E+00	3.05E+00	ER_M	4.48E+01	0.07
PAH, total	**3.02**	**9**	**9**	**3.68E+00**	**8.85E+00**	**REG_IV**	**2.90E+00**	**3.05**
PAH, total	**3.02**	**9**	**9**	**3.68E+00**	**8.85E+00**	**ER_L**	**4.03E+00**	**2.20**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
PAH, total	3.02	9	9	3.68E+00	8.85E+00	ER_M	4.48E+01	0.20
PAH, total	**3.03**	**9**	**9**	**2.56E+00**	**1.05E+01**	**REG_IV**	**2.90E+00**	**3.63**
PAH, total	**3.03**	**9**	**9**	**2.56E+00**	**1.05E+01**	**ER_L**	**4.03E+00**	**2.61**
PAH, total	3.03	9	9	2.56E+00	1.05E+01	ER_M	4.48E+01	0.24
PAH, total	**3.04**	**7**	**7**	**2.92E+00**	**7.81E+00**	**REG_IV**	**2.90E+00**	**2.69**
PAH, total	**3.04**	**7**	**7**	**2.92E+00**	**7.81E+00**	**ER_L**	**4.03E+00**	**1.94**
PAH, total	3.04	7	7	2.92E+00	7.81E+00	ER_M	4.48E+01	0.17
PAH, total	**4.01**	**8**	**10**	**2.52E+00**	**4.62E+00**	**REG_IV**	**2.90E+00**	**1.59**
PAH, total	**4.01**	**8**	**10**	**2.52E+00**	**4.62E+00**	**ER_L**	**4.03E+00**	**1.15**
PAH, total	4.01	8	10	2.52E+00	4.62E+00	ER_M	4.48E+01	0.10
PAH, total	**4.02**	**5**	**5**	**2.67E+00**	**3.37E+00**	**REG_IV**	**2.90E+00**	**1.16**
PAH, total	4.02	5	5	2.67E+00	3.37E+00	ER_L	4.03E+00	0.84
PAH, total	4.02	5	5	2.67E+00	3.37E+00	ER_M	4.48E+01	0.08
PAH, total	**4.03**	**7**	**7**	**2.37E+00**	**3.77E+00**	**REG_IV**	**2.90E+00**	**1.30**
PAH, total	4.03	7	7	2.37E+00	3.77E+00	ER_L	4.03E+00	0.94
PAH, total	4.03	7	7	2.37E+00	3.77E+00	ER_M	4.48E+01	0.08
PAH, total	**4.04**	**11**	**12**	**1.15E+01**	**1.87E+01**	**REG_IV**	**2.90E+00**	**6.45**
PAH, total	**4.04**	**11**	**12**	**1.15E+01**	**1.87E+01**	**ER_L**	**4.03E+00**	**4.64**
PAH, total	4.04	11	12	1.15E+01	1.87E+01	ER_M	4.48E+01	0.42
PAH, total	**7.01**	**1**	**1**	**5.18E+00**	**5.18E+00**	**REG_IV**	**2.90E+00**	**1.79**
PAH, total	**7.01**	**1**	**1**	**5.18E+00**	**5.18E+00**	**ER_L**	**4.03E+00**	**1.29**
PAH, total	7.01	1	1	5.18E+00	5.18E+00	ER_M	4.48E+01	0.12
PAH, total	**7.02**	**1**	**1**	**4.84E+00**	**4.84E+00**	**REG_IV**	**2.90E+00**	**1.67**
PAH, total	**7.02**	**1**	**1**	**4.84E+00**	**4.84E+00**	**ER_L**	**4.03E+00**	**1.20**
PAH, total	7.02	1	1	4.84E+00	4.84E+00	ER_M	4.48E+01	0.11
PAH, total	**8**	**1**	**1**	**4.29E+00**	**4.29E+00**	**REG_IV**	**2.90E+00**	**1.48**
PAH, total	**8**	**1**	**1**	**4.29E+00**	**4.29E+00**	**ER_L**	**4.03E+00**	**1.07**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[a]	HQ max[a]
PAH, total	8	1	1	4.29E+00	4.29E+00	ER_M	4.48E+01	0.10
PAH, total	**13**	**5**	**5**	**3.32E+00**	**3.39E+01**	**REG_IV**	**2.90E+00**	**11.69**
PAH, total	**13**	**5**	**5**	**3.32E+00**	**3.39E+01**	**ER_L**	**4.03E+00**	**8.42**
PAH, total	13	5	5	3.32E+00	3.39E+01	ER_M	4.48E+01	0.76
PAH, total	**18**	**3**	**3**	**1.17E+01**	**1.26E+01**	**REG_IV**	**2.90E+00**	**4.33**
PAH, total	**18**	**3**	**3**	**1.17E+01**	**1.26E+01**	**ER_L**	**4.03E+00**	**3.12**
PAH, total	18	3	3	1.17E+01	1.26E+01	ER_M	4.48E+01	0.28
PCB-1248	3.02	2	9	5.20E-02	2.90E-01	EQ_PART	6.58E-00	0.04
PCB-1248	**3.02**	**2**	**9**	**5.20E-02**	**2.90E-01**	**ER_L**	**2.30E-02**	**12.61**
PCB-1248	**3.02**	**2**	**9**	**5.20E-02**	**2.90E-01**	**ER_M**	**1.80E-01**	**1.61**
PCB-1248	3.04	2	7	4.60E-02	1.48E-01	EQ_PART	9.56E-01	0.15
PCB-1248	**3.04**	**2**	**7**	**4.60E-02**	**1.48E-01**	**ER_L**	**2.30E-02**	**6.43**
PCB-1248	3.04	2	7	4.60E-02	1.48E-01	ER_M	1.80E-01	0.82
PCB-1254	**2.02**	**1**	**1**	**1.17E+00**	**1.17E+00**	**EQ_PART**	**2.97E-01**	**3.93**
PCB-1254	**2.02**	**1**	**1**	**1.17E+00**	**1.17E+00**	**ER_L**	**2.30E-02**	**50.74**
PCB-1254	**2.02**	**1**	**1**	**1.17E+00**	**1.17E+00**	**ER_M**	**1.80E-01**	**6.48**
PCB-1254	**3.02**	**7**	**9**	**1.30E-01**	**1.50E+00**	**EQ_PART**	**1.07E-00**	**1.41**
PCB-1254	**3.02**	**7**	**9**	**1.30E-01**	**1.50E+00**	**ER_L**	**2.30E-02**	**65.17**
PCB-1254	**3.02**	**7**	**9**	**1.30E-01**	**1.50E+00**	**ER_M**	**1.80E-01**	**8.33**
PCB-1254	**3.03**	**9**	**9**	**1.00E-01**	**5.30E-01**	**EQ_PART**	**3.12E-01**	**1.70**
PCB-1254	**3.03**	**9**	**9**	**1.00E-01**	**5.30E-01**	**ER_L**	**2.30E-02**	**23.04**
PCB-1254	**3.03**	**9**	**9**	**1.00E-01**	**5.30E-01**	**ER_M**	**1.80E-01**	**2.94**
PCB-1254	**3.04**	**6**	**7**	**7.88E-02**	**2.25E-01**	**EQ_PART**	**1.55E-01**	**1.45**
PCB-1254	**3.04**	**6**	**7**	**7.88E-02**	**2.25E-01**	**ER_L**	**2.30E-02**	**9.78**
PCB-1254	**3.04**	**6**	**7**	**7.88E-02**	**2.25E-01**	**ER_M**	**1.80E-01**	**1.25**
PCB-1254	**4.01**	**8**	**10**	**2.50E-02**	**8.58E-01**	**EQ_PART**	**1.42E-01**	**6.04**
PCB-1254	**4.01**	**8**	**10**	**2.50E-02**	**8.58E-01**	**ER_L**	**2.30E-02**	**37.30**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
PCB-1254	**4.01**	**8**	**10**	**2.50E-02**	**8.58E-01**	**ER_M**	**1.80E-01**	**4.77**
PCB-1254	4.02	2	5	1.10E-02	4.50E-02	EQ_PART	1.92E-01	0.23
PCB-1254	**4.02**	**2**	**5**	**1.10E-02**	**4.50E-02**	**ER_L**	**2.30E-02**	**1.96**
PCB-1254	4.02	2	5	1.10E-02	4.50E-02	ER_M	1.80E-01	0.25
PCB-1254	4.03	2	7	5.60E-02	8.20E-02	EQ_PART	2.71E-01	0.30
PCB-1254	**4.03**	**2**	**7**	**5.60E-02**	**8.20E-02**	**ER_L**	**2.30E-02**	**3.57**
PCB-1254	4.03	2	7	5.60E-02	8.20E-02	ER_M	1.80E-01	0.46
PCB-1254	**4.04**	**1**	**12**	**2.79E+00**	**2.79E+00**	**EQ_PART**	**4.18E-01**	**6.68**
PCB-1254	**4.04**	**1**	**12**	**2.79E+00**	**2.79E+00**	**ER_L**	**2.30E-02**	**121.40**
PCB-1254	**4.04**	**1**	**12**	**2.79E+00**	**2.79E+00**	**ER_M**	**1.80E-01**	**15.51**
PCB-1254	13	1	5	1.70E-02	1.70E-02	EQ_PART	5.40E-01	0.03
PCB-1254	13	1	5	1.70E-02	1.70E-02	ER_L	2.30E-02	0.74
PCB-1254	13	1	5	1.70E-02	1.70E-02	ER_M	1.80E-01	0.09
PCB-1254	**22**	**1**	**1**	**1.59E+00**	**1.59E+00**	**EQ_PART**	**2.97E-01**	**5.37**
PCB-1254	**22**	**1**	**1**	**1.59E+00**	**1.59E+00**	**ER_L**	**2.30E-02**	**69.30**
PCB-1254	**22**	**1**	**1**	**1.59E+00**	**1.59E+00**	**ER_M**	**1.80E-01**	**8.86**
PCB-1260	2.02	1	1	1.17E+00	1.17E+00	EQ_PART	1.92E+03	0.00
PCB-1260	**2.02**	**1**	**1**	**1.17E+00**	**1.17E+00**	**ER_L**	**2.30E-02**	**50.74**
PCB-1260	**2.02**	**1**	**1**	**1.17E+00**	**1.17E+00**	**ER_M**	**1.80E-01**	**6.48**
PCB-1260	3.01	1	2	1.90E-02	1.90E-02	EQ_PART	9.81E+02	0.00
PCB-1260	3.01	1	2	1.90E-02	1.90E-02	ER_L	2.30E-02	0.83
PCB-1260	3.01	1	2	1.90E-02	1.90E-02	ER_M	1.80E-01	0.11
PCB-1260	3.02	6	9	6.45E-02	5.60E-01	EQ_PART	6.89E+03	0.00
PCB-1260	**3.02**	**6**	**9**	**6.45E-02**	**5.60E-01**	**ER_L**	**2.30E-02**	**24.35**
PCB-1260	**3.02**	**6**	**9**	**6.45E-02**	**5.60E-01**	**ER_M**	**1.80E-01**	**3.11**
PCB-1260	3.03	8	9	4.40E-02	2.80E-01	EQ_PART	2.02E+03	0.00
PCB-1260	**3.03**	**8**	**9**	**4.40E-02**	**2.80E-01**	**ER_L**	**2.30E-02**	**12.17**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
PCB-1260	**3.03**	**8**	**9**	**4.40E-02**	**2.80E-01**	**ER_M**	**1.80E-01**	**1.56**
PCB-1260	3.04	5	7	6.43E-02	1.75E-01	EQ_PART	1.00E+03	0.00
PCB-1260	**3.04**	**5**	**7**	**6.43E-02**	**1.75E-01**	**ER_L**	**2.30E-02**	**7.61**
PCB-1260	3.04	5	7	6.43E-02	1.75E-01	ER_M	1.80E-01	0.97
PCB-1260	4.01	5	10	1.03E-02	3.40E-02	EQ_PART	9.18E+02	0.00
PCB-1260	**4.01**	**5**	**10**	**1.03E-02**	**3.40E-02**	**ER_L**	**2.30E-02**	**1.48**
PCB-1260	4.01	5	10	1.03E-02	3.40E-02	ER_M	1.80E-01	0.19
PCB-1260	4.02	1	5	2.80E-02	2.80E-02	EQ_PART	1.24E+03	0.00
PCB-1260	**4.02**	**1**	**5**	**2.80E-02**	**2.80E-02**	**ER_L**	**2.30E-02**	**1.22**
PCB-1260	4.02	1	5	2.80E-02	2.80E-02	ER_M	1.80E-01	0.16
PCB-1260	4.03	2	7	2.70E-02	4.30E-02	EQ_PART	1.75E+03	0.00
PCB-1260	**4.03**	**2**	**7**	**2.70E-02**	**4.30E-02**	**ER_L**	**2.30E-02**	**1.87**
PCB-1260	4.03	2	7	2.70E-02	4.30E-02	ER_M	1.80E-01	0.24
Phenanthrene	**0**	**5**	**5**	**3.70E-02**	**3.70E-01**	**ER_L**	**2.40E-01**	**1.54**
Phenanthrene	**0**	**5**	**5**	**3.70E-02**	**3.70E-01**	**REG_IV**	**3.30E-01**	**1.12**
Phenanthrene	0	5	5	3.70E-02	3.70E-01	ER_M	1.50E+00	0.25
Phenanthrene	0	5	5	3.70E-02	3.70E-01	EPASQC	2.57E+00	0.14
Phenanthrene	**2.04**	**6**	**8**	**6.70E-02**	**4.96E-01**	**ER_L**	**2.40E-01**	**2.07**
Phenanthrene	**2.04**	**6**	**8**	**6.70E-02**	**4.96E-01**	**REG_IV**	**3.30E-01**	**1.50**
Phenanthrene	2.04	6	8	6.70E-02	4.96E-01	ER_M	1.50E+00	0.33
Phenanthrene	2.04	6	8	6.70E-02	4.96E-01	EPASQC	2.73E+00	0.18
Phenanthrene	3.01	2	2	4.80E-02	7.40E-02	ER_L	2.40E-01	0.31
Phenanthrene	3.01	2	2	4.80E-02	7.40E-02	REG_IV	3.30E-01	0.22
Phenanthrene	3.01	2	2	4.80E-02	7.40E-02	ER_M	1.50E+00	0.05
Phenanthrene	3.01	2	2	4.80E-02	7.40E-02	EPASQC	1.61E+00	0.05
Phenanthrene	**3.02**	**8**	**9**	**2.60E-01**	**7.80E-01**	**ER_L**	**2.40E-01**	**3.25**
Phenanthrene	**3.02**	**8**	**9**	**2.60E-01**	**7.80E-01**	**REG_IV**	**3.30E-01**	**2.36**

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Phenanthrene	3.02	8	9	2.60E-01	7.80E-01	ER_M	1.50E+00	0.52
Phenanthrene	3.02	8	9	2.60E-01	7.80E-01	EPASQC	1.13E+01	0.07
Phenanthrene	**3.03**	**9**	**9**	**2.80E-01**	**1.20E+00**	**ER_L**	**2.40E-01**	**5.00**
Phenanthrene	**3.03**	**9**	**9**	**2.80E-01**	**1.20E+00**	**REG_IV**	**3.30E-01**	**3.64**
Phenanthrene	3.03	9	9	2.80E-01	1.20E+00	ER_M	1.50E+00	0.80
Phenanthrene	3.03	9	9	2.80E-01	1.20E+00	EPASQC	3.30E+00	0.36
Phenanthrene	**3.04**	**7**	**7**	**1.40E-01**	**3.10E-01**	**ER_L**	**2.40E-01**	**1.29**
Phenanthrene	3.04	7	7	1.40E-01	3.10E-01	REG_IV	3.30E-01	0.94
Phenanthrene	3.04	7	7	1.40E-01	3.10E-01	ER_M	1.50E+00	0.21
Phenanthrene	3.04	7	7	1.40E-01	3.10E-01	EPASQC	1.64E+00	0.19
Phenanthrene	4.01	7	10	6.00E-02	1.23E-01	ER_L	2.40E-01	0.51
Phenanthrene	4.01	7	10	6.00E-02	1.23E-01	REG_IV	3.30E-01	0.37
Phenanthrene	4.01	7	10	6.00E-02	1.23E-01	ER_M	1.50E+00	0.08
Phenanthrene	4.01	7	10	6.00E-02	1.23E-01	EPASQC	1.50E+00	0.08
Phenanthrene	4.02	5	5	6.10E-02	2.20E-01	ER_L	2.40E-01	0.92
Phenanthrene	4.02	5	5	6.10E-02	2.20E-01	REG_IV	3.30E-01	0.67
Phenanthrene	4.02	5	5	6.10E-02	2.20E-01	ER_M	1.50E+00	0.15
Phenanthrene	4.02	5	5	6.10E-02	2.20E-01	EPASQC	2.03E+00	0.11
Phenanthrene	4.03	7	7	8.70E-02	1.90E-01	ER_L	2.40E-01	0.79
Phenanthrene	4.03	7	7	8.70E-02	1.90E-01	REG_IV	3.30E-01	0.58
Phenanthrene	4.03	7	7	8.70E-02	1.90E-01	ER_M	1.50E+00	0.13
Phenanthrene	4.03	7	7	8.70E-02	1.90E-01	EPASQC	2.87E+00	0.07
Phenanthrene	4.04	11	12	1.60E-01	2.20E-01	ER_L	2.40E-01	0.92
Phenanthrene	4.04	11	12	1.60E-01	2.20E-01	REG_IV	3.30E-01	0.67
Phenanthrene	4.04	11	12	1.60E-01	2.20E-01	ER_M	1.50E+00	0.15
Phenanthrene	4.04	11	12	1.60E-01	2.20E-01	EPASQC	4.43E+00	0.05
Phenanthrene	7.01	1	1	3.00E-02	3.00E-02	ER_L	2.40E-01	0.13

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Phenanthrene	7.01	1	1	3.00E-02	3.00E-02	REG_IV	3.30E-01	0.09
Phenanthrene	7.01	1	1	3.00E-02	3.00E-02	ER_M	1.50E+00	0.02
Phenanthrene	7.01	1	1	3.00E-02	3.00E-02	EPASQC	3.14E+00	0.01
Phenanthrene	7.02	1	1	7.50E-02	7.50E-02	ER_L	2.40E-01	0.31
Phenanthrene	7.02	1	1	7.50E-02	7.50E-02	REG_IV	3.30E-01	0.23
Phenanthrene	7.02	1	1	7.50E-02	7.50E-02	ER_M	1.50E+00	0.05
Phenanthrene	7.02	1	1	7.50E-02	7.50E-02	EPASQC	3.14E+00	0.02
Phenanthrene	8	1	1	4.40E-02	4.40E-02	ER_L	2.40E-01	0.18
Phenanthrene	8	1	1	4.40E-02	4.40E-02	REG_IV	3.30E-01	0.13
Phenanthrene	8	1	1	4.40E-02	4.40E-02	ER_M	1.50E+00	0.03
Phenanthrene	8	1	1	4.40E-02	4.40E-02	EPASQC	3.14E+00	0.01
Phenanthrene	**13**	**5**	**5**	**1.80E-01**	**3.70E+00**	**ER_L**	**2.40E-01**	**15.42**
Phenanthrene	**13**	**5**	**5**	**1.80E-01**	**3.70E+00**	**REG_IV**	**3.30E-01**	**11.21**
Phenanthrene	**13**	**5**	**5**	**1.80E-01**	**3.70E+00**	**ER_M**	**1.50E+00**	**2.47**
Phenanthrene	13	5	5	1.80E-01	3.70E+00	EPASQC	5.72E+00	0.65
Phenanthrene	18	3	3	1.40E-01	1.90E-01	ER_L	2.40E-01	0.79
Phenanthrene	18	3	3	1.40E-01	1.90E-01	REG_IV	3.30E-01	0.58
Phenanthrene	18	3	3	1.40E-01	1.90E-01	ER_M	1.50E+00	0.13
Phenanthrene	18	3	3	1.40E-01	1.90E-01	EPASQC	2.96E+00	0.06
Pyrene	0	5	5	3.70E-02	1.50E-01	ER_L	6.60E-01	0.23
Pyrene	0	5	5	3.70E-02	1.50E-01	ER_M	2.60E+00	0.06
Pyrene	2.04	4	8	2.70E-02	4.96E-01	ER_L	6.60E-01	0.75
Pyrene	2.04	4	8	2.70E-02	4.96E-01	ER_M	2.60E+00	0.19
Pyrene	3.01	2	2	7.33E-02	1.30E-01	ER_L	6.60E-01	0.20
Pyrene	3.01	2	2	7.33E-02	1.30E-01	ER_M	2.60E+00	0.05
Pyrene	**3.02**	**8**	**9**	**2.80E-01**	**6.60E-01**	**ER_L**	**6.60E-01**	**1.00**
Pyrene	3.02	8	9	2.80E-01	6.60E-01	ER_M	2.60E+00	0.25

Table F3.1 (continued)

Analyte	Reach	Detects	Total samples	Median	Maximum	BMK name	BMK value[b]	HQ max[b]
Pyrene	**3.03**	**9**	**9**	**3.00E-01**	**1.25E+00**	**ER_L**	**6.60E-01**	**1.90**
Pyrene	3.03	9	9	3.00E-01	1.25E+00	ER_M	2.60E+00	0.48
Pyrene	3.04	7	7	1.90E-01	2.70E-01	ER_L	6.60E-01	0.41
Pyrene	3.04	7	7	1.90E-01	2.70E-01	ER_M	2.60E+00	0.10
Pyrene	4.01	7	10	6.40E-02	1.43E-01	ER_L	6.60E-01	0.22
Pyrene	4.01	7	10	6.40E-02	1.43E-01	ER_M	2.60E+00	0.06
Pyrene	4.02	5	5	7.41E-02	2.40E-01	ER_L	6.60E-01	0.36
Pyrene	4.02	5	5	7.41E-02	2.40E-01	ER_M	2.60E+00	0.09
Pyrene	4.03	7	7	9.30E-02	1.50E-01	ER_L	6.60E-01	0.23
Pyrene	4.03	7	7	9.30E-02	1.50E-01	ER_M	2.60E+00	0.06
Pyrene	4.04	11	12	1.50E-01	3.20E-01	ER_L	6.60E-01	0.49
Pyrene	4.04	11	12	1.50E-01	3.20E-01	ER_M	2.60E+00	0.12
Pyrene	7.01	1	1	5.20E-02	5.20E-02	ER_L	6.60E-01	0.08
Pyrene	7.01	1	1	5.20E-02	5.20E-02	ER_M	2.60E+00	0.02
Pyrene	7.02	1	1	1.10E-01	1.10E-01	ER_L	6.60E-01	0.17
Pyrene	7.02	1	1	1.10E-01	1.10E-01	ER_M	2.60E+00	0.04
Pyrene	8	1	1	7.50E-02	7.50E-02	ER_L	6.60E-01	0.11
Pyrene	8	1	1	7.50E-02	7.50E-02	ER_M	2.60E+00	0.03
Pyrene	13	4	5	1.60E-01	6.10E-01	ER_L	6.60E-01	0.92
Pyrene	13	4	5	1.60E-01	6.10E-01	ER_M	2.60E+00	0.23
Pyrene	18	3	3	3.70E-01	3.74E-01	ER_L	6.60E-01	0.57
Pyrene	18	3	3	3.70E-01	3.74E-01	ER_M	2.60E+00	0.14

[a] Units are mg/kg.
[b] Maximum and HQ(Max) for EPASQCand EQ_PART are corrected for site-specific percent total organic carbon.

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Table F3.2. Median and maximum concentrations[a] of contaminants of potential ecological concern[b] in pore water, aqueous ecotoxicological benchmarks (BMK name) and their values (BMK value) for each chemical, and the quotients (HQ max) of maximum/BMK value

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Aluminum	**0**	**5**	**5**	**5.00E-02**	**4.38E-01**	**NAWQ_CHR**	**8.70E-02**	**5.04**
Aluminum	0	5	5	5.00E-02	4.38E-01	LCV_AQPL	4.60E-01	0.95
Aluminum	0	5	5	5.00E-02	4.38E-01	LTV_DAPH	5.40E-01	0.81
Aluminum	0	5	5	5.00E-02	4.38E-01	NAWQ_ACU	7.50E-01	0.58
Aluminum	0	5	5	5.00E-02	4.38E-01	LCV_DAPH	1.90E+00	0.23
Aluminum	0	5	5	5.00E-02	4.38E-01	LCV_FISH	3.29E+00	0.13
Aluminum	0	5	5	5.00E-02	4.38E-01	LTV_FISH	4.70E+00	0.09
Aluminum	2.01	1	1	1.81E-02	1.81E-02	NAWQ_CHR	8.70E-02	0.21
Aluminum	2.01	1	1	1.81E-02	1.81E-02	LCV_AQPL	4.60E-01	0.04
Aluminum	2.01	1	1	1.81E-02	1.81E-02	LTV_DAPH	5.40E-01	0.03
Aluminum	2.01	1	1	1.81E-02	1.81E-02	NAWQ_ACU	7.50E-01	0.02
Aluminum	2.01	1	1	1.81E-02	1.81E-02	LCV_DAPH	1.90E+00	0.01
Aluminum	2.01	1	1	1.81E-02	1.81E-02	LCV_FISH	3.29E+00	0.01
Aluminum	2.01	1	1	1.81E-02	1.81E-02	LTV_FISH	4.70E+00	0.00
Aluminum	2.03	1	1	1.66E-02	1.66E-02	NAWQ_CHR	8.70E-02	0.19
Aluminum	2.03	1	1	1.66E-02	1.66E-02	LCV_AQPL	4.60E-01	0.04
Aluminum	2.03	1	1	1.66E-02	1.66E-02	LTV_DAPH	5.40E-01	0.03
Aluminum	2.03	1	1	1.66E-02	1.66E-02	NAWQ_ACU	7.50E-01	0.02
Aluminum	2.03	1	1	1.66E-02	1.66E-02	LCV_DAPH	1.90E+00	0.01
Aluminum	2.03	1	1	1.66E-02	1.66E-02	LCV_FISH	3.29E+00	0.01
Aluminum	2.03	1	1	1.66E-02	1.66E-02	LTV_FISH	4.70E+00	0.00
Aluminum	2.04	6	6	2.05E-02	4.34E-02	NAWQ_CHR	8.70E-02	0.50
Aluminum	2.04	6	6	2.05E-02	4.34E-02	LCV_AQPL	4.60E-01	0.09
Aluminum	2.04	6	6	2.05E-02	4.34E-02	LTV_DAPH	5.40E-01	0.08
Aluminum	2.04	6	6	2.05E-02	4.34E-02	NAWQ_ACU	7.50E-01	0.06

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Aluminum	2.04	6	6	2.05E-02	4.34E-02	LCV_DAPH	1.90E+00	0.02
Aluminum	2.04	6	6	2.05E-02	4.34E-02	LCV_FISH	3.29E+00	0.01
Aluminum	2.04	6	6	2.05E-02	4.34E-02	LTV_FISH	4.70E+00	0.01
Aluminum	3.01	1	2	4.26E-02	4.26E-02	NAWQ_CHR	8.70E-02	0.49
Aluminum	3.01	1	2	4.26E-02	4.26E-02	LCV_AQPL	4.60E-01	0.09
Aluminum	3.01	1	2	4.26E-02	4.26E-02	LTV_DAPH	5.40E-01	0.08
Aluminum	3.01	1	2	4.26E-02	4.26E-02	NAWQ_ACU	7.50E-01	0.06
Aluminum	3.01	1	2	4.26E-02	4.26E-02	LCV_DAPH	1.90E+00	0.02
Aluminum	3.01	1	2	4.26E-02	4.26E-02	LCV_FISH	3.29E+00	0.01
Aluminum	3.01	1	2	4.26E-02	4.26E-02	LTV_FISH	4.70E+00	0.01
Aluminum	3.02	6	8	1.91E-02	7.52E-02	NAWQ_CHR	8.70E-02	0.86
Aluminum	3.02	6	8	1.91E-02	7.52E-02	LCV_AQPL	4.60E-01	0.16
Aluminum	3.02	6	8	1.91E-02	7.52E-02	LTV_DAPH	5.40E-01	0.14
Aluminum	3.02	6	8	1.91E-02	7.52E-02	NAWQ_ACU	7.50E-01	0.10
Aluminum	3.02	6	8	1.91E-02	7.52E-02	LCV_DAPH	1.90E+00	0.04
Aluminum	3.02	6	8	1.91E-02	7.52E-02	LCV_FISH	3.29E+00	0.02
Aluminum	3.02	6	8	1.91E-02	7.52E-02	LTV_FISH	4.70E+00	0.02
Aluminum	3.03	7	9	1.06E-02	3.53E-02	NAWQ_CHR	8.70E-02	0.41
Aluminum	3.03	7	9	1.06E-02	3.53E-02	LCV_AQPL	4.60E-01	0.08
Aluminum	3.03	7	9	1.06E-02	3.53E-02	LTV_DAPH	5.40E-01	0.07
Aluminum	3.03	7	9	1.06E-02	3.53E-02	NAWQ_ACU	7.50E-01	0.05
Aluminum	3.03	7	9	1.06E-02	3.53E-02	LCV_DAPH	1.90E+00	0.02
Aluminum	3.03	7	9	1.06E-02	3.53E-02	LCV_FISH	3.29E+00	0.01
Aluminum	3.03	7	9	1.06E-02	3.53E-02	LTV_FISH	4.70E+00	0.01
Aluminum	**3.04**	**4**	**6**	**2.06E-02**	**8.99E-02**	**NAWQ_CHR**	**8.70E-02**	**1.03**
Aluminum	3.04	4	6	2.06E-02	8.99E-02	LCV_AQPL	4.60E-01	0.20
Aluminum	3.04	4	6	2.06E-02	8.99E-02	LTV_DAPH	5.40E-01	0.17

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Aluminum	3.04	4	6	2.06E-02	8.99E-02	NAWQ_ACU	7.50E-01	0.12
Aluminum	3.04	4	6	2.06E-02	8.99E-02	LCV_DAPH	1.90E+00	0.05
Aluminum	3.04	4	6	2.06E-02	8.99E-02	LCV_FISH	3.29E+00	0.03
Aluminum	3.04	4	6	2.06E-02	8.99E-02	LTV_FISH	4.70E+00	0.02
Aluminum	**4.01**	**9**	**9**	**1.98E-02**	**6.20E-01**	**NAWQ_CHR**	**8.70E-02**	**7.13**
Aluminum	**4.01**	**9**	**9**	**1.98E-02**	**6.20E-01**	**LCV_AQPL**	**4.60E-01**	**1.35**
Aluminum	**4.01**	**9**	**9**	**1.98E-02**	**6.20E-01**	**LTV_DAPH**	**5.40E-01**	**1.15**
Aluminum	4.01	9	9	1.98E-02	6.20E-01	NAWQ_ACU	7.50E-01	0.83
Aluminum	4.01	9	9	1.98E-02	6.20E-01	LCV_DAPH	1.90E+00	0.33
Aluminum	4.01	9	9	1.98E-02	6.20E-01	LCV_FISH	3.29E+00	0.19
Aluminum	4.01	9	9	1.98E-02	6.20E-01	LTV_FISH	4.70E+00	0.13
Aluminum	**4.02**	**6**	**6**	**2.01E-02**	**8.96E-02**	**NAWQ_CHR**	**8.70E-02**	**1.03**
Aluminum	4.02	6	6	2.01E-02	8.96E-02	LCV_AQPL	4.60E-01	0.19
Aluminum	4.02	6	6	2.01E-02	8.96E-02	LTV_DAPH	5.40E-01	0.17
Aluminum	4.02	6	6	2.01E-02	8.96E-02	NAWQ_ACU	7.50E-01	0.12
Aluminum	4.02	6	6	2.01E-02	8.96E-02	LCV_DAPH	1.90E+00	0.05
Aluminum	4.02	6	6	2.01E-02	8.96E-02	LCV_FISH	3.29E+00	0.03
Aluminum	4.02	6	6	2.01E-02	8.96E-02	LTV_FISH	4.70E+00	0.02
Aluminum	4.03	6	7	1.61E-02	3.35E-02	NAWQ_CHR	8.70E-02	0.39
Aluminum	4.03	6	7	1.61E-02	3.35E-02	LCV_AQPL	4.60E-01	0.07
Aluminum	4.03	6	7	1.61E-02	3.35E-02	LTV_DAPH	5.40E-01	0.06
Aluminum	4.03	6	7	1.61E-02	3.35E-02	NAWQ_ACU	7.50E-01	0.04
Aluminum	4.03	6	7	1.61E-02	3.35E-02	LCV_DAPH	1.90E+00	0.02
Aluminum	4.03	6	7	1.61E-02	3.35E-02	LCV_FISH	3.29E+00	0.01
Aluminum	4.03	6	7	1.61E-02	3.35E-02	LTV_FISH	4.70E+00	0.01
Aluminum	**4.04**	**11**	**11**	**2.84E-02**	**1.20E-01**	**NAWQ_CHR**	**8.70E-02**	**1.38**
Aluminum	4.04	11	11	2.84E-02	1.20E-01	LCV_AQPL	4.60E-01	0.26

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Aluminum	4.04	11	11	2.84E-02	1.20E-01	LTV_DAPH	5.40E-01	0.22
Aluminum	4.04	11	11	2.84E-02	1.20E-01	NAWQ_ACU	7.50E-01	0.16
Aluminum	4.04	11	11	2.84E-02	1.20E-01	LCV_DAPH	1.90E+00	0.06
Aluminum	4.04	11	11	2.84E-02	1.20E-01	LCV_FISH	3.29E+00	0.04
Aluminum	4.04	11	11	2.84E-02	1.20E-01	LTV_FISH	4.70E+00	0.03
Aluminum	7.01	1	1	3.07E-02	3.07E-02	NAWQ_CHR	8.70E-02	0.35
Aluminum	7.01	1	1	3.07E-02	3.07E-02	LCV_AQPL	4.60E-01	0.07
Aluminum	7.01	1	1	3.07E-02	3.07E-02	LTV_DAPH	5.40E-01	0.06
Aluminum	7.01	1	1	3.07E-02	3.07E-02	NAWQ_ACU	7.50E-01	0.04
Aluminum	7.01	1	1	3.07E-02	3.07E-02	LCV_DAPH	1.90E+00	0.02
Aluminum	7.01	1	1	3.07E-02	3.07E-02	LCV_FISH	3.29E+00	0.01
Aluminum	7.01	1	1	3.07E-02	3.07E-02	LTV_FISH	4.70E+00	0.01
Aluminum	**7.02**	**1**	**1**	**2.72E-01**	**2.72E-01**	**NAWQ_CHR**	**8.70E-02**	**3.13**
Aluminum	7.02	1	1	2.72E-01	2.72E-01	LCV_AQPL	4.60E-01	0.59
Aluminum	7.02	1	1	2.72E-01	2.72E-01	LTV_DAPH	5.40E-01	0.50
Aluminum	7.02	1	1	2.72E-01	2.72E-01	NAWQ_ACU	7.50E-01	0.36
Aluminum	7.02	1	1	2.72E-01	2.72E-01	LCV_DAPH	1.90E+00	0.14
Aluminum	7.02	1	1	2.72E-01	2.72E-01	LCV_FISH	3.29E+00	0.08
Aluminum	7.02	1	1	2.72E-01	2.72E-01	LTV_FISH	4.70E+00	0.06
Aluminum	8	1	1	2.66E-02	2.66E-02	NAWQ_CHR	8.70E-02	0.31
Aluminum	8	1	1	2.66E-02	2.66E-02	LCV_AQPL	4.60E-01	0.06
Aluminum	8	1	1	2.66E-02	2.66E-02	LTV_DAPH	5.40E-01	0.05
Aluminum	8	1	1	2.66E-02	2.66E-02	NAWQ_ACU	7.50E-01	0.04
Aluminum	8	1	1	2.66E-02	2.66E-02	LCV_DAPH	1.90E+00	0.01
Aluminum	8	1	1	2.66E-02	2.66E-02	LCV_FISH	3.29E+00	0.01
Aluminum	8	1	1	2.66E-02	2.66E-02	LTV_FISH	4.70E+00	0.01
Aluminum	**18**	**3**	**3**	**4.17E-02**	**3.13E-01**	**NAWQ_CHR**	**8.70E-02**	**3.60**

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Aluminum	18	3	3	4.17E-02	3.13E-01	LCV_AQPL	4.60E-01	0.68
Aluminum	18	3	3	4.17E-02	3.13E-01	LTV_DAPH	5.40E-01	0.58
Aluminum	18	3	3	4.17E-02	3.13E-01	NAWQ_ACU	7.50E-01	0.42
Aluminum	18	3	3	4.17E-02	3.13E-01	LCV_DAPH	1.90E+00	0.16
Aluminum	18	3	3	4.17E-02	3.13E-01	LCV_FISH	3.29E+00	0.10
Aluminum	18	3	3	4.17E-02	3.13E-01	LTV_FISH	4.70E+00	0.07
Arsenic	2.04	2	6	2.10E-03	3.30E-03	NAWQ_CHR	1.90E-01	0.02
Arsenic	2.04	2	6	2.10E-03	3.30E-03	NAWQ_ACU	3.60E-01	0.01
Arsenic	2.04	2	6	2.10E-03	3.30E-03	LTV_DAPH	6.33E-01	0.01
Arsenic	2.04	2	6	2.10E-03	3.30E-03	LCV_DAPH	9.14E-01	0.00
Arsenic	2.04	2	6	2.10E-03	3.30E-03	LTV_FISH	2.13E+00	0.00
Arsenic	2.04	2	6	2.10E-03	3.30E-03	LCV_FISH	2.96E+00	0.00
Arsenic	3.02	5	8	1.40E-03	6.40E-03	NAWQ_CHR	1.90E-01	0.03
Arsenic	3.02	5	8	1.40E-03	6.40E-03	NAWQ_ACU	3.60E-01	0.02
Arsenic	3.02	5	8	1.40E-03	6.40E-03	LTV_DAPH	6.33E-01	0.01
Arsenic	3.02	5	8	1.40E-03	6.40E-03	LCV_DAPH	9.14E-01	0.01
Arsenic	3.02	5	8	1.40E-03	6.40E-03	LTV_FISH	2.13E+00	0.00
Arsenic	3.02	5	8	1.40E-03	6.40E-03	LCV_FISH	2.96E+00	0.00
Arsenic	3.03	3	9	2.09E-03	1.00E-02	NAWQ_CHR	1.90E-01	0.05
Arsenic	3.03	3	9	2.09E-03	1.00E-02	NAWQ_ACU	3.60E-01	0.03
Arsenic	3.03	3	9	2.09E-03	1.00E-02	LTV_DAPH	6.33E-01	0.02
Arsenic	3.03	3	9	2.09E-03	1.00E-02	LCV_DAPH	9.14E-01	0.01
Arsenic	3.03	3	9	2.09E-03	1.00E-02	LTV_FISH	2.13E+00	0.00
Arsenic	3.03	3	9	2.09E-03	1.00E-02	LCV_FISH	2.96E+00	0.00
Arsenic	3.04	6	6	5.85E-03	1.24E-01	NAWQ_CHR	1.90E-01	0.65
Arsenic	3.04	6	6	5.85E-03	1.24E-01	NAWQ_ACU	3.60E-01	0.34
Arsenic	3.04	6	6	5.85E-03	1.24E-01	LTV_DAPH	6.33E-01	0.20

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Arsenic	3.04	6	6	5.85E-03	1.24E-01	LCV_DAPH	9.14E-01	0.14
Arsenic	3.04	6	6	5.85E-03	1.24E-01	LTV_FISH	2.13E+00	0.06
Arsenic	3.04	6	6	5.85E-03	1.24E-01	LCV_FISH	2.96E+00	0.04
Arsenic	4.02	2	6	1.10E-03	2.80E-03	NAWQ_CHR	1.90E-01	0.01
Arsenic	4.02	2	6	1.10E-03	2.80E-03	NAWQ_ACU	3.60E-01	0.01
Arsenic	4.02	2	6	1.10E-03	2.80E-03	LTV_DAPH	6.33E-01	0.00
Arsenic	4.02	2	6	1.10E-03	2.80E-03	LCV_DAPH	9.14E-01	0.00
Arsenic	4.02	2	6	1.10E-03	2.80E-03	LTV_FISH	2.13E+00	0.00
Arsenic	4.02	2	6	1.10E-03	2.80E-03	LCV_FISH	2.96E+00	0.00
Arsenic	4.03	2	7	1.62E-03	1.70E-03	NAWQ_CHR	1.90E-01	0.01
Arsenic	4.03	2	7	1.62E-03	1.70E-03	NAWQ_ACU	3.60E-01	0.00
Arsenic	4.03	2	7	1.62E-03	1.70E-03	LTV_DAPH	6.33E-01	0.00
Arsenic	4.03	2	7	1.62E-03	1.70E-03	LCV_DAPH	9.14E-01	0.00
Arsenic	4.03	2	7	1.62E-03	1.70E-03	LTV_FISH	2.13E+00	0.00
Arsenic	4.03	2	7	1.62E-03	1.70E-03	LCV_FISH	2.96E+00	0.00
Arsenic	4.04	5	11	1.60E-03	3.90E-03	NAWQ_CHR	1.90E-01	0.02
Arsenic	4.04	5	11	1.60E-03	3.90E-03	NAWQ_ACU	3.60E-01	0.01
Arsenic	4.04	5	11	1.60E-03	3.90E-03	LTV_DAPH	6.33E-01	0.01
Arsenic	4.04	5	11	1.60E-03	3.90E-03	LCV_DAPH	9.14E-01	0.00
Arsenic	4.04	5	11	1.60E-03	3.90E-03	LTV_FISH	2.13E+00	0.00
Arsenic	4.04	5	11	1.60E-03	3.90E-03	LCV_FISH	2.96E+00	0.00
Arsenic	7.01	1	1	1.26E-01	1.26E-01	NAWQ_CHR	1.90E-01	0.66
Arsenic	7.01	1	1	1.26E-01	1.26E-01	NAWQ_ACU	3.60E-01	0.35
Arsenic	7.01	1	1	1.26E-01	1.26E-01	LTV_DAPH	6.33E-01	0.20
Arsenic	7.01	1	1	1.26E-01	1.26E-01	LCV_DAPH	9.14E-01	0.14
Arsenic	7.01	1	1	1.26E-01	1.26E-01	LTV_FISH	2.13E+00	0.06
Arsenic	7.01	1	1	1.26E-01	1.26E-01	LCV_FISH	2.96E+00	0.04

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Arsenic	7.02	1	1	1.45E-02	1.45E-02	NAWQ_CHR	1.90E-01	0.08
Arsenic	7.02	1	1	1.45E-02	1.45E-02	NAWQ_ACU	3.60E-01	0.04
Arsenic	7.02	1	1	1.45E-02	1.45E-02	LTV_DAPH	6.33E-01	0.02
Arsenic	7.02	1	1	1.45E-02	1.45E-02	LCV_DAPH	9.14E-01	0.02
Arsenic	7.02	1	1	1.45E-02	1.45E-02	LTV_FISH	2.13E+00	0.01
Arsenic	7.02	1	1	1.45E-02	1.45E-02	LCV_FISH	2.96E+00	0.00
Arsenic	18	2	3	1.20E-03	1.30E-03	NAWQ_CHR	1.90E-01	0.01
Arsenic	18	2	3	1.20E-03	1.30E-03	NAWQ_ACU	3.60E-01	0.00
Arsenic	18	2	3	1.20E-03	1.30E-03	LTV_DAPH	6.33E-01	0.00
Arsenic	18	2	3	1.20E-03	1.30E-03	LCV_DAPH	9.14E-01	0.00
Arsenic	18	2	3	1.20E-03	1.30E-03	LTV_FISH	2.13E+00	0.00
Arsenic	18	2	3	1.20E-03	1.30E-03	LCV_FISH	2.96E+00	0.00
Barium	**0**	**5**	**5**	**9.57E-02**	**9.97E-02**	**S_CHR_V**	**3.80E-03**	**26.24**
Barium	**0**	**5**	**5**	**9.57E-02**	**9.97E-02**	**S_ACU_V**	**6.91E-02**	**1.44**
Barium	0	5	5	9.57E-02	9.97E-02	LCV_DAPH	5.80E+00	0.02
Barium	**2.01**	**1**	**1**	**9.74E-02**	**9.74E-02**	**S_CHR_V**	**3.80E-03**	**25.63**
Barium	**2.01**	**1**	**1**	**9.74E-02**	**9.74E-02**	**S_ACU_V**	**6.91E-02**	**1.41**
Barium	2.01	1	1	9.74E-02	9.74E-02	LCV_DAPH	5.80E+00	0.02
Barium	**2.03**	**1**	**1**	**2.83E-02**	**2.83E-02**	**S_CHR_V**	**3.80E-03**	**7.45**
Barium	2.03	1	1	2.83E-02	2.83E-02	S_ACU_V	6.91E-02	0.41
Barium	2.03	1	1	2.83E-02	2.83E-02	LCV_DAPH	5.80E+00	0.00
Barium	**2.04**	**6**	**6**	**4.28E-02**	**8.69E-02**	**S_CHR_V**	**3.80E-03**	**22.88**
Barium	**2.04**	**6**	**6**	**4.28E-02**	**8.69E-02**	**S_ACU_V**	**6.91E-02**	**1.26**
Barium	2.04	6	6	4.28E-02	8.69E-02	LCV_DAPH	5.80E+00	0.01
Barium	**3.01**	**2**	**2**	**3.73E-02**	**4.72E-02**	**S_CHR_V**	**3.80E-03**	**12.42**
Barium	3.01	2	2	3.73E-02	4.72E-02	S_ACU_V	6.91E-02	0.68
Barium	3.01	2	2	3.73E-02	4.72E-02	LCV_DAPH	5.80E+00	0.01

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Barium	**3.02**	**8**	**8**	**6.32E-02**	**1.18E-01**	**S_CHR_V**	**3.80E-03**	**31.05**
Barium	**3.02**	**8**	**8**	**6.32E-02**	**1.18E-01**	**S_ACU_V**	**6.91E-02**	**1.71**
Barium	3.02	8	8	6.32E-02	1.18E-01	LCV_DAPH	5.80E+00	0.02
Barium	**3.03**	**9**	**9**	**4.57E-02**	**8.65E-02**	**S_CHR_V**	**3.80E-03**	**22.77**
Barium	**3.03**	**9**	**9**	**4.57E-02**	**8.65E-02**	**S_ACU_V**	**6.91E-02**	**1.25**
Barium	3.03	9	9	4.57E-02	8.65E-02	LCV_DAPH	5.80E+00	0.01
Barium	**3.04**	**6**	**6**	**6.49E-02**	**1.09E-01**	**S_CHR_V**	**3.80E-03**	**28.68**
Barium	**3.04**	**6**	**6**	**6.49E-02**	**1.09E-01**	**S_ACU_V**	**6.91E-02**	**1.58**
Barium	3.04	6	6	6.49E-02	1.09E-01	LCV_DAPH	5.80E+00	0.02
Barium	**4.01**	**9**	**9**	**4.14E-02**	**5.56E-02**	**S_CHR_V**	**3.80E-03**	**14.63**
Barium	4.01	9	9	4.14E-02	5.56E-02	S_ACU_V	6.91E-02	0.80
Barium	4.01	9	9	4.14E-02	5.56E-02	LCV_DAPH	5.80E+00	0.01
Barium	**4.02**	**6**	**6**	**6.10E-02**	**8.75E-02**	**S_CHR_V**	**3.80E-03**	**23.03**
Barium	**4.02**	**6**	**6**	**6.10E-02**	**8.75E-02**	**S_ACU_V**	**6.91E-02**	**1.27**
Barium	4.02	6	6	6.10E-02	8.75E-02	LCV_DAPH	5.80E+00	0.02
Barium	**4.03**	**7**	**7**	**4.96E-02**	**2.21E-01**	**S_CHR_V**	**3.80E-03**	**58.07**
Barium	**4.03**	**7**	**7**	**4.96E-02**	**2.21E-01**	**S_ACU_V**	**6.91E-02**	**3.19**
Barium	4.03	7	7	4.96E-02	2.21E-01	LCV_DAPH	5.80E+00	0.04
Barium	**4.04**	**11**	**11**	**4.14E-02**	**2.03E-01**	**S_CHR_V**	**3.80E-03**	**53.42**
Barium	**4.04**	**11**	**11**	**4.14E-02**	**2.03E-01**	**S_ACU_V**	**6.91E-02**	**2.94**
Barium	4.04	11	11	4.14E-02	2.03E-01	LCV_DAPH	5.80E+00	0.04
Barium	**7.01**	**1**	**1**	**6.04E-02**	**6.04E-02**	**S_CHR_V**	**3.80E-03**	**15.89**
Barium	7.01	1	1	6.04E-02	6.04E-02	S_ACU_V	6.91E-02	0.87
Barium	7.01	1	1	6.04E-02	6.04E-02	LCV_DAPH	5.80E+00	0.01
Barium	**7.02**	**1**	**1**	**6.23E-02**	**6.23E-02**	**S_CHR_V**	**3.80E-03**	**16.39**
Barium	7.02	1	1	6.23E-02	6.23E-02	S_ACU_V	6.91E-02	0.90
Barium	7.02	1	1	6.23E-02	6.23E-02	LCV_DAPH	5.80E+00	0.01

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Barium	**8**	**1**	**1**	**5.36E-02**	**5.36E-02**	**S_CHR_V**	**3.80E-03**	**14.11**
Barium	8	1	1	5.36E-02	5.36E-02	S_ACU_V	6.91E-02	0.78
Barium	8	1	1	5.36E-02	5.36E-02	LCV_DAPH	5.80E+00	0.01
Barium	**13**	**5**	**5**	**6.98E-02**	**1.24E-01**	**S_CHR_V**	**3.80E-03**	**32.63**
Barium	**13**	**5**	**5**	**6.98E-02**	**1.24E-01**	**S_ACU_V**	**6.91E-02**	**1.79**
Barium	13	5	5	6.98E-02	1.24E-01	LCV_DAPH	5.80E+00	0.02
Barium	**18**	**3**	**3**	**5.69E-02**	**6.49E-02**	**S_CHR_V**	**3.80E-03**	**17.08**
Barium	18	3	3	5.69E-02	6.49E-02	S_ACU_V	6.91E-02	0.94
Barium	18	3	3	5.69E-02	6.49E-02	LCV_DAPH	5.80E+00	0.01
Boron	**0**	**4**	**5**	**3.96E-02**	**1.71E-01**	**LTV_DAPH**	**7.00E-03**	**24.43**
Boron	0	4	5	3.96E-02	1.71E-01	S_CHR_V	5.47E-01	0.31
Boron	0	4	5	3.96E-02	1.71E-01	LCV_DAPH	8.83E+00	0.02
Boron	0	4	5	3.96E-02	1.71E-01	S_ACU_V	1.10E+01	0.02
Boron	**2.04**	**4**	**6**	**3.55E-02**	**6.69E-02**	**LTV_DAPH**	**7.00E-03**	**9.56**
Boron	2.04	4	6	3.55E-02	6.69E-02	S_CHR_V	5.47E-01	0.12
Boron	2.04	4	6	3.55E-02	6.69E-02	LCV_DAPH	8.83E+00	0.01
Boron	2.04	4	6	3.55E-02	6.69E-02	S_ACU_V	1.10E+01	0.01
Boron	**3.01**	**1**	**2**	**5.49E-02**	**5.49E-02**	**LTV_DAPH**	**7.00E-03**	**7.84**
Boron	3.01	1	2	5.49E-02	5.49E-02	S_CHR_V	5.47E-01	0.10
Boron	3.01	1	2	5.49E-02	5.49E-02	LCV_DAPH	8.83E+00	0.01
Boron	3.01	1	2	5.49E-02	5.49E-02	S_ACU_V	1.10E+01	0.00
Boron	**3.02**	**6**	**8**	**6.78E-02**	**9.65E-02**	**LTV_DAPH**	**7.00E-03**	**13.79**
Boron	3.02	6	8	6.78E-02	9.65E-02	S_CHR_V	5.47E-01	0.18
Boron	3.02	6	8	6.78E-02	9.65E-02	LCV_DAPH	8.83E+00	0.01
Boron	3.02	6	8	6.78E-02	9.65E-02	S_ACU_V	1.10E+01	0.01
Boron	**3.03**	**8**	**9**	**4.52E-02**	**8.88E-02**	**LTV_DAPH**	**7.00E-03**	**12.69**
Boron	3.03	8	9	4.52E-02	8.88E-02	S_CHR_V	5.47E-01	0.16

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Boron	3.03	8	9	4.52E-02	8.88E-02	LCV_DAPH	8.83E+00	0.01
Boron	3.03	8	9	4.52E-02	8.88E-02	S_ACU_V	1.10E+01	0.01
Boron	**3.04**	**5**	**6**	**9.97E-02**	**1.17E+00**	**LTV_DAPH**	**7.00E-03**	**167.14**
Boron	**3.04**	**5**	**6**	**9.97E-02**	**1.17E+00**	**S_CHR_V**	**5.47E-01**	**2.14**
Boron	3.04	5	6	9.97E-02	1.17E+00	LCV_DAPH	8.83E+00	0.13
Boron	3.04	5	6	9.97E-02	1.17E+00	S_ACU_V	1.10E+01	0.11
Boron	**4.01**	**9**	**9**	**2.82E-02**	**6.29E-02**	**LTV_DAPH**	**7.00E-03**	**8.99**
Boron	4.01	9	9	2.82E-02	6.29E-02	S_CHR_V	5.47E-01	0.11
Boron	4.01	9	9	2.82E-02	6.29E-02	LCV_DAPH	8.83E+00	0.01
Boron	4.01	9	9	2.82E-02	6.29E-02	S_ACU_V	1.10E+01	0.01
Boron	**4.02**	**5**	**6**	**4.29E-02**	**4.75E-02**	**LTV_DAPH**	**7.00E-03**	**6.79**
Boron	4.02	5	6	4.29E-02	4.75E-02	S_CHR_V	5.47E-01	0.09
Boron	4.02	5	6	4.29E-02	4.75E-02	LCV_DAPH	8.83E+00	0.01
Boron	4.02	5	6	4.29E-02	4.75E-02	S_ACU_V	1.10E+01	0.00
Boron	**4.03**	**6**	**7**	**3.56E-02**	**4.97E-02**	**LTV_DAPH**	**7.00E-03**	**7.10**
Boron	4.03	6	7	3.56E-02	4.97E-02	S_CHR_V	5.47E-01	0.09
Boron	4.03	6	7	3.56E-02	4.97E-02	LCV_DAPH	8.83E+00	0.01
Boron	4.03	6	7	3.56E-02	4.97E-02	S_ACU_V	1.10E+01	0.00
Boron	**4.04**	**11**	**11**	**2.98E-02**	**4.01E-02**	**LTV_DAPH**	**7.00E-03**	**5.73**
Boron	4.04	11	11	2.98E-02	4.01E-02	S_CHR_V	5.47E-01	0.07
Boron	4.04	11	11	2.98E-02	4.01E-02	LCV_DAPH	8.83E+00	0.00
Boron	4.04	11	11	2.98E-02	4.01E-02	S_ACU_V	1.10E+01	0.00
Boron	**7.01**	**1**	**1**	**4.35E-02**	**4.35E-02**	**LTV_DAPH**	**7.00E-03**	**6.21**
Boron	7.01	1	1	4.35E-02	4.35E-02	S_CHR_V	5.47E-01	0.08
Boron	7.01	1	1	4.35E-02	4.35E-02	LCV_DAPH	8.83E+00	0.00
Boron	7.01	1	1	4.35E-02	4.35E-02	S_ACU_V	1.10E+01	0.00
Boron	**7.02**	**1**	**1**	**3.45E-02**	**3.45E-02**	**LTV_DAPH**	**7.00E-03**	**4.93**

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Boron	7.02	1	1	3.45E-02	3.45E-02	S_CHR_V	5.47E-01	0.06
Boron	7.02	1	1	3.45E-02	3.45E-02	LCV_DAPH	8.83E+00	0.00
Boron	7.02	1	1	3.45E-02	3.45E-02	S_ACU_V	1.10E+01	0.00
Boron	**13**	**2**	**5**	**2.59E-02**	**4.76E-02**	**LTV_DAPH**	**7.00E-03**	**6.80**
Boron	13	2	5	2.59E-02	4.76E-02	S_CHR_V	5.47E-01	0.09
Boron	13	2	5	2.59E-02	4.76E-02	LCV_DAPH	8.83E+00	0.01
Boron	13	2	5	2.59E-02	4.76E-02	S_ACU_V	1.10E+01	0.00
Boron	**18**	**3**	**3**	**3.37E-02**	**3.85E-02**	**LTV_DAPH**	**7.00E-03**	**5.50**
Boron	18	3	3	3.37E-02	3.85E-02	S_CHR_V	5.47E-01	0.07
Boron	18	3	3	3.37E-02	3.85E-02	LCV_DAPH	8.83E+00	0.00
Boron	18	3	3	3.37E-02	3.85E-02	S_ACU_V	1.10E+01	0.00
Cadmium	**4.04**	**1**	**11**	**1.00E-03**	**1.00E-03**	**LCV_DAPH**	**1.50E-04**	**6.67**
Cadmium	**4.04**	**1**	**11**	**1.00E-03**	**1.00E-03**	**LTV_DAPH**	**7.50E-04**	**1.33**
Cadmium	4.04	1	11	1.00E-03	1.00E-03	NAWQ_CHR	1.10E-03	0.91
Cadmium	4.04	1	11	1.00E-03	1.00E-03	LCV_FISH	1.70E-03	0.59
Cadmium	4.04	1	11	1.00E-03	1.00E-03	LTV_FISH	1.80E-03	0.56
Cadmium	4.04	1	11	1.00E-03	1.00E-03	LCV_AQPL	2.00E-03	0.50
Cadmium	4.04	1	11	1.00E-03	1.00E-03	NAWQ_ACU	3.90E-03	0.26
Chromium	0	4	5	1.62E-03	1.90E-03	LCV_DAPH	4.40E-02	0.04
Chromium	0	4	5	1.62E-03	1.90E-03	LCV_FISH	6.88E-02	0.03
Chromium	0	4	5	1.62E-03	1.90E-03	LTV_FISH	8.90E-02	0.02
Chromium	0	4	5	1.62E-03	1.90E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	0	4	5	1.62E-03	1.90E-03	LCV_AQPL	3.97E-01	0.00
Chromium	0	4	5	1.62E-03	1.90E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	2.04	4	6	1.05E-03	2.30E-03	LCV_DAPH	4.40E-02	0.05
Chromium	2.04	4	6	1.05E-03	2.30E-03	LCV_FISH	6.88E-02	0.03
Chromium	2.04	4	6	1.05E-03	2.30E-03	LTV_FISH	8.90E-02	0.03

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Chromium	2.04	4	6	1.05E-03	2.30E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	2.04	4	6	1.05E-03	2.30E-03	LCV_AQPL	3.97E-01	0.01
Chromium	2.04	4	6	1.05E-03	2.30E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	3.01	2	2	2.05E-03	2.80E-03	LCV_DAPH	4.40E-02	0.06
Chromium	3.01	2	2	2.05E-03	2.80E-03	LCV_FISH	6.88E-02	0.04
Chromium	3.01	2	2	2.05E-03	2.80E-03	LTV_FISH	8.90E-02	0.03
Chromium	3.01	2	2	2.05E-03	2.80E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	3.01	2	2	2.05E-03	2.80E-03	LCV_AQPL	3.97E-01	0.01
Chromium	3.01	2	2	2.05E-03	2.80E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	3.02	7	8	2.00E-03	2.70E-03	LCV_DAPH	4.40E-02	0.06
Chromium	3.02	7	8	2.00E-03	2.70E-03	LCV_FISH	6.88E-02	0.04
Chromium	3.02	7	8	2.00E-03	2.70E-03	LTV_FISH	8.90E-02	0.03
Chromium	3.02	7	8	2.00E-03	2.70E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	3.02	7	8	2.00E-03	2.70E-03	LCV_AQPL	3.97E-01	0.01
Chromium	3.02	7	8	2.00E-03	2.70E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	3.03	7	9	2.10E-03	3.70E-03	LCV_DAPH	4.40E-02	0.08
Chromium	3.03	7	9	2.10E-03	3.70E-03	LCV_FISH	6.88E-02	0.05
Chromium	3.03	7	9	2.10E-03	3.70E-03	LTV_FISH	8.90E-02	0.04
Chromium	3.03	7	9	2.10E-03	3.70E-03	NAWQ_CHR	2.10E-01	0.02
Chromium	3.03	7	9	2.10E-03	3.70E-03	LCV_AQPL	3.97E-01	0.01
Chromium	3.03	7	9	2.10E-03	3.70E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	3.04	4	6	1.13E-03	2.85E-03	LCV_DAPH	4.40E-02	0.06
Chromium	3.04	4	6	1.13E-03	2.85E-03	LCV_FISH	6.88E-02	0.04
Chromium	3.04	4	6	1.13E-03	2.85E-03	LTV_FISH	8.90E-02	0.03
Chromium	3.04	4	6	1.13E-03	2.85E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	3.04	4	6	1.13E-03	2.85E-03	LCV_AQPL	3.97E-01	0.01
Chromium	3.04	4	6	1.13E-03	2.85E-03	NAWQ_ACU	1.70E+00	0.00

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Chromium	4.01	8	9	1.80E-03	2.70E-03	LCV_DAPH	4.40E-02	0.06
Chromium	4.01	8	9	1.80E-03	2.70E-03	LCV_FISH	6.88E-02	0.04
Chromium	4.01	8	9	1.80E-03	2.70E-03	LTV_FISH	8.90E-02	0.03
Chromium	4.01	8	9	1.80E-03	2.70E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	4.01	8	9	1.80E-03	2.70E-03	LCV_AQPL	3.97E-01	0.01
Chromium	4.01	8	9	1.80E-03	2.70E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	4.02	3	6	1.00E-03	2.20E-03	LCV_DAPH	4.40E-02	0.05
Chromium	4.02	3	6	1.00E-03	2.20E-03	LCV_FISH	6.88E-02	0.03
Chromium	4.02	3	6	1.00E-03	2.20E-03	LTV_FISH	8.90E-02	0.02
Chromium	4.02	3	6	1.00E-03	2.20E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	4.02	3	6	1.00E-03	2.20E-03	LCV_AQPL	3.97E-01	0.01
Chromium	4.02	3	6	1.00E-03	2.20E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	4.03	5	7	1.10E-03	2.03E-03	LCV_DAPH	4.40E-02	0.05
Chromium	4.03	5	7	1.10E-03	2.03E-03	LCV_FISH	6.88E-02	0.03
Chromium	4.03	5	7	1.10E-03	2.03E-03	LTV_FISH	8.90E-02	0.02
Chromium	4.03	5	7	1.10E-03	2.03E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	4.03	5	7	1.10E-03	2.03E-03	LCV_AQPL	3.97E-01	0.01
Chromium	4.03	5	7	1.10E-03	2.03E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	4.04	9	11	1.20E-03	3.10E-03	LCV_DAPH	4.40E-02	0.07
Chromium	4.04	9	11	1.20E-03	3.10E-03	LCV_FISH	6.88E-02	0.05
Chromium	4.04	9	11	1.20E-03	3.10E-03	LTV_FISH	8.90E-02	0.03
Chromium	4.04	9	11	1.20E-03	3.10E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	4.04	9	11	1.20E-03	3.10E-03	LCV_AQPL	3.97E-01	0.01
Chromium	4.04	9	11	1.20E-03	3.10E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	7.01	1	1	1.10E-03	1.10E-03	LCV_DAPH	4.40E-02	0.03
Chromium	7.01	1	1	1.10E-03	1.10E-03	LCV_FISH	6.88E-02	0.02
Chromium	7.01	1	1	1.10E-03	1.10E-03	LTV_FISH	8.90E-02	0.01

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Chromium	7.01	1	1	1.10E-03	1.10E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	7.01	1	1	1.10E-03	1.10E-03	LCV_AQPL	3.97E-01	0.00
Chromium	7.01	1	1	1.10E-03	1.10E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	8	1	1	1.10E-03	1.10E-03	LCV_DAPH	4.40E-02	0.03
Chromium	8	1	1	1.10E-03	1.10E-03	LCV_FISH	6.88E-02	0.02
Chromium	8	1	1	1.10E-03	1.10E-03	LTV_FISH	8.90E-02	0.01
Chromium	8	1	1	1.10E-03	1.10E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	8	1	1	1.10E-03	1.10E-03	LCV_AQPL	3.97E-01	0.00
Chromium	8	1	1	1.10E-03	1.10E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	13	1	5	1.50E-03	1.50E-03	LCV_DAPH	4.40E-02	0.03
Chromium	13	1	5	1.50E-03	1.50E-03	LCV_FISH	6.88E-02	0.02
Chromium	13	1	5	1.50E-03	1.50E-03	LTV_FISH	8.90E-02	0.02
Chromium	13	1	5	1.50E-03	1.50E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	13	1	5	1.50E-03	1.50E-03	LCV_AQPL	3.97E-01	0.00
Chromium	13	1	5	1.50E-03	1.50E-03	NAWQ_ACU	1.70E+00	0.00
Chromium	18	3	3	1.10E-03	1.20E-03	LCV_DAPH	4.40E-02	0.03
Chromium	18	3	3	1.10E-03	1.20E-03	LCV_FISH	6.88E-02	0.02
Chromium	18	3	3	1.10E-03	1.20E-03	LTV_FISH	8.90E-02	0.01
Chromium	18	3	3	1.10E-03	1.20E-03	NAWQ_CHR	2.10E-01	0.01
Chromium	18	3	3	1.10E-03	1.20E-03	LCV_AQPL	3.97E-01	0.00
Chromium	18	3	3	1.10E-03	1.20E-03	NAWQ_ACU	1.70E+00	0.00
Cobalt	**0**	**3**	**5**	**1.15E-03**	**3.30E-03**	**S_CHR_V**	**3.06E-03**	**1.08**
Cobalt	0	3	5	1.15E-03	3.30E-03	LTV_DAPH	4.40E-03	0.75
Cobalt	0	3	5	1.15E-03	3.30E-03	LCV_DAPH	5.10E-03	0.65
Cobalt	0	3	5	1.15E-03	3.30E-03	S_ACU_V	1.95E-01	0.02
Cobalt	0	3	5	1.15E-03	3.30E-03	LCV_FISH	2.90E-01	0.01
Cobalt	0	3	5	1.15E-03	3.30E-03	LTV_FISH	8.10E-01	0.00

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Cobalt	2.01	1	1	1.90E-03	1.90E-03	S_CHR_V	3.06E-03	0.62
Cobalt	2.01	1	1	1.90E-03	1.90E-03	LTV_DAPH	4.40E-03	0.43
Cobalt	2.01	1	1	1.90E-03	1.90E-03	LCV_DAPH	5.10E-03	0.37
Cobalt	2.01	1	1	1.90E-03	1.90E-03	S_ACU_V	1.95E-01	0.01
Cobalt	2.01	1	1	1.90E-03	1.90E-03	LCV_FISH	2.90E-01	0.01
Cobalt	2.01	1	1	1.90E-03	1.90E-03	LTV_FISH	8.10E-01	0.00
Cobalt	2.04	1	6	1.50E-03	1.50E-03	S_CHR_V	3.06E-03	0.49
Cobalt	2.04	1	6	1.50E-03	1.50E-03	LTV_DAPH	4.40E-03	0.34
Cobalt	2.04	1	6	1.50E-03	1.50E-03	LCV_DAPH	5.10E-03	0.29
Cobalt	2.04	1	6	1.50E-03	1.50E-03	S_ACU_V	1.95E-01	0.01
Cobalt	2.04	1	6	1.50E-03	1.50E-03	LCV_FISH	2.90E-01	0.01
Cobalt	2.04	1	6	1.50E-03	1.50E-03	LTV_FISH	8.10E-01	0.00
Cobalt	**3.01**	**2**	**2**	**1.03E-02**	**1.39E-02**	**S_CHR_V**	**3.06E-03**	**4.54**
Cobalt	**3.01**	**2**	**2**	**1.03E-02**	**1.39E-02**	**LTV_DAPH**	**4.40E-03**	**3.16**
Cobalt	**3.01**	**2**	**2**	**1.03E-02**	**1.39E-02**	**LCV_DAPH**	**5.10E-03**	**2.73**
Cobalt	3.01	2	2	1.03E-02	1.39E-02	S_ACU_V	1.95E-01	0.07
Cobalt	3.01	2	2	1.03E-02	1.39E-02	LCV_FISH	2.90E-01	0.05
Cobalt	3.01	2	2	1.03E-02	1.39E-02	LTV_FISH	8.10E-01	0.02
Cobalt	**3.02**	**7**	**8**	**2.15E-03**	**4.00E-03**	**S_CHR_V**	**3.06E-03**	**1.31**
Cobalt	3.02	7	8	2.15E-03	4.00E-03	LTV_DAPH	4.40E-03	0.91
Cobalt	3.02	7	8	2.15E-03	4.00E-03	LCV_DAPH	5.10E-03	0.78
Cobalt	3.02	7	8	2.15E-03	4.00E-03	S_ACU_V	1.95E-01	0.02
Cobalt	3.02	7	8	2.15E-03	4.00E-03	LCV_FISH	2.90E-01	0.01
Cobalt	3.02	7	8	2.15E-03	4.00E-03	LTV_FISH	8.10E-01	0.00
Cobalt	**3.03**	**8**	**9**	**2.40E-03**	**6.52E-03**	**S_CHR_V**	**3.06E-03**	**2.13**
Cobalt	**3.03**	**8**	**9**	**2.40E-03**	**6.52E-03**	**LTV_DAPH**	**4.40E-03**	**1.48**
Cobalt	**3.03**	**8**	**9**	**2.40E-03**	**6.52E-03**	**LCV_DAPH**	**5.10E-03**	**1.28**

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Cobalt	3.03	8	9	2.40E-03	6.52E-03	S_ACU_V	1.95E-01	0.03
Cobalt	3.03	8	9	2.40E-03	6.52E-03	LCV_FISH	2.90E-01	0.02
Cobalt	3.03	8	9	2.40E-03	6.52E-03	LTV_FISH	8.10E-01	0.01
Cobalt	3.04	5	6	1.43E-03	2.00E-03	S_CHR_V	3.06E-03	0.65
Cobalt	3.04	5	6	1.43E-03	2.00E-03	LTV_DAPH	4.40E-03	0.45
Cobalt	3.04	5	6	1.43E-03	2.00E-03	LCV_DAPH	5.10E-03	0.39
Cobalt	3.04	5	6	1.43E-03	2.00E-03	S_ACU_V	1.95E-01	0.01
Cobalt	3.04	5	6	1.43E-03	2.00E-03	LCV_FISH	2.90E-01	0.01
Cobalt	3.04	5	6	1.43E-03	2.00E-03	LTV_FISH	8.10E-01	0.00
Cobalt	4.01	1	9	1.30E-03	1.30E-03	S_CHR_V	3.06E-03	0.42
Cobalt	4.01	1	9	1.30E-03	1.30E-03	LTV_DAPH	4.40E-03	0.30
Cobalt	4.01	1	9	1.30E-03	1.30E-03	LCV_DAPH	5.10E-03	0.25
Cobalt	4.01	1	9	1.30E-03	1.30E-03	S_ACU_V	1.95E-01	0.01
Cobalt	4.01	1	9	1.30E-03	1.30E-03	LCV_FISH	2.90E-01	0.00
Cobalt	4.01	1	9	1.30E-03	1.30E-03	LTV_FISH	8.10E-01	0.00
Cobalt	4.02	5	6	1.25E-03	3.00E-03	S_CHR_V	3.06E-03	0.98
Cobalt	4.02	5	6	1.25E-03	3.00E-03	LTV_DAPH	4.40E-03	0.68
Cobalt	4.02	5	6	1.25E-03	3.00E-03	LCV_DAPH	5.10E-03	0.59
Cobalt	4.02	5	6	1.25E-03	3.00E-03	S_ACU_V	1.95E-01	0.02
Cobalt	4.02	5	6	1.25E-03	3.00E-03	LCV_FISH	2.90E-01	0.01
Cobalt	4.02	5	6	1.25E-03	3.00E-03	LTV_FISH	8.10E-01	0.00
Cobalt	**4.03**	**5**	**7**	**1.66E-03**	**1.23E-02**	**S_CHR_V**	**3.06E-03**	**4.01**
Cobalt	**4.03**	**5**	**7**	**1.66E-03**	**1.23E-02**	**LTV_DAPH**	**4.40E-03**	**2.79**
Cobalt	**4.03**	**5**	**7**	**1.66E-03**	**1.23E-02**	**LCV_DAPH**	**5.10E-03**	**2.41**
Cobalt	4.03	5	7	1.66E-03	1.23E-02	S_ACU_V	1.95E-01	0.06
Cobalt	4.03	5	7	1.66E-03	1.23E-02	LCV_FISH	2.90E-01	0.04
Cobalt	4.03	5	7	1.66E-03	1.23E-02	LTV_FISH	8.10E-01	0.02

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Cobalt	**4.04**	**10**	**11**	**1.50E-03**	**9.20E-03**	**S_CHR_V**	**3.06E-03**	**3.01**
Cobalt	**4.04**	**10**	**11**	**1.50E-03**	**9.20E-03**	**LTV_DAPH**	**4.40E-03**	**2.09**
Cobalt	**4.04**	**10**	**11**	**1.50E-03**	**9.20E-03**	**LCV_DAPH**	**5.10E-03**	**1.80**
Cobalt	4.04	10	11	1.50E-03	9.20E-03	S_ACU_V	1.95E-01	0.05
Cobalt	4.04	10	11	1.50E-03	9.20E-03	LCV_FISH	2.90E-01	0.03
Cobalt	4.04	10	11	1.50E-03	9.20E-03	LTV_FISH	8.10E-01	0.01
Cobalt	**13**	**4**	**5**	**1.50E-03**	**8.70E-03**	**S_CHR_V**	**3.06E-03**	**2.84**
Cobalt	**13**	**4**	**5**	**1.50E-03**	**8.70E-03**	**LTV_DAPH**	**4.40E-03**	**1.98**
Cobalt	**13**	**4**	**5**	**1.50E-03**	**8.70E-03**	**LCV_DAPH**	**5.10E-03**	**1.71**
Cobalt	13	4	5	1.50E-03	8.70E-03	S_ACU_V	1.95E-01	0.04
Cobalt	13	4	5	1.50E-03	8.70E-03	LCV_FISH	2.90E-01	0.03
Cobalt	13	4	5	1.50E-03	8.70E-03	LTV_FISH	8.10E-01	0.01
Cobalt	18	2	3	1.10E-03	1.40E-03	S_CHR_V	3.06E-03	0.46
Cobalt	18	2	3	1.10E-03	1.40E-03	LTV_DAPH	4.40E-03	0.32
Cobalt	18	2	3	1.10E-03	1.40E-03	LCV_DAPH	5.10E-03	0.27
Cobalt	18	2	3	1.10E-03	1.40E-03	S_ACU_V	1.95E-01	0.01
Cobalt	18	2	3	1.10E-03	1.40E-03	LCV_FISH	2.90E-01	0.00
Cobalt	18	2	3	1.10E-03	1.40E-03	LTV_FISH	8.10E-01	0.00
Copper	**0**	**5**	**5**	**2.00E-03**	**2.20E-03**	**LTV_DAPH**	**2.05E-04**	**10.73**
Copper	**0**	**5**	**5**	**2.00E-03**	**2.20E-03**	**LCV_DAPH**	**2.30E-04**	**9.57**
Copper	**0**	**5**	**5**	**2.00E-03**	**2.20E-03**	**LCV_AQPL**	**1.00E-03**	**2.20**
Copper	0	5	5	2.00E-03	2.20E-03	LCV_FISH	3.80E-03	0.58
Copper	0	5	5	2.00E-03	2.20E-03	LTV_FISH	5.00E-03	0.44
Copper	0	5	5	2.00E-03	2.20E-03	LCV_NDI	6.07E-03	0.36
Copper	0	5	5	2.00E-03	2.20E-03	NAWQ_CHR	1.20E-02	0.18
Copper	0	5	5	2.00E-03	2.20E-03	NAWQ_ACU	1.80E-02	0.12
Copper	**2.01**	**1**	**1**	**3.70E-03**	**3.70E-03**	**LTV_DAPH**	**2.05E-04**	**18.05**

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Copper	**2.01**	**1**	**1**	**3.70E-03**	**3.70E-03**	**LCV_DAPH**	**2.30E-04**	**16.09**
Copper	**2.01**	**1**	**1**	**3.70E-03**	**3.70E-03**	**LCV_AQPL**	**1.00E-03**	**3.70**
Copper	2.01	1	1	3.70E-03	3.70E-03	LCV_FISH	3.80E-03	0.97
Copper	2.01	1	1	3.70E-03	3.70E-03	LTV_FISH	5.00E-03	0.74
Copper	2.01	1	1	3.70E-03	3.70E-03	LCV_NDI	6.07E-03	0.61
Copper	2.01	1	1	3.70E-03	3.70E-03	NAWQ_CHR	1.20E-02	0.31
Copper	2.01	1	1	3.70E-03	3.70E-03	NAWQ_ACU	1.80E-02	0.21
Copper	**2.03**	**1**	**1**	**1.10E-03**	**1.10E-03**	**LTV_DAPH**	**2.05E-04**	**5.37**
Copper	**2.03**	**1**	**1**	**1.10E-03**	**1.10E-03**	**LCV_DAPH**	**2.30E-04**	**4.78**
Copper	**2.03**	**1**	**1**	**1.10E-03**	**1.10E-03**	**LCV_AQPL**	**1.00E-03**	**1.10**
Copper	2.03	1	1	1.10E-03	1.10E-03	LCV_FISH	3.80E-03	0.29
Copper	2.03	1	1	1.10E-03	1.10E-03	LTV_FISH	5.00E-03	0.22
Copper	2.03	1	1	1.10E-03	1.10E-03	LCV_NDI	6.07E-03	0.18
Copper	2.03	1	1	1.10E-03	1.10E-03	NAWQ_CHR	1.20E-02	0.09
Copper	2.03	1	1	1.10E-03	1.10E-03	NAWQ_ACU	1.80E-02	0.06
Copper	**2.04**	**6**	**6**	**2.00E-03**	**2.90E-03**	**LTV_DAPH**	**2.05E-04**	**14.15**
Copper	**2.04**	**6**	**6**	**2.00E-03**	**2.90E-03**	**LCV_DAPH**	**2.30E-04**	**12.61**
Copper	**2.04**	**6**	**6**	**2.00E-03**	**2.90E-03**	**LCV_AQPL**	**1.00E-03**	**2.90**
Copper	2.04	6	6	2.00E-03	2.90E-03	LCV_FISH	3.80E-03	0.76
Copper	2.04	6	6	2.00E-03	2.90E-03	LTV_FISH	5.00E-03	0.58
Copper	2.04	6	6	2.00E-03	2.90E-03	LCV_NDI	6.07E-03	0.48
Copper	2.04	6	6	2.00E-03	2.90E-03	NAWQ_CHR	1.20E-02	0.24
Copper	2.04	6	6	2.00E-03	2.90E-03	NAWQ_ACU	1.80E-02	0.16
Copper	**3.01**	**1**	**2**	**1.17E-02**	**1.17E-02**	**LTV_DAPH**	**2.05E-04**	**57.07**
Copper	**3.01**	**1**	**2**	**1.17E-02**	**1.17E-02**	**LCV_DAPH**	**2.30E-04**	**50.87**
Copper	**3.01**	**1**	**2**	**1.17E-02**	**1.17E-02**	**LCV_AQPL**	**1.00E-03**	**11.70**
Copper	**3.01**	**1**	**2**	**1.17E-02**	**1.17E-02**	**LCV_FISH**	**3.80E-03**	**3.08**

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Copper	**3.01**	**1**	**2**	**1.17E-02**	**1.17E-02**	**LTV_FISH**	**5.00E-03**	**2.34**
Copper	**3.01**	**1**	**2**	**1.17E-02**	**1.17E-02**	**LCV_NDI**	**6.07E-03**	**1.93**
Copper	3.01	1	2	1.17E-02	1.17E-02	NAWQ_CHR	1.20E-02	0.98
Copper	3.01	1	2	1.17E-02	1.17E-02	NAWQ_ACU	1.80E-02	0.65
Copper	**3.02**	**8**	**8**	**3.50E-03**	**8.60E-03**	**LTV_DAPH**	**2.05E-04**	**41.95**
Copper	**3.02**	**8**	**8**	**3.50E-03**	**8.60E-03**	**LCV_DAPH**	**2.30E-04**	**37.39**
Copper	**3.02**	**8**	**8**	**3.50E-03**	**8.60E-03**	**LCV_AQPL**	**1.00E-03**	**8.60**
Copper	**3.02**	**8**	**8**	**3.50E-03**	**8.60E-03**	**LCV_FISH**	**3.80E-03**	**2.26**
Copper	**3.02**	**8**	**8**	**3.50E-03**	**8.60E-03**	**LTV_FISH**	**5.00E-03**	**1.72**
Copper	**3.02**	**8**	**8**	**3.50E-03**	**8.60E-03**	**LCV_NDI**	**6.07E-03**	**1.42**
Copper	3.02	8	8	3.50E-03	8.60E-03	NAWQ_CHR	1.20E-02	0.72
Copper	3.02	8	8	3.50E-03	8.60E-03	NAWQ_ACU	1.80E-02	0.48
Copper	**3.03**	**9**	**9**	**2.40E-03**	**8.30E-03**	**LTV_DAPH**	**2.05E-04**	**40.49**
Copper	**3.03**	**9**	**9**	**2.40E-03**	**8.30E-03**	**LCV_DAPH**	**2.30E-04**	**36.09**
Copper	**3.03**	**9**	**9**	**2.40E-03**	**8.30E-03**	**LCV_AQPL**	**1.00E-03**	**8.30**
Copper	**3.03**	**9**	**9**	**2.40E-03**	**8.30E-03**	**LCV_FISH**	**3.80E-03**	**2.18**
Copper	**3.03**	**9**	**9**	**2.40E-03**	**8.30E-03**	**LTV_FISH**	**5.00E-03**	**1.66**
Copper	**3.03**	**9**	**9**	**2.40E-03**	**8.30E-03**	**LCV_NDI**	**6.07E-03**	**1.37**
Copper	3.03	9	9	2.40E-03	8.30E-03	NAWQ_CHR	1.20E-02	0.69
Copper	3.03	9	9	2.40E-03	8.30E-03	NAWQ_ACU	1.80E-02	0.46
Copper	**3.04**	**6**	**6**	**2.95E-03**	**1.36E-02**	**LTV_DAPH**	**2.05E-04**	**66.10**
Copper	**3.04**	**6**	**6**	**2.95E-03**	**1.36E-02**	**LCV_DAPH**	**2.30E-04**	**58.91**
Copper	**3.04**	**6**	**6**	**2.95E-03**	**1.36E-02**	**LCV_AQPL**	**1.00E-03**	**13.55**
Copper	**3.04**	**6**	**6**	**2.95E-03**	**1.36E-02**	**LCV_FISH**	**3.80E-03**	**3.57**
Copper	**3.04**	**6**	**6**	**2.95E-03**	**1.36E-02**	**LTV_FISH**	**5.00E-03**	**2.71**
Copper	**3.04**	**6**	**6**	**2.95E-03**	**1.36E-02**	**LCV_NDI**	**6.07E-03**	**2.23**
Copper	**3.04**	**6**	**6**	**2.95E-03**	**1.36E-02**	**NAWQ_CHR**	**1.20E-02**	**1.13**

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Copper	3.04	6	6	2.95E-03	1.36E-02	NAWQ_ACU	1.80E-02	0.75
Copper	**4.01**	**9**	**9**	**2.70E-03**	**4.00E-03**	**LTV_DAPH**	**2.05E-04**	**19.51**
Copper	**4.01**	**9**	**9**	**2.70E-03**	**4.00E-03**	**LCV_DAPH**	**2.30E-04**	**17.39**
Copper	**4.01**	**9**	**9**	**2.70E-03**	**4.00E-03**	**LCV_AQPL**	**1.00E-03**	**4.00**
Copper	**4.01**	**9**	**9**	**2.70E-03**	**4.00E-03**	**LCV_FISH**	**3.80E-03**	**1.05**
Copper	4.01	9	9	2.70E-03	4.00E-03	LTV_FISH	5.00E-03	0.80
Copper	4.01	9	9	2.70E-03	4.00E-03	LCV_NDI	6.07E-03	0.66
Copper	4.01	9	9	2.70E-03	4.00E-03	NAWQ_CHR	1.20E-02	0.33
Copper	4.01	9	9	2.70E-03	4.00E-03	NAWQ_ACU	1.80E-02	0.22
Copper	**4.02**	**6**	**6**	**2.25E-03**	**3.60E-03**	**LTV_DAPH**	**2.05E-04**	**17.56**
Copper	**4.02**	**6**	**6**	**2.25E-03**	**3.60E-03**	**LCV_DAPH**	**2.30E-04**	**15.65**
Copper	**4.02**	**6**	**6**	**2.25E-03**	**3.60E-03**	**LCV_AQPL**	**1.00E-03**	**3.60**
Copper	4.02	6	6	2.25E-03	3.60E-03	LCV_FISH	3.80E-03	0.95
Copper	4.02	6	6	2.25E-03	3.60E-03	LTV_FISH	5.00E-03	0.72
Copper	4.02	6	6	2.25E-03	3.60E-03	LCV_NDI	6.07E-03	0.59
Copper	4.02	6	6	2.25E-03	3.60E-03	NAWQ_CHR	1.20E-02	0.30
Copper	4.02	6	6	2.25E-03	3.60E-03	NAWQ_ACU	1.80E-02	0.20
Copper	**4.03**	**7**	**7**	**2.30E-03**	**8.50E-03**	**LTV_DAPH**	**2.05E-04**	**41.46**
Copper	**4.03**	**7**	**7**	**2.30E-03**	**8.50E-03**	**LCV_DAPH**	**2.30E-04**	**36.96**
Copper	**4.03**	**7**	**7**	**2.30E-03**	**8.50E-03**	**LCV_AQPL**	**1.00E-03**	**8.50**
Copper	**4.03**	**7**	**7**	**2.30E-03**	**8.50E-03**	**LCV_FISH**	**3.80E-03**	**2.24**
Copper	**4.03**	**7**	**7**	**2.30E-03**	**8.50E-03**	**LTV_FISH**	**5.00E-03**	**1.70**
Copper	**4.03**	**7**	**7**	**2.30E-03**	**8.50E-03**	**LCV_NDI**	**6.07E-03**	**1.40**
Copper	4.03	7	7	2.30E-03	8.50E-03	NAWQ_CHR	1.20E-02	0.71
Copper	4.03	7	7	2.30E-03	8.50E-03	NAWQ_ACU	1.80E-02	0.47
Copper	**4.04**	**11**	**11**	**4.30E-03**	**8.30E-03**	**LTV_DAPH**	**2.05E-04**	**40.49**
Copper	**4.04**	**11**	**11**	**4.30E-03**	**8.30E-03**	**LCV_DAPH**	**2.30E-04**	**36.09**

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Copper	**4.04**	**11**	**11**	**4.30E-03**	**8.30E-03**	**LCV_AQPL**	**1.00E-03**	**8.30**
Copper	**4.04**	**11**	**11**	**4.30E-03**	**8.30E-03**	**LCV_FISH**	**3.80E-03**	**2.18**
Copper	**4.04**	**11**	**11**	**4.30E-03**	**8.30E-03**	**LTV_FISH**	**5.00E-03**	**1.66**
Copper	**4.04**	**11**	**11**	**4.30E-03**	**8.30E-03**	**LCV_NDI**	**6.07E-03**	**1.37**
Copper	4.04	11	11	4.30E-03	8.30E-03	NAWQ_CHR	1.20E-02	0.69
Copper	4.04	11	11	4.30E-03	8.30E-03	NAWQ_ACU	1.80E-02	0.46
Copper	**7.01**	**1**	**1**	**4.20E-03**	**4.20E-03**	**LTV_DAPH**	**2.05E-04**	**20.49**
Copper	**7.01**	**1**	**1**	**4.20E-03**	**4.20E-03**	**LCV_DAPH**	**2.30E-04**	**18.26**
Copper	**7.01**	**1**	**1**	**4.20E-03**	**4.20E-03**	**LCV_AQPL**	**1.00E-03**	**4.20**
Copper	**7.01**	**1**	**1**	**4.20E-03**	**4.20E-03**	**LCV_FISH**	**3.80E-03**	**1.11**
Copper	7.01	1	1	4.20E-03	4.20E-03	LTV_FISH	5.00E-03	0.84
Copper	7.01	1	1	4.20E-03	4.20E-03	LCV_NDI	6.07E-03	0.69
Copper	7.01	1	1	4.20E-03	4.20E-03	NAWQ_CHR	1.20E-02	0.35
Copper	7.01	1	1	4.20E-03	4.20E-03	NAWQ_ACU	1.80E-02	0.23
Copper	**7.02**	**1**	**1**	**2.30E-03**	**2.30E-03**	**LTV_DAPH**	**2.05E-04**	**11.22**
Copper	**7.02**	**1**	**1**	**2.30E-03**	**2.30E-03**	**LCV_DAPH**	**2.30E-04**	**10.00**
Copper	**7.02**	**1**	**1**	**2.30E-03**	**2.30E-03**	**LCV_AQPL**	**1.00E-03**	**2.30**
Copper	7.02	1	1	2.30E-03	2.30E-03	LCV_FISH	3.80E-03	0.61
Copper	7.02	1	1	2.30E-03	2.30E-03	LTV_FISH	5.00E-03	0.46
Copper	7.02	1	1	2.30E-03	2.30E-03	LCV_NDI	6.07E-03	0.38
Copper	7.02	1	1	2.30E-03	2.30E-03	NAWQ_CHR	1.20E-02	0.19
Copper	7.02	1	1	2.30E-03	2.30E-03	NAWQ_ACU	1.80E-02	0.13
Copper	**8**	**1**	**1**	**2.60E-03**	**2.60E-03**	**LTV_DAPH**	**2.05E-04**	**12.68**
Copper	**8**	**1**	**1**	**2.60E-03**	**2.60E-03**	**LCV_DAPH**	**2.30E-04**	**11.30**
Copper	**8**	**1**	**1**	**2.60E-03**	**2.60E-03**	**LCV_AQPL**	**1.00E-03**	**2.60**
Copper	8	1	1	2.60E-03	2.60E-03	LCV_FISH	3.80E-03	0.68
Copper	8	1	1	2.60E-03	2.60E-03	LTV_FISH	5.00E-03	0.52

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Copper	8	1	1	2.60E-03	2.60E-03	LCV_NDI	6.07E-03	0.43
Copper	8	1	1	2.60E-03	2.60E-03	NAWQ_CHR	1.20E-02	0.22
Copper	8	1	1	2.60E-03	2.60E-03	NAWQ_ACU	1.80E-02	0.14
Copper	**13**	**4**	**5**	**1.30E-03**	**3.50E-03**	**LTV_DAPH**	**2.05E-04**	**17.07**
Copper	**13**	**4**	**5**	**1.30E-03**	**3.50E-03**	**LCV_DAPH**	**2.30E-04**	**15.22**
Copper	**13**	**4**	**5**	**1.30E-03**	**3.50E-03**	**LCV_AQPL**	**1.00E-03**	**3.50**
Copper	13	4	5	1.30E-03	3.50E-03	LCV_FISH	3.80E-03	0.92
Copper	13	4	5	1.30E-03	3.50E-03	LTV_FISH	5.00E-03	0.70
Copper	13	4	5	1.30E-03	3.50E-03	LCV_NDI	6.07E-03	0.58
Copper	13	4	5	1.30E-03	3.50E-03	NAWQ_CHR	1.20E-02	0.29
Copper	13	4	5	1.30E-03	3.50E-03	NAWQ_ACU	1.80E-02	0.19
Copper	**18**	**3**	**3**	**4.90E-03**	**5.40E-03**	**LTV_DAPH**	**2.05E-04**	**26.34**
Copper	**18**	**3**	**3**	**4.90E-03**	**5.40E-03**	**LCV_DAPH**	**2.30E-04**	**23.48**
Copper	**18**	**3**	**3**	**4.90E-03**	**5.40E-03**	**LCV_AQPL**	**1.00E-03**	**5.40**
Copper	**18**	**3**	**3**	**4.90E-03**	**5.40E-03**	**LCV_FISH**	**3.80E-03**	**1.42**
Copper	**18**	**3**	**3**	**4.90E-03**	**5.40E-03**	**LTV_FISH**	**5.00E-03**	**1.08**
Copper	18	3	3	4.90E-03	5.40E-03	LCV_NDI	6.07E-03	0.89
Copper	18	3	3	4.90E-03	5.40E-03	NAWQ_CHR	1.20E-02	0.45
Copper	18	3	3	4.90E-03	5.40E-03	NAWQ_ACU	1.80E-02	0.30
Iron	**0**	**5**	**5**	**3.29E-02**	**2.18E-01**	**LTV_DAPH**	**1.60E-02**	**13.63**
Iron	**0**	**5**	**5**	**3.29E-02**	**2.18E-01**	**LCV_DAPH**	**1.58E-01**	**1.38**
Iron	0	5	5	3.29E-02	2.18E-01	NAWQ_CHR	1.00E+00	0.22
Iron	0	5	5	3.29E-02	2.18E-01	LCV_FISH	1.30E+00	0.17
Iron	**2.01**	**1**	**1**	**3.40E-01**	**3.40E-01**	**LTV_DAPH**	**1.60E-02**	**21.25**
Iron	**2.01**	**1**	**1**	**3.40E-01**	**3.40E-01**	**LCV_DAPH**	**1.58E-01**	**2.15**
Iron	2.01	1	1	3.40E-01	3.40E-01	NAWQ_CHR	1.00E+00	0.34
Iron	2.01	1	1	3.40E-01	3.40E-01	LCV_FISH	1.30E+00	0.26

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Iron	**2.03**	**1**	**1**	**2.41E-01**	**2.41E-01**	**LTV_DAPH**	**1.60E-02**	**15.06**
Iron	**2.03**	**1**	**1**	**2.41E-01**	**2.41E-01**	**LCV_DAPH**	**1.58E-01**	**1.53**
Iron	2.03	1	1	2.41E-01	2.41E-01	NAWQ_CHR	1.00E+00	0.24
Iron	2.03	1	1	2.41E-01	2.41E-01	LCV_FISH	1.30E+00	0.19
Iron	**2.04**	**6**	**6**	**5.41E-02**	**1.72E-01**	**LTV_DAPH**	**1.60E-02**	**10.75**
Iron	**2.04**	**6**	**6**	**5.41E-02**	**1.72E-01**	**LCV_DAPH**	**1.58E-01**	**1.09**
Iron	2.04	6	6	5.41E-02	1.72E-01	NAWQ_CHR	1.00E+00	0.17
Iron	2.04	6	6	5.41E-02	1.72E-01	LCV_FISH	1.30E+00	0.13
Iron	**3.01**	**1**	**2**	**3.09E-02**	**3.09E-02**	**LTV_DAPH**	**1.60E-02**	**1.93**
Iron	3.01	1	2	3.09E-02	3.09E-02	LCV_DAPH	1.58E-01	0.20
Iron	3.01	1	2	3.09E-02	3.09E-02	NAWQ_CHR	1.00E+00	0.03
Iron	3.01	1	2	3.09E-02	3.09E-02	LCV_FISH	1.30E+00	0.02
Iron	**3.02**	**8**	**8**	**8.61E-02**	**2.12E+00**	**LTV_DAPH**	**1.60E-02**	**132.50**
Iron	**3.02**	**8**	**8**	**8.61E-02**	**2.12E+00**	**LCV_DAPH**	**1.58E-01**	**13.42**
Iron	**3.02**	**8**	**8**	**8.61E-02**	**2.12E+00**	**NAWQ_CHR**	**1.00E+00**	**2.12**
Iron	**3.02**	**8**	**8**	**8.61E-02**	**2.12E+00**	**LCV_FISH**	**1.30E+00**	**1.63**
Iron	**3.03**	**8**	**9**	**4.18E-02**	**2.35E-01**	**LTV_DAPH**	**1.60E-02**	**14.71**
Iron	**3.03**	**8**	**9**	**4.18E-02**	**2.35E-01**	**LCV_DAPH**	**1.58E-01**	**1.49**
Iron	3.03	8	9	4.18E-02	2.35E-01	NAWQ_CHR	1.00E+00	0.24
Iron	3.03	8	9	4.18E-02	2.35E-01	LCV_FISH	1.30E+00	0.18
Iron	**3.04**	**6**	**6**	**9.75E-02**	**3.68E-01**	**LTV_DAPH**	**1.60E-02**	**22.97**
Iron	**3.04**	**6**	**6**	**9.75E-02**	**3.68E-01**	**LCV_DAPH**	**1.58E-01**	**2.33**
Iron	3.04	6	6	9.75E-02	3.68E-01	NAWQ_CHR	1.00E+00	0.37
Iron	3.04	6	6	9.75E-02	3.68E-01	LCV_FISH	1.30E+00	0.28
Iron	**4.01**	**9**	**9**	**3.22E-01**	**3.62E-01**	**LTV_DAPH**	**1.60E-02**	**22.63**
Iron	**4.01**	**9**	**9**	**3.22E-01**	**3.62E-01**	**LCV_DAPH**	**1.58E-01**	**2.29**
Iron	4.01	9	9	3.22E-01	3.62E-01	NAWQ_CHR	1.00E+00	0.36

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Iron	4.01	9	9	3.22E-01	3.62E-01	LCV_FISH	1.30E+00	0.28
Iron	**4.02**	**6**	**6**	**4.14E-02**	**8.64E-02**	**LTV_DAPH**	**1.60E-02**	**5.40**
Iron	4.02	6	6	4.14E-02	8.64E-02	LCV_DAPH	1.58E-01	0.55
Iron	4.02	6	6	4.14E-02	8.64E-02	NAWQ_CHR	1.00E+00	0.09
Iron	4.02	6	6	4.14E-02	8.64E-02	LCV_FISH	1.30E+00	0.07
Iron	**4.03**	**7**	**7**	**3.14E-02**	**1.00E-01**	**LTV_DAPH**	**1.60E-02**	**6.26**
Iron	4.03	7	7	3.14E-02	1.00E-01	LCV_DAPH	1.58E-01	0.63
Iron	4.03	7	7	3.14E-02	1.00E-01	NAWQ_CHR	1.00E+00	0.10
Iron	4.03	7	7	3.14E-02	1.00E-01	LCV_FISH	1.30E+00	0.08
Iron	**4.04**	**11**	**11**	**2.42E-01**	**6.03E+00**	**LTV_DAPH**	**1.60E-02**	**376.88**
Iron	**4.04**	**11**	**11**	**2.42E-01**	**6.03E+00**	**LCV_DAPH**	**1.58E-01**	**38.16**
Iron	**4.04**	**11**	**11**	**2.42E-01**	**6.03E+00**	**NAWQ_CHR**	**1.00E+00**	**6.03**
Iron	**4.04**	**11**	**11**	**2.42E-01**	**6.03E+00**	**LCV_FISH**	**1.30E+00**	**4.64**
Iron	**7.01**	**1**	**1**	**3.32E-02**	**3.32E-02**	**LTV_DAPH**	**1.60E-02**	**2.08**
Iron	7.01	1	1	3.32E-02	3.32E-02	LCV_DAPH	1.58E-01	0.21
Iron	7.01	1	1	3.32E-02	3.32E-02	NAWQ_CHR	1.00E+00	0.03
Iron	7.01	1	1	3.32E-02	3.32E-02	LCV_FISH	1.30E+00	0.03
Iron	**7.02**	**1**	**1**	**2.20E-02**	**2.20E-02**	**LTV_DAPH**	**1.60E-02**	**1.38**
Iron	7.02	1	1	2.20E-02	2.20E-02	LCV_DAPH	1.58E-01	0.14
Iron	7.02	1	1	2.20E-02	2.20E-02	NAWQ_CHR	1.00E+00	0.02
Iron	7.02	1	1	2.20E-02	2.20E-02	LCV_FISH	1.30E+00	0.02
Iron	**8**	**1**	**1**	**2.86E-02**	**2.86E-02**	**LTV_DAPH**	**1.60E-02**	**1.79**
Iron	8	1	1	2.86E-02	2.86E-02	LCV_DAPH	1.58E-01	0.18
Iron	8	1	1	2.86E-02	2.86E-02	NAWQ_CHR	1.00E+00	0.03
Iron	8	1	1	2.86E-02	2.86E-02	LCV_FISH	1.30E+00	0.02
Iron	**13**	**1**	**5**	**4.42E-02**	**4.42E-02**	**LTV_DAPH**	**1.60E-02**	**2.76**
Iron	13	1	5	4.42E-02	4.42E-02	LCV_DAPH	1.58E-01	0.28

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Iron	13	1	5	4.42E-02	4.42E-02	NAWQ_CHR	1.00E+00	0.04
Iron	13	1	5	4.42E-02	4.42E-02	LCV_FISH	1.30E+00	0.03
Iron	**18**	**3**	**3**	**1.27E-01**	**1.86E-01**	**LTV_DAPH**	**1.60E-02**	**11.63**
Iron	**18**	**3**	**3**	**1.27E-01**	**1.86E-01**	**LCV_DAPH**	**1.58E-01**	**1.18**
Iron	18	3	3	1.27E-01	1.86E-01	NAWQ_CHR	1.00E+00	0.19
Iron	18	3	3	1.27E-01	1.86E-01	LCV_FISH	1.30E+00	0.14
Lead	4.03	3	7	1.20E-03	2.80E-03	NAWQ_CHR	3.20E-03	0.88
Lead	4.03	3	7	1.20E-03	2.80E-03	LCV_DAPH	1.23E-02	0.23
Lead	4.03	3	7	1.20E-03	2.80E-03	LCV_FISH	1.89E-02	0.15
Lead	4.03	3	7	1.20E-03	2.80E-03	LTV_FISH	2.20E-02	0.13
Lead	4.03	3	7	1.20E-03	2.80E-03	LCV_NDI	2.55E-02	0.11
Lead	4.03	3	7	1.20E-03	2.80E-03	NAWQ_ACU	8.20E-02	0.03
Lead	4.03	3	7	1.20E-03	2.80E-03	LCV_AQPL	5.00E-01	0.01
Manganese	**0**	**4**	**5**	**5.14E+00**	**1.14E+01**	**S_CHR_V**	**8.03E-02**	**141.97**
Manganese	**0**	**4**	**5**	**5.14E+00**	**1.14E+01**	**LCV_DAPH**	**1.10E+00**	**10.36**
Manganese	**0**	**4**	**5**	**5.14E+00**	**1.14E+01**	**LTV_DAPH**	**1.10E+00**	**10.36**
Manganese	**0**	**4**	**5**	**5.14E+00**	**1.14E+01**	**LTV_FISH**	**1.27E+00**	**8.98**
Manganese	**0**	**4**	**5**	**5.14E+00**	**1.14E+01**	**S_ACU_V**	**1.47E+00**	**7.76**
Manganese	**0**	**4**	**5**	**5.14E+00**	**1.14E+01**	**LCV_FISH**	**1.77E+00**	**6.44**
Manganese	**2.01**	**1**	**1**	**6.46E+00**	**6.46E+00**	**S_CHR_V**	**8.03E-02**	**80.45**
Manganese	**2.01**	**1**	**1**	**6.46E+00**	**6.46E+00**	**LCV_DAPH**	**1.10E+00**	**5.87**
Manganese	**2.01**	**1**	**1**	**6.46E+00**	**6.46E+00**	**LTV_DAPH**	**1.10E+00**	**5.87**
Manganese	**2.01**	**1**	**1**	**6.46E+00**	**6.46E+00**	**LTV_FISH**	**1.27E+00**	**5.09**
Manganese	**2.01**	**1**	**1**	**6.46E+00**	**6.46E+00**	**S_ACU_V**	**1.47E+00**	**4.39**
Manganese	**2.01**	**1**	**1**	**6.46E+00**	**6.46E+00**	**LCV_FISH**	**1.77E+00**	**3.65**
Manganese	2.03	1	1	3.00E-03	3.00E-03	S_CHR_V	8.03E-02	0.04
Manganese	2.03	1	1	3.00E-03	3.00E-03	LCV_DAPH	1.10E+00	0.00

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Manganese	2.03	1	1	3.00E-03	3.00E-03	LTV_DAPH	1.10E+00	0.00
Manganese	2.03	1	1	3.00E-03	3.00E-03	LTV_FISH	1.27E+00	0.00
Manganese	2.03	1	1	3.00E-03	3.00E-03	S_ACU_V	1.47E+00	0.00
Manganese	2.03	1	1	3.00E-03	3.00E-03	LCV_FISH	1.77E+00	0.00
Manganese	2.04	6	6	1.17E+00	3.16E+00	S_CHR_V	8.03E-02	39.36
Manganese	2.04	6	6	1.17E+00	3.16E+00	LCV_DAPH	1.10E+00	2.87
Manganese	2.04	6	6	1.17E+00	3.16E+00	LTV_DAPH	1.10E+00	2.87
Manganese	2.04	6	6	1.17E+00	3.16E+00	LTV_FISH	1.27E+00	2.49
Manganese	2.04	6	6	1.17E+00	3.16E+00	S_ACU_V	1.47E+00	2.15
Manganese	2.04	6	6	1.17E+00	3.16E+00	LCV_FISH	1.77E+00	1.79
Manganese	3.01	2	2	2.41E+00	2.61E+00	S_CHR_V	8.03E-02	32.50
Manganese	3.01	2	2	2.41E+00	2.61E+00	LCV_DAPH	1.10E+00	2.37
Manganese	3.01	2	2	2.41E+00	2.61E+00	LTV_DAPH	1.10E+00	2.37
Manganese	3.01	2	2	2.41E+00	2.61E+00	LTV_FISH	1.27E+00	2.06
Manganese	3.01	2	2	2.41E+00	2.61E+00	S_ACU_V	1.47E+00	1.78
Manganese	3.01	2	2	2.41E+00	2.61E+00	LCV_FISH	1.77E+00	1.47
Manganese	3.02	8	8	4.14E+00	9.67E+00	S_CHR_V	8.03E-02	120.42
Manganese	3.02	8	8	4.14E+00	9.67E+00	LCV_DAPH	1.10E+00	8.79
Manganese	3.02	8	8	4.14E+00	9.67E+00	LTV_DAPH	1.10E+00	8.79
Manganese	3.02	8	8	4.14E+00	9.67E+00	LTV_FISH	1.27E+00	7.61
Manganese	3.02	8	8	4.14E+00	9.67E+00	S_ACU_V	1.47E+00	6.58
Manganese	3.02	8	8	4.14E+00	9.67E+00	LCV_FISH	1.77E+00	5.46
Manganese	3.03	9	9	3.31E+00	5.78E+00	S_CHR_V	8.03E-02	72.02
Manganese	3.03	9	9	3.31E+00	5.78E+00	LCV_DAPH	1.10E+00	5.26
Manganese	3.03	9	9	3.31E+00	5.78E+00	LTV_DAPH	1.10E+00	5.26
Manganese	3.03	9	9	3.31E+00	5.78E+00	LTV_FISH	1.27E+00	4.55
Manganese	3.03	9	9	3.31E+00	5.78E+00	S_ACU_V	1.47E+00	3.93

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Manganese	3.03	9	9	3.31E+00	5.78E+00	LCV_FISH	1.77E+00	3.27
Manganese	3.04	6	6	3.03E+00	6.30E+00	S_CHR_V	8.03E-02	78.46
Manganese	3.04	6	6	3.03E+00	6.30E+00	LCV_DAPH	1.10E+00	5.73
Manganese	3.04	6	6	3.03E+00	6.30E+00	LTV_DAPH	1.10E+00	5.73
Manganese	3.04	6	6	3.03E+00	6.30E+00	LTV_FISH	1.27E+00	4.96
Manganese	3.04	6	6	3.03E+00	6.30E+00	S_ACU_V	1.47E+00	4.29
Manganese	3.04	6	6	3.03E+00	6.30E+00	LCV_FISH	1.77E+00	3.56
Manganese	4.01	9	9	1.79E-01	2.39E+00	S_CHR_V	8.03E-02	29.76
Manganese	4.01	9	9	1.79E-01	2.39E+00	LCV_DAPH	1.10E+00	2.17
Manganese	4.01	9	9	1.79E-01	2.39E+00	LTV_DAPH	1.10E+00	2.17
Manganese	4.01	9	9	1.79E-01	2.39E+00	LTV_FISH	1.27E+00	1.88
Manganese	4.01	9	9	1.79E-01	2.39E+00	S_ACU_V	1.47E+00	1.63
Manganese	4.01	9	9	1.79E-01	2.39E+00	LCV_FISH	1.77E+00	1.35
Manganese	4.02	6	6	3.90E+00	7.85E+00	S_CHR_V	8.03E-02	97.76
Manganese	4.02	6	6	3.90E+00	7.85E+00	LCV_DAPH	1.10E+00	7.14
Manganese	4.02	6	6	3.90E+00	7.85E+00	LTV_DAPH	1.10E+00	7.14
Manganese	4.02	6	6	3.90E+00	7.85E+00	LTV_FISH	1.27E+00	6.18
Manganese	4.02	6	6	3.90E+00	7.85E+00	S_ACU_V	1.47E+00	5.34
Manganese	4.02	6	6	3.90E+00	7.85E+00	LCV_FISH	1.77E+00	4.44
Manganese	4.03	7	7	2.77E+00	1.95E+01	S_CHR_V	8.03E-02	243.30
Manganese	4.03	7	7	2.77E+00	1.95E+01	LCV_DAPH	1.10E+00	17.76
Manganese	4.03	7	7	2.77E+00	1.95E+01	LTV_DAPH	1.10E+00	17.76
Manganese	4.03	7	7	2.77E+00	1.95E+01	LTV_FISH	1.27E+00	15.38
Manganese	4.03	7	7	2.77E+00	1.95E+01	S_ACU_V	1.47E+00	13.29
Manganese	4.03	7	7	2.77E+00	1.95E+01	LCV_FISH	1.77E+00	11.04
Manganese	4.04	8	11	2.87E+00	4.34E+00	S_CHR_V	8.03E-02	54.05
Manganese	4.04	8	11	2.87E+00	4.34E+00	LCV_DAPH	1.10E+00	3.95

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Manganese	4.04	8	11	2.87E+00	4.34E+00	LTV_DAPH	1.10E+00	3.95
Manganese	4.04	8	11	2.87E+00	4.34E+00	LTV_FISH	1.27E+00	3.42
Manganese	4.04	8	11	2.87E+00	4.34E+00	S_ACU_V	1.47E+00	2.95
Manganese	4.04	8	11	2.87E+00	4.34E+00	LCV_FISH	1.77E+00	2.45
Manganese	7.01	1	1	5.23E+00	5.23E+00	S_CHR_V	8.03E-02	65.13
Manganese	7.01	1	1	5.23E+00	5.23E+00	LCV_DAPH	1.10E+00	4.75
Manganese	7.01	1	1	5.23E+00	5.23E+00	LTV_DAPH	1.10E+00	4.75
Manganese	7.01	1	1	5.23E+00	5.23E+00	LTV_FISH	1.27E+00	4.12
Manganese	7.01	1	1	5.23E+00	5.23E+00	S_ACU_V	1.47E+00	3.56
Manganese	7.01	1	1	5.23E+00	5.23E+00	LCV_FISH	1.77E+00	2.95
Manganese	7.02	1	1	4.17E+00	4.17E+00	S_CHR_V	8.03E-02	51.93
Manganese	7.02	1	1	4.17E+00	4.17E+00	LCV_DAPH	1.10E+00	3.79
Manganese	7.02	1	1	4.17E+00	4.17E+00	LTV_DAPH	1.10E+00	3.79
Manganese	7.02	1	1	4.17E+00	4.17E+00	LTV_FISH	1.27E+00	3.28
Manganese	7.02	1	1	4.17E+00	4.17E+00	S_ACU_V	1.47E+00	2.84
Manganese	7.02	1	1	4.17E+00	4.17E+00	LCV_FISH	1.77E+00	2.36
Manganese	8	1	1	3.35E+00	3.35E+00	S_CHR_V	8.03E-02	41.72
Manganese	8	1	1	3.35E+00	3.35E+00	LCV_DAPH	1.10E+00	3.05
Manganese	8	1	1	3.35E+00	3.35E+00	LTV_DAPH	1.10E+00	3.05
Manganese	8	1	1	3.35E+00	3.35E+00	LTV_FISH	1.27E+00	2.64
Manganese	8	1	1	3.35E+00	3.35E+00	S_ACU_V	1.47E+00	2.28
Manganese	8	1	1	3.35E+00	3.35E+00	LCV_FISH	1.77E+00	1.89
Manganese	13	5	5	5.33E+00	9.09E+00	S_CHR_V	8.03E-02	113.20
Manganese	13	5	5	5.33E+00	9.09E+00	LCV_DAPH	1.10E+00	8.26
Manganese	13	5	5	5.33E+00	9.09E+00	LTV_DAPH	1.10E+00	8.26
Manganese	13	5	5	5.33E+00	9.09E+00	LTV_FISH	1.27E+00	7.16
Manganese	13	5	5	5.33E+00	9.09E+00	S_ACU_V	1.47E+00	6.18

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Manganese	**13**	**5**	**5**	**5.33E+00**	**9.09E+00**	**LCV_FISH**	**1.77E+00**	**5.14**
Mercury	**3.01**	**2**	**4**	**5.60E-04**	**6.02E-04**	**LCV_FISH**	**2.30E-04**	**2.62**
Mercury	3.01	2	4	5.60E-04	6.02E-04	LTV_DAPH	8.70E-04	0.69
Mercury	3.01	2	4	5.60E-04	6.02E-04	LTV_FISH	8.70E-04	0.69
Mercury	3.01	2	4	5.60E-04	6.02E-04	LCV_DAPH	9.60E-04	0.63
Mercury	3.01	2	4	5.60E-04	6.02E-04	S_CHR_V	1.30E-03	0.46
Mercury	3.01	2	4	5.60E-04	6.02E-04	NAWQ_ACU	2.40E-03	0.25
Mercury	3.01	2	4	5.60E-04	6.02E-04	LCV_AQPL	5.00E-03	0.12
Mercury	**3.02**	**5**	**12**	**9.60E-06**	**2.30E-04**	**LCV_FISH**	**2.30E-04**	**1.00**
Mercury	3.02	5	12	9.60E-06	2.30E-04	LTV_DAPH	8.70E-04	0.26
Mercury	3.02	5	12	9.60E-06	2.30E-04	LTV_FISH	8.70E-04	0.26
Mercury	3.02	5	12	9.60E-06	2.30E-04	LCV_DAPH	9.60E-04	0.24
Mercury	3.02	5	12	9.60E-06	2.30E-04	S_CHR_V	1.30E-03	0.18
Mercury	3.02	5	12	9.60E-06	2.30E-04	NAWQ_ACU	2.40E-03	0.10
Mercury	3.02	5	12	9.60E-06	2.30E-04	LCV_AQPL	5.00E-03	0.05
Mercury	3.03	9	17	1.37E-05	2.00E-04	LCV_FISH	2.30E-04	0.87
Mercury	3.03	9	17	1.37E-05	2.00E-04	LTV_DAPH	8.70E-04	0.23
Mercury	3.03	9	17	1.37E-05	2.00E-04	LTV_FISH	8.70E-04	0.23
Mercury	3.03	9	17	1.37E-05	2.00E-04	LCV_DAPH	9.60E-04	0.21
Mercury	3.03	9	17	1.37E-05	2.00E-04	S_CHR_V	1.30E-03	0.15
Mercury	3.03	9	17	1.37E-05	2.00E-04	NAWQ_ACU	2.40E-03	0.08
Mercury	3.03	9	17	1.37E-05	2.00E-04	LCV_AQPL	5.00E-03	0.04
Mercury	3.04	4	12	9.47E-06	3.60E-05	LCV_FISH	2.30E-04	0.16
Mercury	3.04	4	12	9.47E-06	3.60E-05	LTV_DAPH	8.70E-04	0.04
Mercury	3.04	4	12	9.47E-06	3.60E-05	LTV_FISH	8.70E-04	0.04
Mercury	3.04	4	12	9.47E-06	3.60E-05	LCV_DAPH	9.60E-04	0.04
Mercury	3.04	4	12	9.47E-06	3.60E-05	S_CHR_V	1.30E-03	0.03

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Mercury	3.04	4	12	9.47E-06	3.60E-05	NAWQ_ACU	2.40E-03	0.02
Mercury	3.04	4	12	9.47E-06	3.60E-05	LCV_AQPL	5.00E-03	0.01
Mercury	4.01	1	14	5.54E-06	5.54E-06	LCV_FISH	2.30E-04	0.02
Mercury	4.01	1	14	5.54E-06	5.54E-06	LTV_DAPH	8.70E-04	0.01
Mercury	4.01	1	14	5.54E-06	5.54E-06	LTV_FISH	8.70E-04	0.01
Mercury	4.01	1	14	5.54E-06	5.54E-06	LCV_DAPH	9.60E-04	0.01
Mercury	4.01	1	14	5.54E-06	5.54E-06	S_CHR_V	1.30E-03	0.00
Mercury	4.01	1	14	5.54E-06	5.54E-06	NAWQ_ACU	2.40E-03	0.00
Mercury	4.01	1	14	5.54E-06	5.54E-06	LCV_AQPL	5.00E-03	0.00
Mercury	4.03	1	8	9.15E-06	9.15E-06	LCV_FISH	2.30E-04	0.04
Mercury	4.03	1	8	9.15E-06	9.15E-06	LTV_DAPH	8.70E-04	0.01
Mercury	4.03	1	8	9.15E-06	9.15E-06	LTV_FISH	8.70E-04	0.01
Mercury	4.03	1	8	9.15E-06	9.15E-06	LCV_DAPH	9.60E-04	0.01
Mercury	4.03	1	8	9.15E-06	9.15E-06	S_CHR_V	1.30E-03	0.01
Mercury	4.03	1	8	9.15E-06	9.15E-06	NAWQ_ACU	2.40E-03	0.00
Mercury	4.03	1	8	9.15E-06	9.15E-06	LCV_AQPL	5.00E-03	0.00
Mercury	**4.04**	**1**	**14**	**8.10E-04**	**8.10E-04**	**LCV_FISH**	**2.30E-04**	**3.52**
Mercury	4.04	1	14	8.10E-04	8.10E-04	LTV_DAPH	8.70E-04	0.93
Mercury	4.04	1	14	8.10E-04	8.10E-04	LTV_FISH	8.70E-04	0.93
Mercury	4.04	1	14	8.10E-04	8.10E-04	LCV_DAPH	9.60E-04	0.84
Mercury	4.04	1	14	8.10E-04	8.10E-04	S_CHR_V	1.30E-03	0.62
Mercury	4.04	1	14	8.10E-04	8.10E-04	NAWQ_ACU	2.40E-03	0.34
Mercury	4.04	1	14	8.10E-04	8.10E-04	LCV_AQPL	5.00E-03	0.16
Mercury	13	3	10	4.92E-06	1.30E-05	LCV_FISH	2.30E-04	0.06
Mercury	13	3	10	4.92E-06	1.30E-05	LTV_DAPH	8.70E-04	0.01
Mercury	13	3	10	4.92E-06	1.30E-05	LTV_FISH	8.70E-04	0.01
Mercury	13	3	10	4.92E-06	1.30E-05	LCV_DAPH	9.60E-04	0.01

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Mercury	13	3	10	4.92E-06	1.30E-05	S_CHR_V	1.30E-03	0.01
Mercury	13	3	10	4.92E-06	1.30E-05	NAWQ_ACU	2.40E-03	0.01
Mercury	13	3	10	4.92E-06	1.30E-05	LCV_AQPL	5.00E-03	0.00
Nickel	**0**	**4**	**5**	**1.45E-02**	**2.35E-02**	**LCV_AQPL**	**5.00E-03**	**4.70**
Nickel	**0**	**4**	**5**	**1.45E-02**	**2.35E-02**	**LCV_DAPH**	**5.00E-03**	**4.70**
Nickel	0	4	5	1.45E-02	2.35E-02	LCV_FISH	3.50E-02	0.67
Nickel	0	4	5	1.45E-02	2.35E-02	LTV_DAPH	4.50E-02	0.52
Nickel	0	4	5	1.45E-02	2.35E-02	LTV_FISH	6.20E-02	0.38
Nickel	0	4	5	1.45E-02	2.35E-02	LCV_NDI	1.28E-01	0.18
Nickel	0	4	5	1.45E-02	2.35E-02	NAWQ_CHR	1.60E-01	0.15
Nickel	0	4	5	1.45E-02	2.35E-02	NAWQ_ACU	1.40E+00	0.02
Nickel	2.01	1	1	2.60E-03	2.60E-03	LCV_AQPL	5.00E-03	0.52
Nickel	2.01	1	1	2.60E-03	2.60E-03	LCV_DAPH	5.00E-03	0.52
Nickel	2.01	1	1	2.60E-03	2.60E-03	LCV_FISH	3.50E-02	0.07
Nickel	2.01	1	1	2.60E-03	2.60E-03	LTV_DAPH	4.50E-02	0.06
Nickel	2.01	1	1	2.60E-03	2.60E-03	LTV_FISH	6.20E-02	0.04
Nickel	2.01	1	1	2.60E-03	2.60E-03	LCV_NDI	1.28E-01	0.02
Nickel	2.01	1	1	2.60E-03	2.60E-03	NAWQ_CHR	1.60E-01	0.02
Nickel	2.01	1	1	2.60E-03	2.60E-03	NAWQ_ACU	1.40E+00	0.00
Nickel	**2.04**	**6**	**6**	**5.58E-03**	**1.69E-02**	**LCV_AQPL**	**5.00E-03**	**3.37**
Nickel	**2.04**	**6**	**6**	**5.58E-03**	**1.69E-02**	**LCV_DAPH**	**5.00E-03**	**3.37**
Nickel	2.04	6	6	5.58E-03	1.69E-02	LCV_FISH	3.50E-02	0.48
Nickel	2.04	6	6	5.58E-03	1.69E-02	LTV_DAPH	4.50E-02	0.37
Nickel	2.04	6	6	5.58E-03	1.69E-02	LTV_FISH	6.20E-02	0.27
Nickel	2.04	6	6	5.58E-03	1.69E-02	LCV_NDI	1.28E-01	0.13
Nickel	2.04	6	6	5.58E-03	1.69E-02	NAWQ_CHR	1.60E-01	0.11
Nickel	2.04	6	6	5.58E-03	1.69E-02	NAWQ_ACU	1.40E+00	0.01

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Nickel	**3.01**	**2**	**2**	**5.41E-02**	**1.01E-01**	**LCV_AQPL**	**5.00E-03**	**20.20**
Nickel	**3.01**	**2**	**2**	**5.41E-02**	**1.01E-01**	**LCV_DAPH**	**5.00E-03**	**20.20**
Nickel	**3.01**	**2**	**2**	**5.41E-02**	**1.01E-01**	**LCV_FISH**	**3.50E-02**	**2.89**
Nickel	**3.01**	**2**	**2**	**5.41E-02**	**1.01E-01**	**LTV_DAPH**	**4.50E-02**	**2.24**
Nickel	**3.01**	**2**	**2**	**5.41E-02**	**1.01E-01**	**LTV_FISH**	**6.20E-02**	**1.63**
Nickel	3.01	2	2	5.41E-02	1.01E-01	LCV_NDI	1.28E-01	0.79
Nickel	3.01	2	2	5.41E-02	1.01E-01	NAWQ_CHR	1.60E-01	0.63
Nickel	3.01	2	2	5.41E-02	1.01E-01	NAWQ_ACU	1.40E+00	0.07
Nickel	**3.02**	**7**	**8**	**9.85E-03**	**4.15E-02**	**LCV_AQPL**	**5.00E-03**	**8.30**
Nickel	**3.02**	**7**	**8**	**9.85E-03**	**4.15E-02**	**LCV_DAPH**	**5.00E-03**	**8.30**
Nickel	**3.02**	**7**	**8**	**9.85E-03**	**4.15E-02**	**LCV_FISH**	**3.50E-02**	**1.19**
Nickel	3.02	7	8	9.85E-03	4.15E-02	LTV_DAPH	4.50E-02	0.92
Nickel	3.02	7	8	9.85E-03	4.15E-02	LTV_FISH	6.20E-02	0.67
Nickel	3.02	7	8	9.85E-03	4.15E-02	LCV_NDI	1.28E-01	0.32
Nickel	3.02	7	8	9.85E-03	4.15E-02	NAWQ_CHR	1.60E-01	0.26
Nickel	3.02	7	8	9.85E-03	4.15E-02	NAWQ_ACU	1.40E+00	0.03
Nickel	**3.03**	**9**	**9**	**1.09E-02**	**2.52E-02**	**LCV_AQPL**	**5.00E-03**	**5.04**
Nickel	**3.03**	**9**	**9**	**1.09E-02**	**2.52E-02**	**LCV_DAPH**	**5.00E-03**	**5.04**
Nickel	3.03	9	9	1.09E-02	2.52E-02	LCV_FISH	3.50E-02	0.72
Nickel	3.03	9	9	1.09E-02	2.52E-02	LTV_DAPH	4.50E-02	0.56
Nickel	3.03	9	9	1.09E-02	2.52E-02	LTV_FISH	6.20E-02	0.41
Nickel	3.03	9	9	1.09E-02	2.52E-02	LCV_NDI	1.28E-01	0.20
Nickel	3.03	9	9	1.09E-02	2.52E-02	NAWQ_CHR	1.60E-01	0.16
Nickel	3.03	9	9	1.09E-02	2.52E-02	NAWQ_ACU	1.40E+00	0.02
Nickel	**3.04**	**6**	**6**	**5.88E-03**	**7.00E-03**	**LCV_AQPL**	**5.00E-03**	**1.40**
Nickel	**3.04**	**6**	**6**	**5.88E-03**	**7.00E-03**	**LCV_DAPH**	**5.00E-03**	**1.40**
Nickel	3.04	6	6	5.88E-03	7.00E-03	LCV_FISH	3.50E-02	0.20

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Nickel	3.04	6	6	5.88E-03	7.00E-03	LTV_DAPH	4.50E-02	0.16
Nickel	3.04	6	6	5.88E-03	7.00E-03	LTV_FISH	6.20E-02	0.11
Nickel	3.04	6	6	5.88E-03	7.00E-03	LCV_NDI	1.28E-01	0.05
Nickel	3.04	6	6	5.88E-03	7.00E-03	NAWQ_CHR	1.60E-01	0.04
Nickel	3.04	6	6	5.88E-03	7.00E-03	NAWQ_ACU	1.40E+00	0.01
Nickel	**4.01**	**9**	**9**	**3.50E-03**	**5.20E-03**	**LCV_AQPL**	**5.00E-03**	**1.04**
Nickel	**4.01**	**9**	**9**	**3.50E-03**	**5.20E-03**	**LCV_DAPH**	**5.00E-03**	**1.04**
Nickel	4.01	9	9	3.50E-03	5.20E-03	LCV_FISH	3.50E-02	0.15
Nickel	4.01	9	9	3.50E-03	5.20E-03	LTV_DAPH	4.50E-02	0.12
Nickel	4.01	9	9	3.50E-03	5.20E-03	LTV_FISH	6.20E-02	0.08
Nickel	4.01	9	9	3.50E-03	5.20E-03	LCV_NDI	1.28E-01	0.04
Nickel	4.01	9	9	3.50E-03	5.20E-03	NAWQ_CHR	1.60E-01	0.03
Nickel	4.01	9	9	3.50E-03	5.20E-03	NAWQ_ACU	1.40E+00	0.00
Nickel	**4.02**	**6**	**6**	**9.15E-03**	**2.87E-02**	**LCV_AQPL**	**5.00E-03**	**5.74**
Nickel	**4.02**	**6**	**6**	**9.15E-03**	**2.87E-02**	**LCV_DAPH**	**5.00E-03**	**5.74**
Nickel	4.02	6	6	9.15E-03	2.87E-02	LCV_FISH	3.50E-02	0.82
Nickel	4.02	6	6	9.15E-03	2.87E-02	LTV_DAPH	4.50E-02	0.64
Nickel	4.02	6	6	9.15E-03	2.87E-02	LTV_FISH	6.20E-02	0.46
Nickel	4.02	6	6	9.15E-03	2.87E-02	LCV_NDI	1.28E-01	0.22
Nickel	4.02	6	6	9.15E-03	2.87E-02	NAWQ_CHR	1.60E-01	0.18
Nickel	4.02	6	6	9.15E-03	2.87E-02	NAWQ_ACU	1.40E+00	0.02
Nickel	**4.03**	**7**	**7**	**1.10E-02**	**1.84E-02**	**LCV_AQPL**	**5.00E-03**	**3.68**
Nickel	**4.03**	**7**	**7**	**1.10E-02**	**1.84E-02**	**LCV_DAPH**	**5.00E-03**	**3.68**
Nickel	4.03	7	7	1.10E-02	1.84E-02	LCV_FISH	3.50E-02	0.53
Nickel	4.03	7	7	1.10E-02	1.84E-02	LTV_DAPH	4.50E-02	0.41
Nickel	4.03	7	7	1.10E-02	1.84E-02	LTV_FISH	6.20E-02	0.30
Nickel	4.03	7	7	1.10E-02	1.84E-02	LCV_NDI	1.28E-01	0.14

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Nickel	4.03	7	7	1.10E-02	1.84E-02	NAWQ_CHR	1.60E-01	0.12
Nickel	4.03	7	7	1.10E-02	1.84E-02	NAWQ_ACU	1.40E+00	0.01
Nickel	**4.04**	**11**	**11**	**4.60E-03**	**6.70E-03**	**LCV_AQPL**	**5.00E-03**	**1.34**
Nickel	**4.04**	**11**	**11**	**4.60E-03**	**6.70E-03**	**LCV_DAPH**	**5.00E-03**	**1.34**
Nickel	4.04	11	11	4.60E-03	6.70E-03	LCV_FISH	3.50E-02	0.19
Nickel	4.04	11	11	4.60E-03	6.70E-03	LTV_DAPH	4.50E-02	0.15
Nickel	4.04	11	11	4.60E-03	6.70E-03	LTV_FISH	6.20E-02	0.11
Nickel	4.04	11	11	4.60E-03	6.70E-03	LCV_NDI	1.28E-01	0.05
Nickel	4.04	11	11	4.60E-03	6.70E-03	NAWQ_CHR	1.60E-01	0.04
Nickel	4.04	11	11	4.60E-03	6.70E-03	NAWQ_ACU	1.40E+00	0.00
Nickel	**7.01**	**1**	**1**	**1.16E-02**	**1.16E-02**	**LCV_AQPL**	**5.00E-03**	**2.32**
Nickel	**7.01**	**1**	**1**	**1.16E-02**	**1.16E-02**	**LCV_DAPH**	**5.00E-03**	**2.32**
Nickel	7.01	1	1	1.16E-02	1.16E-02	LCV_FISH	3.50E-02	0.33
Nickel	7.01	1	1	1.16E-02	1.16E-02	LTV_DAPH	4.50E-02	0.26
Nickel	7.01	1	1	1.16E-02	1.16E-02	LTV_FISH	6.20E-02	0.19
Nickel	7.01	1	1	1.16E-02	1.16E-02	LCV_NDI	1.28E-01	0.09
Nickel	7.01	1	1	1.16E-02	1.16E-02	NAWQ_CHR	1.60E-01	0.07
Nickel	7.01	1	1	1.16E-02	1.16E-02	NAWQ_ACU	1.40E+00	0.01
Nickel	**7.02**	**1**	**1**	**1.05E-02**	**1.05E-02**	**LCV_AQPL**	**5.00E-03**	**2.10**
Nickel	**7.02**	**1**	**1**	**1.05E-02**	**1.05E-02**	**LCV_DAPH**	**5.00E-03**	**2.10**
Nickel	7.02	1	1	1.05E-02	1.05E-02	LCV_FISH	3.50E-02	0.30
Nickel	7.02	1	1	1.05E-02	1.05E-02	LTV_DAPH	4.50E-02	0.23
Nickel	7.02	1	1	1.05E-02	1.05E-02	LTV_FISH	6.20E-02	0.17
Nickel	7.02	1	1	1.05E-02	1.05E-02	LCV_NDI	1.28E-01	0.08
Nickel	7.02	1	1	1.05E-02	1.05E-02	NAWQ_CHR	1.60E-01	0.07
Nickel	7.02	1	1	1.05E-02	1.05E-02	NAWQ_ACU	1.40E+00	0.01
Nickel	**8**	**1**	**1**	**1.24E-02**	**1.24E-02**	**LCV_AQPL**	**5.00E-03**	**2.48**

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Nickel	**8**	**1**	**1**	**1.24E-02**	**1.24E-02**	**LCV_DAPH**	**5.00E-03**	**2.48**
Nickel	8	1	1	1.24E-02	1.24E-02	LCV_FISH	3.50E-02	0.35
Nickel	8	1	1	1.24E-02	1.24E-02	LTV_DAPH	4.50E-02	0.28
Nickel	8	1	1	1.24E-02	1.24E-02	LTV_FISH	6.20E-02	0.20
Nickel	8	1	1	1.24E-02	1.24E-02	LCV_NDI	1.28E-01	0.10
Nickel	8	1	1	1.24E-02	1.24E-02	NAWQ_CHR	1.60E-01	0.08
Nickel	8	1	1	1.24E-02	1.24E-02	NAWQ_ACU	1.40E+00	0.01
Nickel	**13**	**3**	**5**	**4.40E-03**	**1.15E-02**	**LCV_AQPL**	**5.00E-03**	**2.30**
Nickel	**13**	**3**	**5**	**4.40E-03**	**1.15E-02**	**LCV_DAPH**	**5.00E-03**	**2.30**
Nickel	13	3	5	4.40E-03	1.15E-02	LCV_FISH	3.50E-02	0.33
Nickel	13	3	5	4.40E-03	1.15E-02	LTV_DAPH	4.50E-02	0.26
Nickel	13	3	5	4.40E-03	1.15E-02	LTV_FISH	6.20E-02	0.19
Nickel	13	3	5	4.40E-03	1.15E-02	LCV_NDI	1.28E-01	0.09
Nickel	13	3	5	4.40E-03	1.15E-02	NAWQ_CHR	1.60E-01	0.07
Nickel	13	3	5	4.40E-03	1.15E-02	NAWQ_ACU	1.40E+00	0.01
Nickel	18	3	3	2.50E-03	4.30E-03	LCV_AQPL	5.00E-03	0.86
Nickel	18	3	3	2.50E-03	4.30E-03	LCV_DAPH	5.00E-03	0.86
Nickel	18	3	3	2.50E-03	4.30E-03	LCV_FISH	3.50E-02	0.12
Nickel	18	3	3	2.50E-03	4.30E-03	LTV_DAPH	4.50E-02	0.10
Nickel	18	3	3	2.50E-03	4.30E-03	LTV_FISH	6.20E-02	0.07
Nickel	18	3	3	2.50E-03	4.30E-03	LCV_NDI	1.28E-01	0.03
Nickel	18	3	3	2.50E-03	4.30E-03	NAWQ_CHR	1.60E-01	0.03
Nickel	18	3	3	2.50E-03	4.30E-03	NAWQ_ACU	1.40E+00	0.00
Uranium	**3.02**	**8**	**8**	**9.10E-03**	**9.89E-02**	**S_CHR_V**	**1.87E-03**	**52.89**
Uranium	**3.02**	**8**	**8**	**9.10E-03**	**9.89E-02**	**S_ACU_V**	**3.35E-02**	**2.95**
Uranium	3.02	8	8	9.10E-03	9.89E-02	LCV_FISH	1.42E-01	0.70
Uranium	3.02	8	8	9.10E-03	9.89E-02	LTV_FISH	4.55E-01	0.22

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Uranium	**3.03**	**9**	**9**	**6.90E-03**	**2.07E-02**	**S_CHR_V**	**1.87E-03**	**11.10**
Uranium	3.03	9	9	6.90E-03	2.07E-02	S_ACU_V	3.35E-02	0.62
Uranium	3.03	9	9	6.90E-03	2.07E-02	LCV_FISH	1.42E-01	0.15
Uranium	3.03	9	9	6.90E-03	2.07E-02	LTV_FISH	4.55E-01	0.05
Uranium	**3.04**	**6**	**6**	**5.05E-03**	**1.02E-02**	**S_CHR_V**	**1.87E-03**	**5.45**
Uranium	3.04	6	6	5.05E-03	1.02E-02	S_ACU_V	3.35E-02	0.30
Uranium	3.04	6	6	5.05E-03	1.02E-02	LCV_FISH	1.42E-01	0.07
Uranium	3.04	6	6	5.05E-03	1.02E-02	LTV_FISH	4.55E-01	0.02
Uranium	4.01	3	9	1.20E-03	1.60E-03	S_CHR_V	1.87E-03	0.86
Uranium	4.01	3	9	1.20E-03	1.60E-03	S_ACU_V	3.35E-02	0.05
Uranium	4.01	3	9	1.20E-03	1.60E-03	LCV_FISH	1.42E-01	0.01
Uranium	4.01	3	9	1.20E-03	1.60E-03	LTV_FISH	4.55E-01	0.00
Uranium	4.02	2	6	1.10E-03	1.80E-03	S_CHR_V	1.87E-03	0.96
Uranium	4.02	2	6	1.10E-03	1.80E-03	S_ACU_V	3.35E-02	0.05
Uranium	4.02	2	6	1.10E-03	1.80E-03	LCV_FISH	1.42E-01	0.01
Uranium	4.02	2	6	1.10E-03	1.80E-03	LTV_FISH	4.55E-01	0.00
Uranium	**4.03**	**1**	**7**	**2.07E-03**	**2.07E-03**	**S_CHR_V**	**1.87E-03**	**1.11**
Uranium	4.03	1	7	2.07E-03	2.07E-03	S_ACU_V	3.35E-02	0.06
Uranium	4.03	1	7	2.07E-03	2.07E-03	LCV_FISH	1.42E-01	0.01
Uranium	4.03	1	7	2.07E-03	2.07E-03	LTV_FISH	4.55E-01	0.00
Uranium	13	2	5	1.00E-03	1.50E-03	S_CHR_V	1.87E-03	0.80
Uranium	13	2	5	1.00E-03	1.50E-03	S_ACU_V	3.35E-02	0.04
Uranium	13	2	5	1.00E-03	1.50E-03	LCV_FISH	1.42E-01	0.01
Uranium	13	2	5	1.00E-03	1.50E-03	LTV_FISH	4.55E-01	0.00
Zinc	0	5	5	7.90E-03	8.53E-03	LCV_AQPL	3.00E-02	0.28
Zinc	0	5	5	7.90E-03	8.53E-03	LCV_FISH	3.64E-02	0.23
Zinc	0	5	5	7.90E-03	8.53E-03	LCV_DAPH	4.67E-02	0.18

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Zinc	0	5	5	7.90E-03	8.53E-03	LTV_FISH	4.70E-02	0.18
Zinc	0	5	5	7.90E-03	8.53E-03	NAWQ_CHR	1.10E-01	0.08
Zinc	0	5	5	7.90E-03	8.53E-03	NAWQ_ACU	1.20E-01	0.07
Zinc	0	5	5	7.90E-03	8.53E-03	LCV_NDI	5.24E+00	0.00
Zinc	2.01	1	1	3.10E-03	3.10E-03	LCV_AQPL	3.00E-02	0.10
Zinc	2.01	1	1	3.10E-03	3.10E-03	LCV_FISH	3.64E-02	0.09
Zinc	2.01	1	1	3.10E-03	3.10E-03	LCV_DAPH	4.67E-02	0.07
Zinc	2.01	1	1	3.10E-03	3.10E-03	LTV_FISH	4.70E-02	0.07
Zinc	2.01	1	1	3.10E-03	3.10E-03	NAWQ_CHR	1.10E-01	0.03
Zinc	2.01	1	1	3.10E-03	3.10E-03	NAWQ_ACU	1.20E-01	0.03
Zinc	2.01	1	1	3.10E-03	3.10E-03	LCV_NDI	5.24E+00	0.00
Zinc	2.03	1	1	1.09E-02	1.09E-02	LCV_AQPL	3.00E-02	0.36
Zinc	2.03	1	1	1.09E-02	1.09E-02	LCV_FISH	3.64E-02	0.30
Zinc	2.03	1	1	1.09E-02	1.09E-02	LCV_DAPH	4.67E-02	0.23
Zinc	2.03	1	1	1.09E-02	1.09E-02	LTV_FISH	4.70E-02	0.23
Zinc	2.03	1	1	1.09E-02	1.09E-02	NAWQ_CHR	1.10E-01	0.10
Zinc	2.03	1	1	1.09E-02	1.09E-02	NAWQ_ACU	1.20E-01	0.09
Zinc	2.03	1	1	1.09E-02	1.09E-02	LCV_NDI	5.24E+00	0.00
Zinc	2.04	6	6	6.20E-03	1.72E-02	LCV_AQPL	3.00E-02	0.57
Zinc	2.04	6	6	6.20E-03	1.72E-02	LCV_FISH	3.64E-02	0.47
Zinc	2.04	6	6	6.20E-03	1.72E-02	LCV_DAPH	4.67E-02	0.37
Zinc	2.04	6	6	6.20E-03	1.72E-02	LTV_FISH	4.70E-02	0.37
Zinc	2.04	6	6	6.20E-03	1.72E-02	NAWQ_CHR	1.10E-01	0.16
Zinc	2.04	6	6	6.20E-03	1.72E-02	NAWQ_ACU	1.20E-01	0.14
Zinc	2.04	6	6	6.20E-03	1.72E-02	LCV_NDI	5.24E+00	0.00
Zinc	3.01	1	2	2.32E-02	2.32E-02	LCV_AQPL	3.00E-02	0.77
Zinc	3.01	1	2	2.32E-02	2.32E-02	LCV_FISH	3.64E-02	0.64

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Zinc	3.01	1	2	2.32E-02	2.32E-02	LCV_DAPH	4.67E-02	0.50
Zinc	3.01	1	2	2.32E-02	2.32E-02	LTV_FISH	4.70E-02	0.49
Zinc	3.01	1	2	2.32E-02	2.32E-02	NAWQ_CHR	1.10E-01	0.21
Zinc	3.01	1	2	2.32E-02	2.32E-02	NAWQ_ACU	1.20E-01	0.19
Zinc	3.01	1	2	2.32E-02	2.32E-02	LCV_NDI	5.24E+00	0.00
Zinc	3.02	7	8	7.40E-03	1.23E-02	LCV_AQPL	3.00E-02	0.41
Zinc	3.02	7	8	7.40E-03	1.23E-02	LCV_FISH	3.64E-02	0.34
Zinc	3.02	7	8	7.40E-03	1.23E-02	LCV_DAPH	4.67E-02	0.26
Zinc	3.02	7	8	7.40E-03	1.23E-02	LTV_FISH	4.70E-02	0.26
Zinc	3.02	7	8	7.40E-03	1.23E-02	NAWQ_CHR	1.10E-01	0.11
Zinc	3.02	7	8	7.40E-03	1.23E-02	NAWQ_ACU	1.20E-01	0.10
Zinc	3.02	7	8	7.40E-03	1.23E-02	LCV_NDI	5.24E+00	0.00
Zinc	**3.03**	**8**	**9**	**1.00E-02**	**3.19E-02**	**LCV_AQPL**	**3.00E-02**	**1.06**
Zinc	3.03	8	9	1.00E-02	3.19E-02	LCV_FISH	3.64E-02	0.88
Zinc	3.03	8	9	1.00E-02	3.19E-02	LCV_DAPH	4.67E-02	0.68
Zinc	3.03	8	9	1.00E-02	3.19E-02	LTV_FISH	4.70E-02	0.68
Zinc	3.03	8	9	1.00E-02	3.19E-02	NAWQ_CHR	1.10E-01	0.29
Zinc	3.03	8	9	1.00E-02	3.19E-02	NAWQ_ACU	1.20E-01	0.27
Zinc	3.03	8	9	1.00E-02	3.19E-02	LCV_NDI	5.24E+00	0.01
Zinc	3.04	6	6	4.93E-03	1.19E-02	LCV_AQPL	3.00E-02	0.40
Zinc	3.04	6	6	4.93E-03	1.19E-02	LCV_FISH	3.64E-02	0.33
Zinc	3.04	6	6	4.93E-03	1.19E-02	LCV_DAPH	4.67E-02	0.25
Zinc	3.04	6	6	4.93E-03	1.19E-02	LTV_FISH	4.70E-02	0.25
Zinc	3.04	6	6	4.93E-03	1.19E-02	NAWQ_CHR	1.10E-01	0.11
Zinc	3.04	6	6	4.93E-03	1.19E-02	NAWQ_ACU	1.20E-01	0.10
Zinc	3.04	6	6	4.93E-03	1.19E-02	LCV_NDI	5.24E+00	0.00
Zinc	4.01	9	9	6.40E-03	1.84E-02	LCV_AQPL	3.00E-02	0.61

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Zinc	4.01	9	9	6.40E-03	1.84E-02	LCV_FISH	3.64E-02	0.51
Zinc	4.01	9	9	6.40E-03	1.84E-02	LCV_DAPH	4.67E-02	0.39
Zinc	4.01	9	9	6.40E-03	1.84E-02	LTV_FISH	4.70E-02	0.39
Zinc	4.01	9	9	6.40E-03	1.84E-02	NAWQ_CHR	1.10E-01	0.17
Zinc	4.01	9	9	6.40E-03	1.84E-02	NAWQ_ACU	1.20E-01	0.15
Zinc	4.01	9	9	6.40E-03	1.84E-02	LCV_NDI	5.24E+00	0.00
Zinc	4.02	6	6	1.20E-02	2.85E-02	LCV_AQPL	3.00E-02	0.95
Zinc	4.02	6	6	1.20E-02	2.85E-02	LCV_FISH	3.64E-02	0.78
Zinc	4.02	6	6	1.20E-02	2.85E-02	LCV_DAPH	4.67E-02	0.61
Zinc	4.02	6	6	1.20E-02	2.85E-02	LTV_FISH	4.70E-02	0.61
Zinc	4.02	6	6	1.20E-02	2.85E-02	NAWQ_CHR	1.10E-01	0.26
Zinc	4.02	6	6	1.20E-02	2.85E-02	NAWQ_ACU	1.20E-01	0.24
Zinc	4.02	6	6	1.20E-02	2.85E-02	LCV_NDI	5.24E+00	0.01
Zinc	**4.03**	**7**	**7**	**2.15E-02**	**7.35E-02**	**LCV_AQPL**	**3.00E-02**	**2.45**
Zinc	**4.03**	**7**	**7**	**2.15E-02**	**7.35E-02**	**LCV_FISH**	**3.64E-02**	**2.02**
Zinc	**4.03**	**7**	**7**	**2.15E-02**	**7.35E-02**	**LCV_DAPH**	**4.67E-02**	**1.57**
Zinc	**4.03**	**7**	**7**	**2.15E-02**	**7.35E-02**	**LTV_FISH**	**4.70E-02**	**1.56**
Zinc	4.03	7	7	2.15E-02	7.35E-02	NAWQ_CHR	1.10E-01	0.67
Zinc	4.03	7	7	2.15E-02	7.35E-02	NAWQ_ACU	1.20E-01	0.61
Zinc	4.03	7	7	2.15E-02	7.35E-02	LCV_NDI	5.24E+00	0.01
Zinc	4.04	11	11	4.80E-03	2.63E-02	LCV_AQPL	3.00E-02	0.88
Zinc	4.04	11	11	4.80E-03	2.63E-02	LCV_FISH	3.64E-02	0.72
Zinc	4.04	11	11	4.80E-03	2.63E-02	LCV_DAPH	4.67E-02	0.56
Zinc	4.04	11	11	4.80E-03	2.63E-02	LTV_FISH	4.70E-02	0.56
Zinc	4.04	11	11	4.80E-03	2.63E-02	NAWQ_CHR	1.10E-01	0.24
Zinc	4.04	11	11	4.80E-03	2.63E-02	NAWQ_ACU	1.20E-01	0.22
Zinc	4.04	11	11	4.80E-03	2.63E-02	LCV_NDI	5.24E+00	0.01

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Zinc	7.01	1	1	4.50E-03	4.50E-03	LCV_AQPL	3.00E-02	0.15
Zinc	7.01	1	1	4.50E-03	4.50E-03	LCV_FISH	3.64E-02	0.12
Zinc	7.01	1	1	4.50E-03	4.50E-03	LCV_DAPH	4.67E-02	0.10
Zinc	7.01	1	1	4.50E-03	4.50E-03	LTV_FISH	4.70E-02	0.10
Zinc	7.01	1	1	4.50E-03	4.50E-03	NAWQ_CHR	1.10E-01	0.04
Zinc	7.01	1	1	4.50E-03	4.50E-03	NAWQ_ACU	1.20E-01	0.04
Zinc	7.01	1	1	4.50E-03	4.50E-03	LCV_NDI	5.24E+00	0.00
Zinc	7.02	1	1	6.60E-03	6.60E-03	LCV_AQPL	3.00E-02	0.22
Zinc	7.02	1	1	6.60E-03	6.60E-03	LCV_FISH	3.64E-02	0.18
Zinc	7.02	1	1	6.60E-03	6.60E-03	LCV_DAPH	4.67E-02	0.14
Zinc	7.02	1	1	6.60E-03	6.60E-03	LTV_FISH	4.70E-02	0.14
Zinc	7.02	1	1	6.60E-03	6.60E-03	NAWQ_CHR	1.10E-01	0.06
Zinc	7.02	1	1	6.60E-03	6.60E-03	NAWQ_ACU	1.20E-01	0.06
Zinc	7.02	1	1	6.60E-03	6.60E-03	LCV_NDI	5.24E+00	0.00
Zinc	8	1	1	4.80E-03	4.80E-03	LCV_AQPL	3.00E-02	0.16
Zinc	8	1	1	4.80E-03	4.80E-03	LCV_FISH	3.64E-02	0.13
Zinc	8	1	1	4.80E-03	4.80E-03	LCV_DAPH	4.67E-02	0.10
Zinc	8	1	1	4.80E-03	4.80E-03	LTV_FISH	4.70E-02	0.10
Zinc	8	1	1	4.80E-03	4.80E-03	NAWQ_CHR	1.10E-01	0.04
Zinc	8	1	1	4.80E-03	4.80E-03	NAWQ_ACU	1.20E-01	0.04
Zinc	8	1	1	4.80E-03	4.80E-03	LCV_NDI	5.24E+00	0.00
Zinc	13	4	5	4.70E-03	5.50E-03	LCV_AQPL	3.00E-02	0.18
Zinc	13	4	5	4.70E-03	5.50E-03	LCV_FISH	3.64E-02	0.15
Zinc	13	4	5	4.70E-03	5.50E-03	LCV_DAPH	4.67E-02	0.12
Zinc	13	4	5	4.70E-03	5.50E-03	LTV_FISH	4.70E-02	0.12
Zinc	13	4	5	4.70E-03	5.50E-03	NAWQ_CHR	1.10E-01	0.05
Zinc	13	4	5	4.70E-03	5.50E-03	NAWQ_ACU	1.20E-01	0.05

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Zinc	13	4	5	4.70E-03	5.50E-03	LCV_NDI	5.24E+00	0.00
Zinc	18	3	3	1.02E-02	1.27E-02	LCV_AQPL	3.00E-02	0.42
Zinc	18	3	3	1.02E-02	1.27E-02	LCV_FISH	3.64E-02	0.35
Zinc	18	3	3	1.02E-02	1.27E-02	LCV_DAPH	4.67E-02	0.27
Zinc	18	3	3	1.02E-02	1.27E-02	LTV_FISH	4.70E-02	0.27
Zinc	18	3	3	1.02E-02	1.27E-02	NAWQ_CHR	1.10E-01	0.12
Zinc	18	3	3	1.02E-02	1.27E-02	NAWQ_ACU	1.20E-01	0.11
Zinc	18	3	3	1.02E-02	1.27E-02	LCV_NDI	5.24E+00	0.00
Bis(2-ethylhexyl)phthalate	2.04	1	3	1.00E-03	1.00E-03	LCV_DAPH	3.00E-03	0.33
Bis(2-ethylhexyl)phthalate	2.04	1	3	1.00E-03	1.00E-03	LTV_DAPH	3.00E-03	0.33
Bis(2-ethylhexyl)phthalate	2.04	1	3	1.00E-03	1.00E-03	LCV_FISH	8.40E-03	0.12
Bis(2-ethylhexyl)phthalate	2.04	1	3	1.00E-03	1.00E-03	S_CHR_V	3.22E-02	0.03
Bis(2-ethylhexyl)phthalate	2.04	1	3	1.00E-03	1.00E-03	LTV_FISH	5.40E-02	0.02
Bis(2-ethylhexyl)phthalate	2.04	1	3	1.00E-03	1.00E-03	S_ACU_V	2.86E-01	0.00
Bis(2-ethylhexyl)phthalate	3.02	1	5	2.00E-03	2.00E-03	LCV_DAPH	3.00E-03	0.67
Bis(2-ethylhexyl)phthalate	3.02	1	5	2.00E-03	2.00E-03	LTV_DAPH	3.00E-03	0.67
Bis(2-ethylhexyl)phthalate	3.02	1	5	2.00E-03	2.00E-03	LCV_FISH	8.40E-03	0.24
Bis(2-ethylhexyl)phthalate	3.02	1	5	2.00E-03	2.00E-03	S_CHR_V	3.22E-02	0.06
Bis(2-ethylhexyl)phthalate	3.02	1	5	2.00E-03	2.00E-03	LTV_FISH	5.40E-02	0.04
Bis(2-ethylhexyl)phthalate	3.02	1	5	2.00E-03	2.00E-03	S_ACU_V	2.86E-01	0.01
Bis(2-ethylhexyl)phthalate	**3.03**	**1**	**5**	**3.50E-03**	**3.50E-03**	**LCV_DAPH**	**3.00E-03**	**1.17**
Bis(2-ethylhexyl)phthalate	**3.03**	**1**	**5**	**3.50E-03**	**3.50E-03**	**LTV_DAPH**	**3.00E-03**	**1.17**
Bis(2-ethylhexyl)phthalate	3.03	1	5	3.50E-03	3.50E-03	LCV_FISH	8.40E-03	0.42
Bis(2-ethylhexyl)phthalate	3.03	1	5	3.50E-03	3.50E-03	S_CHR_V	3.22E-02	0.11
Bis(2-ethylhexyl)phthalate	3.03	1	5	3.50E-03	3.50E-03	LTV_FISH	5.40E-02	0.06
Bis(2-ethylhexyl)phthalate	3.03	1	5	3.50E-03	3.50E-03	S_ACU_V	2.86E-01	0.01
Bis(2-ethylhexyl)phthalate	**4.01**	**2**	**5**	**2.25E-03**	**3.50E-03**	**LCV_DAPH**	**3.00E-03**	**1.17**

Table F3.2 (continued)

Analyte	Subreach	Detects	Total samples	Median	Maximum	BMK name	BMK value	HQ max
Bis(2-ethylhexyl)phthalate	**4.01**	**2**	**5**	**2.25E-03**	**3.50E-03**	**LTV_DAPH**	**3.00E-03**	**1.17**
Bis(2-ethylhexyl)phthalate	4.01	2	5	2.25E-03	3.50E-03	LCV_FISH	8.40E-03	0.42
Bis(2-ethylhexyl)phthalate	4.01	2	5	2.25E-03	3.50E-03	S_CHR_V	3.22E-02	0.11
Bis(2-ethylhexyl)phthalate	4.01	2	5	2.25E-03	3.50E-03	LTV_FISH	5.40E-02	0.06
Bis(2-ethylhexyl)phthalate	4.01	2	5	2.25E-03	3.50E-03	S_ACU_V	2.86E-01	0.01
PCB-1254	**18**	**1**	**4**	**7.15E-04**	**7.15E-04**	**S_CHR_V**	**2.00E-05**	**35.75**
PCB-1254	**18**	**1**	**4**	**7.15E-04**	**7.15E-04**	**LCV_AQPL**	**1.00E-04**	**7.15**
PCB-1254	**18**	**1**	**4**	**7.15E-04**	**7.15E-04**	**S_ACU_V**	**2.10E-04**	**3.40**
PCB-1254	**18**	**1**	**4**	**7.15E-04**	**7.15E-04**	**LTV_FISH**	**5.20E-04**	**1.38**
PCB-1254	18	1	4	7.15E-04	7.15E-04	LCV_NDI	8.00E-04	0.89
PCB-1254	18	1	4	7.15E-04	7.15E-04	LCV_FISH	1.00E-03	0.72
PCB-1254	18	1	4	7.15E-04	7.15E-04	LTV_DAPH	1.20E-03	0.60
PCB-1254	18	1	4	7.15E-04	7.15E-04	LCV_DAPH	2.10E-03	0.34

[a] All units are mg/L.
[b] Includes Contaminants of Potential Ecological Concern in whole sediment and pore water which were detected at least once in the pore water samples

Table F3.3. Measured concentrations of reach 3 contaminants of ecological concern at sites with *H. azteca* toxicity tests and the determination of potential toxicity

COEC	Reach	Site[a]	Chemical Sampling Date	Concentration (mg/kg)[b]	Potentially Toxic[c]
Arsenic	3.04	PCM 1.0	28-Feb-94	64.300	Yes
Arsenic	3.04	PCM 1.0	7-Mar-90	53.551	Yes
Arsenic	3.04	PCM 0.5	21-Feb-94	**25.332**	
Arsenic	3.02	PCM 4.5	18-Jul-94	17.800	
Arsenic	3.02	PCM 4.3	7-Mar-94	6.600	Yes
Arsenic	3.02	PCM 4.0	18-Jul-94	2.800	
Arsenic	3.03	PCM 2.9	7-Mar-94	1.916	Yes
Arsenic	3.01	PCM 5.1	14-Mar-94	1.600	Yes
Chromium	3.02	PCM 4.5	18-Jul-94	**67.400**	
Chromium	3.04	PCM 0.5	21-Feb-94	45.552	
Chromium	3.04	PCM 1.0	28-Feb-94	30.300	Yes
Chromium	3.02	PCM 4.3	7-Mar-94	25.700	Yes
Chromium	3.04	PCM 1.0	7-Mar-90	25.609	Yes
Chromium	3.02	PCM 4.0	18-Jul-94	18.000	
Chromium	3.03	PCM 2.9	7-Mar-94	15.417	Yes
Chromium	3.01	PCM 5.1	14-Mar-94	12.000	Yes
Mercury	3.04	PCM 0.5	21-Feb-94	**139.409**	
Mercury	3.04	PCM 1.0	28-Feb-94	20.600	Yes
Mercury	3.02	PCM 4.5	18-Jul-94	9.293	
Mercury	3.02	PCM 4.3	7-Mar-94	5.868	Yes
Mercury	3.04	PCM 1.0	7-Mar-94	5.593	Yes
Mercury	3.04	PCM 1.0	7-Mar-90	2.778	Yes
Mercury	3.03	PCM 2.9	7-Mar-94	1.980	Yes
Mercury	3.02	PCM 4.0	18-Jul-94	0.628	
Mercury	3.01	PCM 5.1	14-Mar-94	0.031	Yes
Nickel	3.02	PCM 4.5	18-Jul-94	**228.000**	
Nickel	3.04	PCM 0.5	21-Feb-94	69.562	
Nickel	3.04	PCM 1.0	28-Feb-94	58.100	Yes
Nickel	3.02	PCM 4.3	7-Mar-94	52.900	Yes
Nickel	7.02	MBM 0.2	11-Jun-91	41.023	

Table F3.3 (continued)

COEC	Reach	Site[a]	Chemical Sampling Date	Concentration (mg/kg)[b]	Potentially Toxic[c]
Nickel	3.04	PCM 1.0	7-Mar-90	36.692	Yes
Nickel	7.02	MBM 0.2	3-Jun-94	29.300	
Nickel	7.02	MBM 0.2	11-Jun-91	28.014	
Nickel	7.02	MBM 0.2	11-Jun-91	27.765	
Nickel	7.01	MBM 0.4	3-Jun-94	26.663	
Nickel	7.02	MBM 0.2	11-Jun-91	25.400	
Nickel	3.02	PCM 4.0	18-Jul-94	24.600	
Nickel	7.02	MBM 0.2	11-Jun-91	24.178	
Nickel	7.02	MBM 0.2	11-Jun-91	24.113	
Nickel	7.02	MBM 0.2	11-Jun-91	20.825	
Nickel	7.02	MBM 0.2	11-Jun-91	17.709	
Nickel	3.03	PCM 2.9	7-Mar-94	16.895	Yes
Nickel	3.01	PCM 5.1	14-Mar-94	11.900	Yes
Nickel	4.01	CRM 9.0	28-Feb-94	8.079	Yes
Silver	3.02	PCM 4.3	7-Mar-94	1.400	Yes
Silver	3.04	PCM 0.5	21-Feb-94	**1.289**	
Silver	3.04	PCM 1.0	28-Feb-94	1.100	Yes
Silver	3.02	PCM 4.5	18-Jul-94	0.820	
Silver	7.02	MBM 0.2	11-Jun-91	0.261	
Silver	3.03	PCM 2.9	7-Mar-94	0.138	Yes
Silver	7.02	MBM 0.2	11-Jun-91	0.132	
Silver	7.02	MBM 0.2	3-Jun-94	0.120	
Silver	3.02	PCM 4.0	18-Jul-94	0.090	
Silver	7.02	MBM 0.2	11-Jun-91	0.079	
Silver	7.02	MBM 0.2	11-Jun-91	0.077	
Silver	4.01	CRM 9.0	28-Feb-94	0.068	Yes
Silver	7.02	MBM 0.2	11-Jun-91	0.050	
Silver	3.01	PCM 5.1	14-Mar-94	0.040	Yes
PCB, Total	3.04	PCM 0.5	21-Feb-94	**0.548**	
PCB, Total	3.02	PCM 4.5	18-Jul-94	0.280	
PCB, Total	3.04	PCM 1.0	28-Feb-94	0.270	Yes
PCB, Total	3.02	PCM 4.3	7-Mar-94	0.162	Yes

Table F3.3 (continued)

COEC	Reach	Site[a]	Chemical Sampling Date	Concentration (mg/kg)[b]	Potentially Toxic[c]
PCB, Total	3.03	PCM 2.9	7-Mar-94	0.154	Yes
PAH, Total[d]	3.03	PCM 2.9	7-Mar-94	10.068	Yes
PAH, Total	3.02	PCM 4.3	7-Mar-94	5.625	Yes
PAH, Total	3.02	PCM 4.5	18-Jul-94	3.933	
PAH, Total	3.04	PCM 0.5	21-Feb-94	1.785	
PAH, Total	3.04	PCM 1.0	7-Mar-90	1.423	Yes
PAH, Total	3.04	PCM 1.0	28-Feb-94	0.877	Yes
PAH, Total	3.02	PCM 4.0	18-Jul-94	0.230	
PAH, Total	3.01	PCM 5.1	14-Mar-94	0.105	Yes

[a] Only data for Poplar Creek were used for chemicals that may vary between reaches in chemical speciation (i.e., As, Cr, and Hg) or mixture composition (i.e., Total PCBs).
[b] The Site-Specific No Apparent Effects Level (SSNAEL) is in bold.
[c] COEC concentrations are considered to be potentially toxic if one or more *H. azteca* toxicity tests were significant.
[d] PAH, Total is the sum of the measured concentrations of all detected PAHs in a single sediment sample. PAHs are likely contributors to toxicity in Reach 3, but RGOs were not developed for PAHs because they present a greater risk above the OU (Reach 13) than in Reach 3. They are presented here in completeness.

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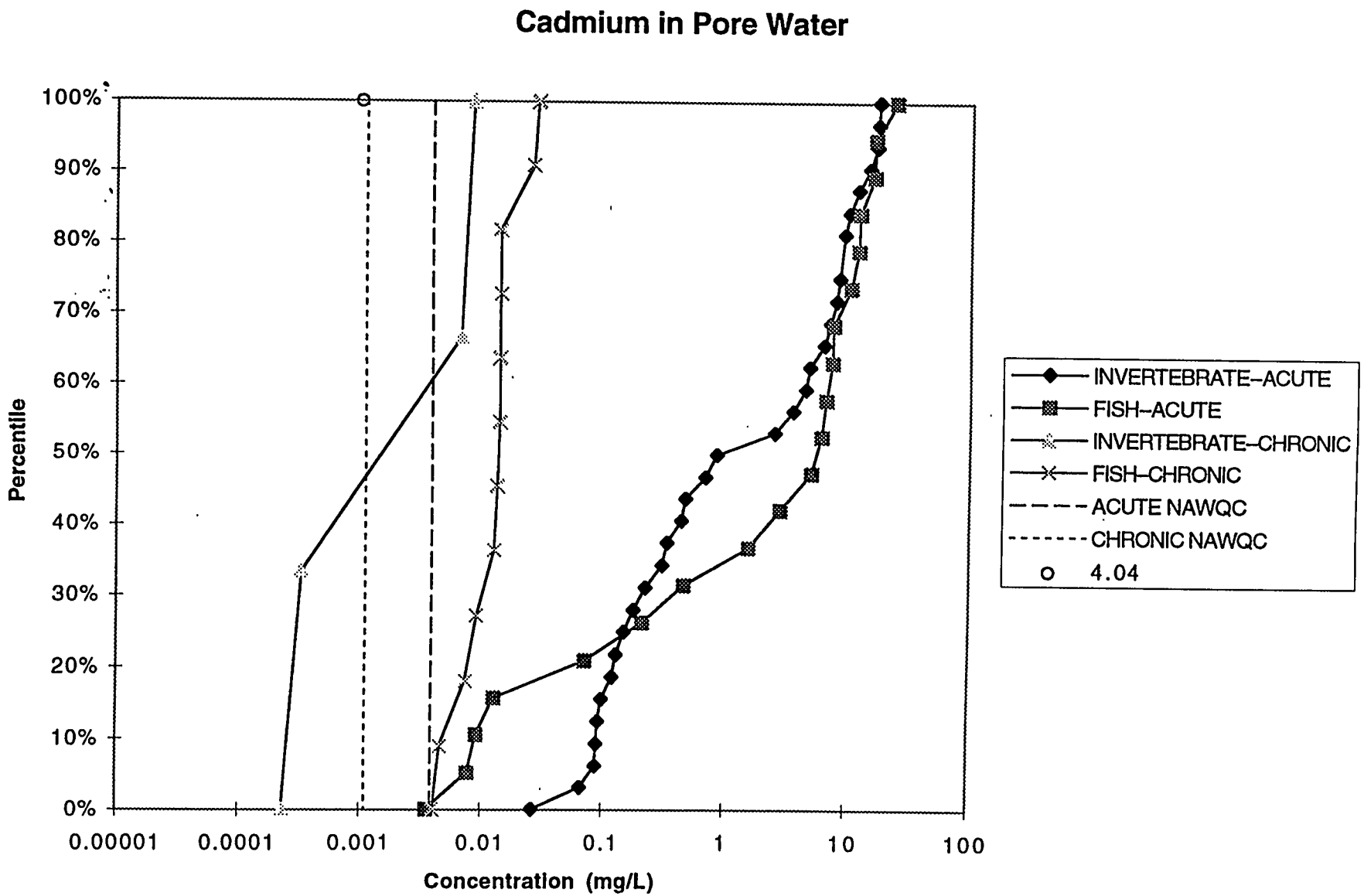


Fig. F3.1. Empirical distribution functions for acute toxicity and chronic toxicity of cadmium to aquatic organisms and individual measurements of cadmium in reaches for which potentially significant concentrations were reported.

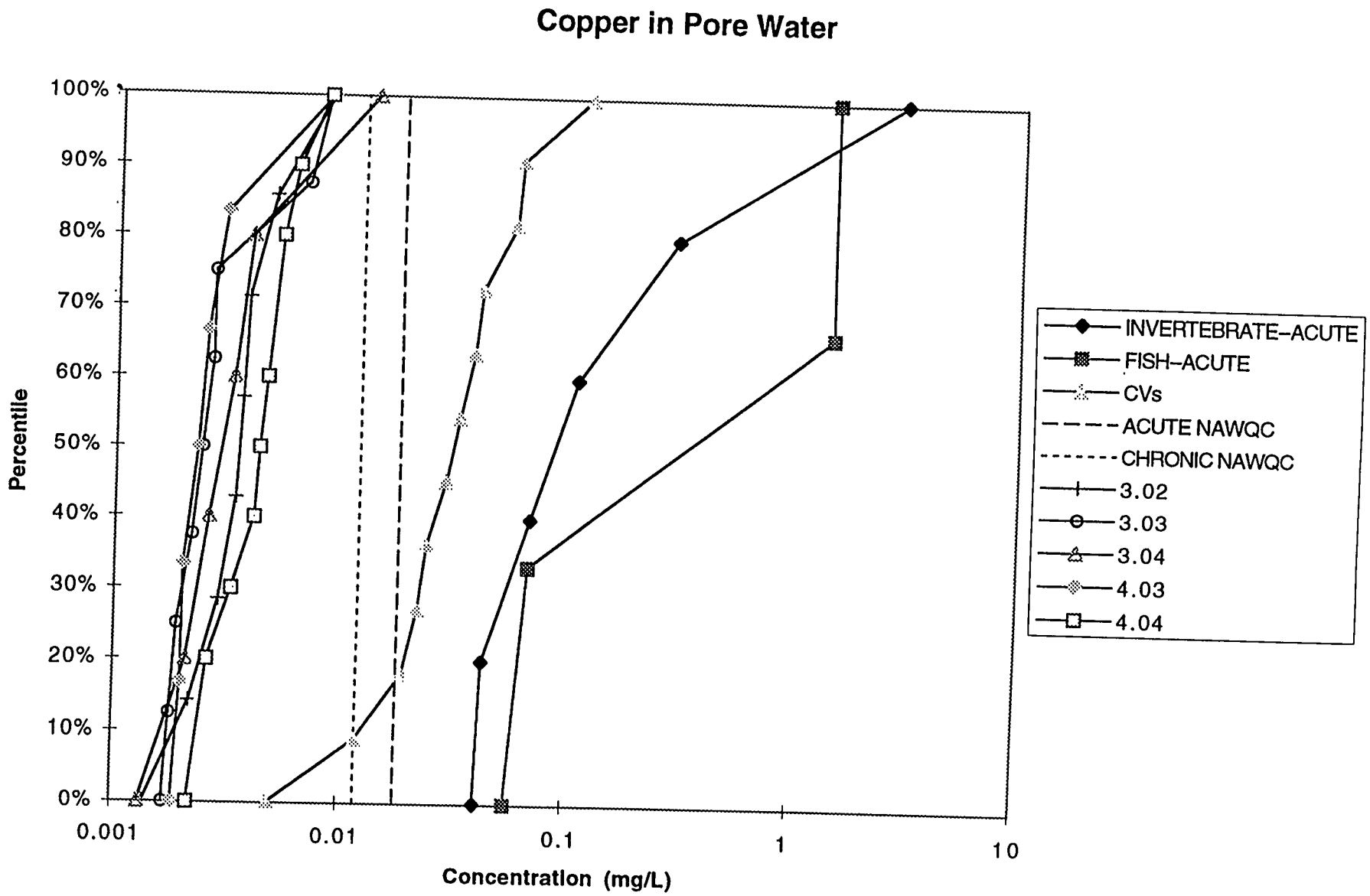


Fig. F3.2. Empirical distribution functions for acute toxicity and chronic toxicity of copper to aquatic organisms and individual measurements of copper in reaches for which potentially significant concentrations were reported.

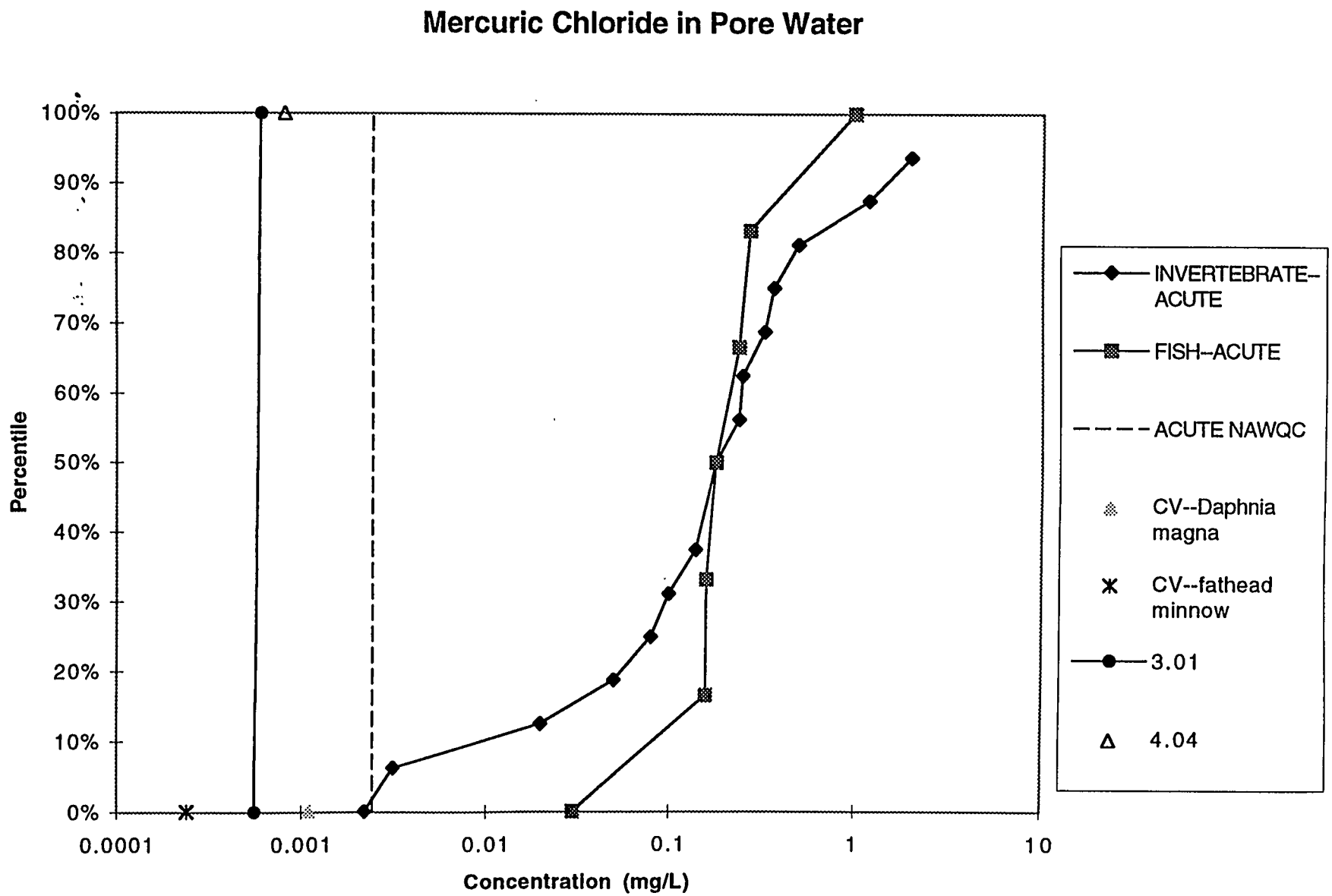


Fig. F3.3. Empirical distribution functions for acute toxicity and chronic toxicity of mercury to aquatic organisms and individual measurements of mercury in reaches for which potentially significant concentrations were reported.

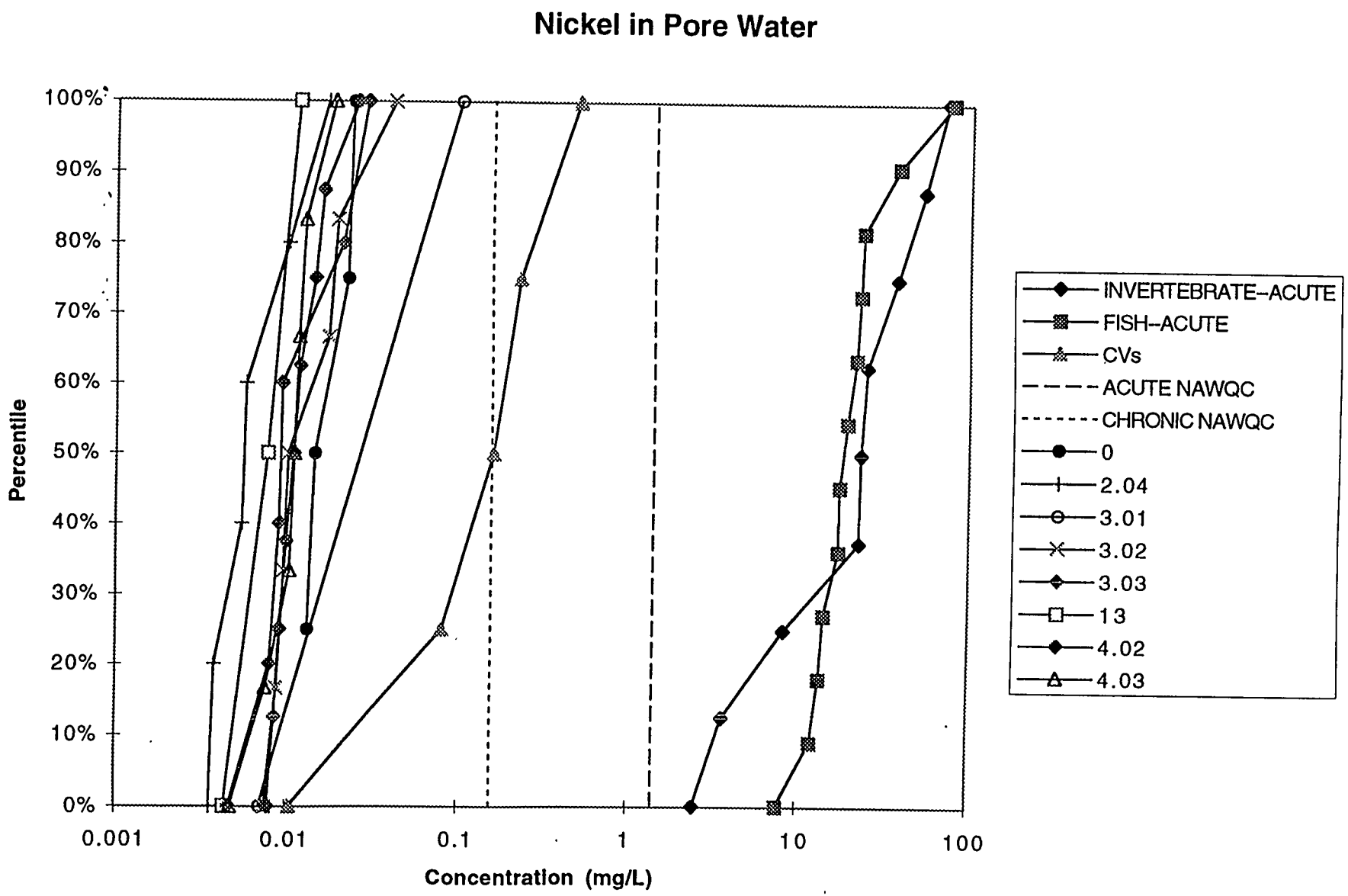


Fig. F3.4. Empirical distribution functions for acute toxicity and chronic toxicity of nickel to aquatic organisms and individual measurements of nickel in reaches for which potentially significant concentrations were reported.

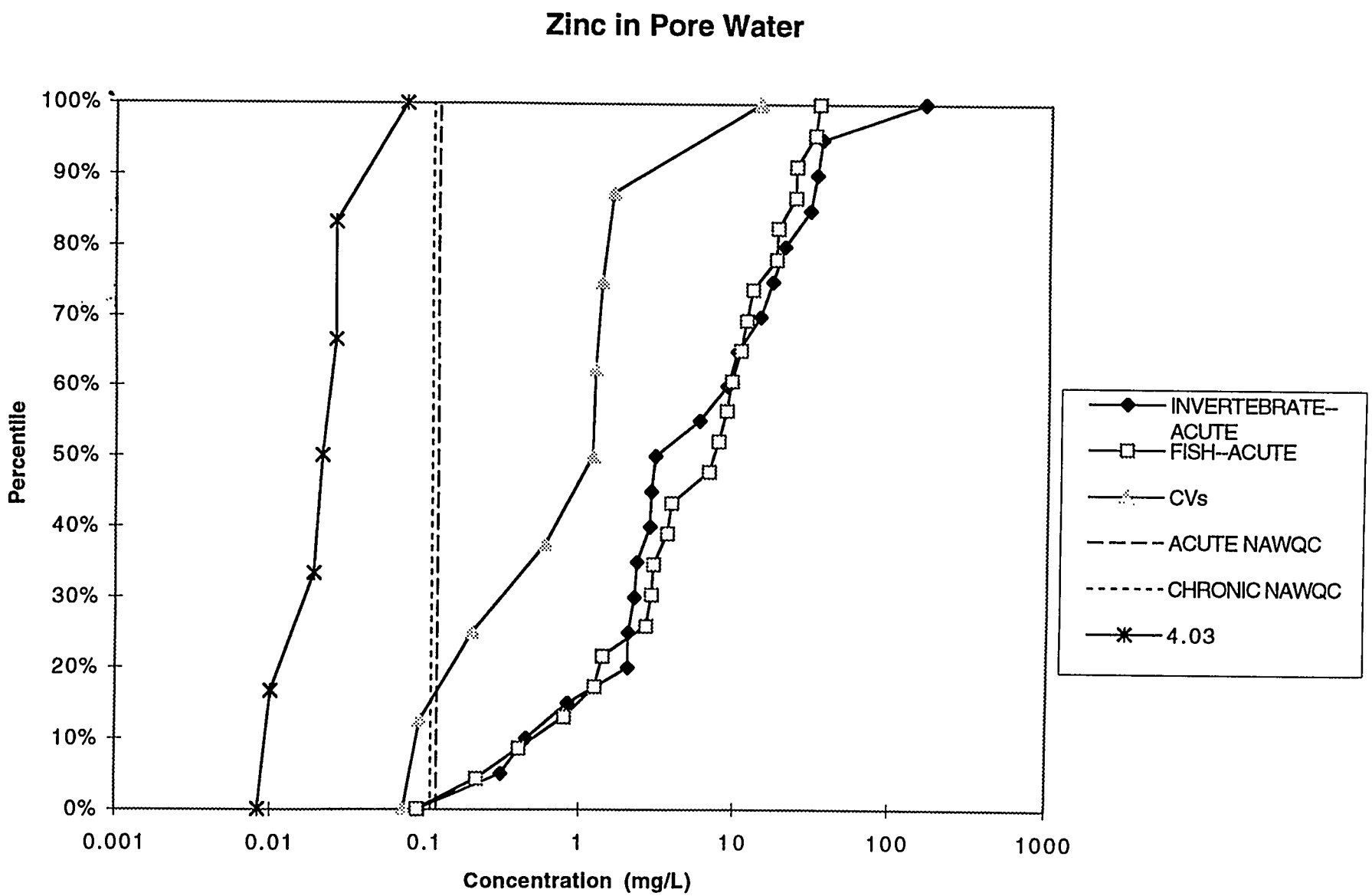


Fig. F3.5. Empirical distribution functions for acute toxicity and chronic toxicity of zinc to aquatic organisms and individual measurements of zinc in reaches for which potentially significant concentrations were reported.

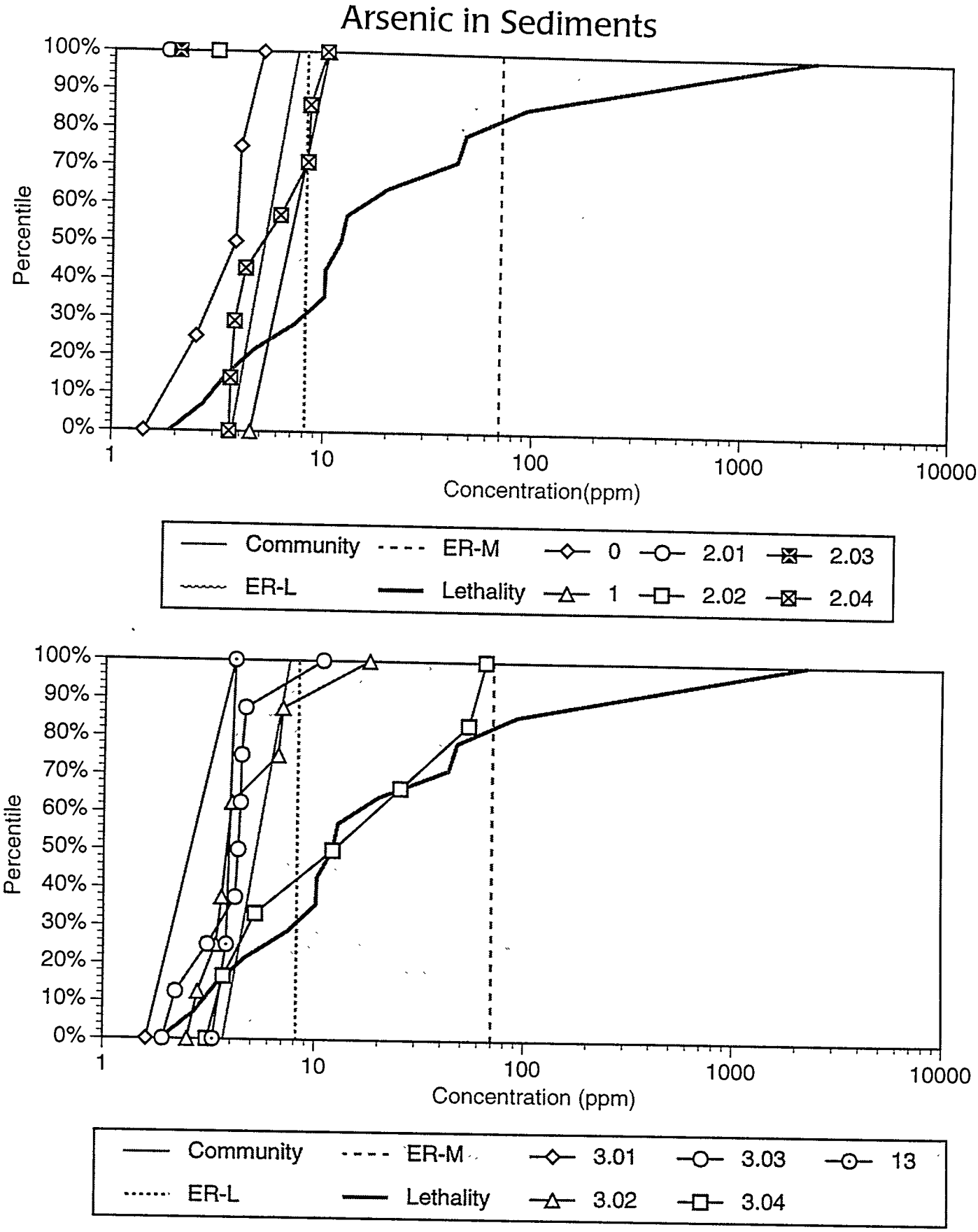
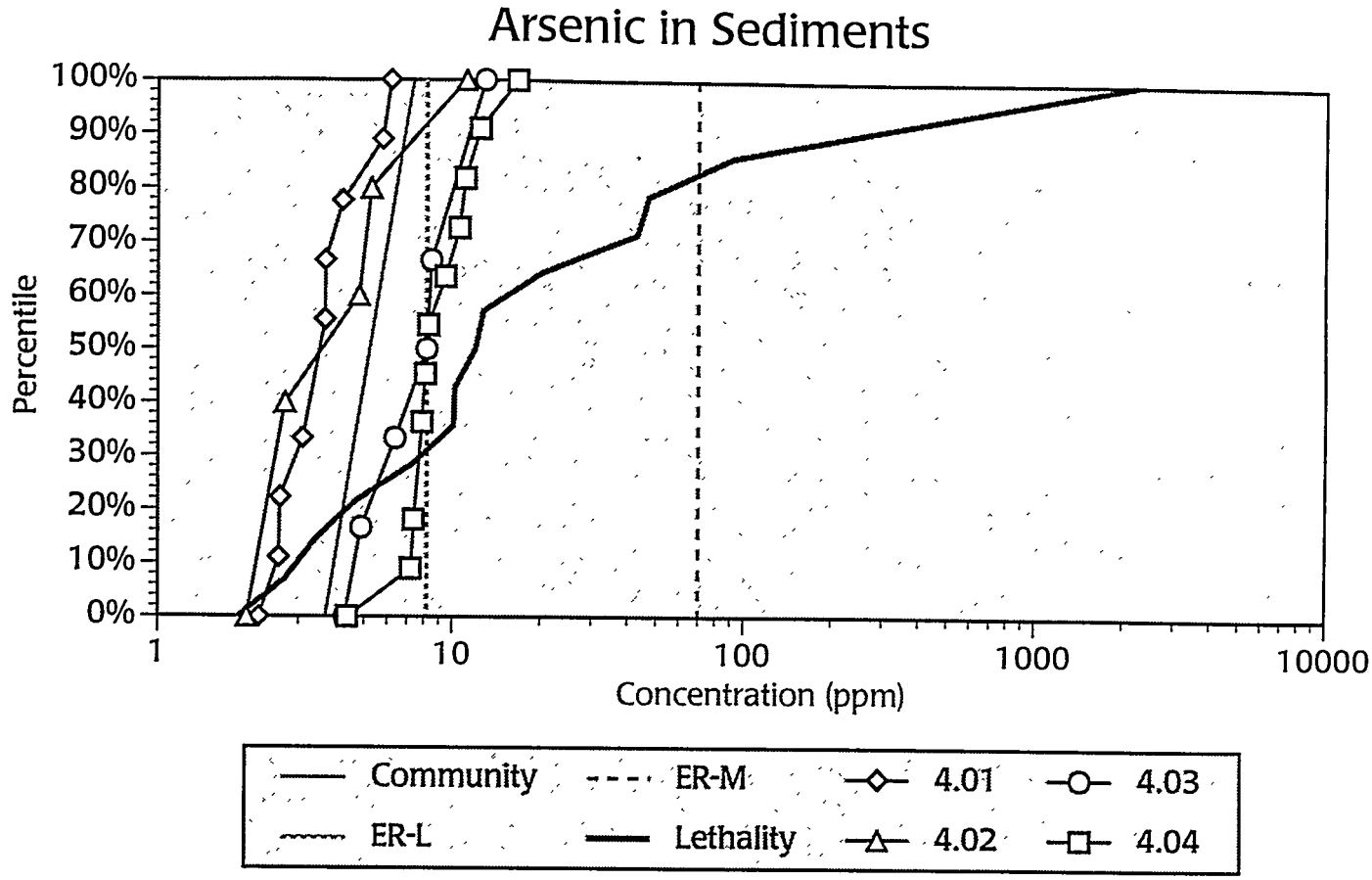


Fig. F3.6(a-b). Empirical distribution functions for sediment toxicity of arsenic to sediment-associated organisms and individual measurements of arsenic in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.



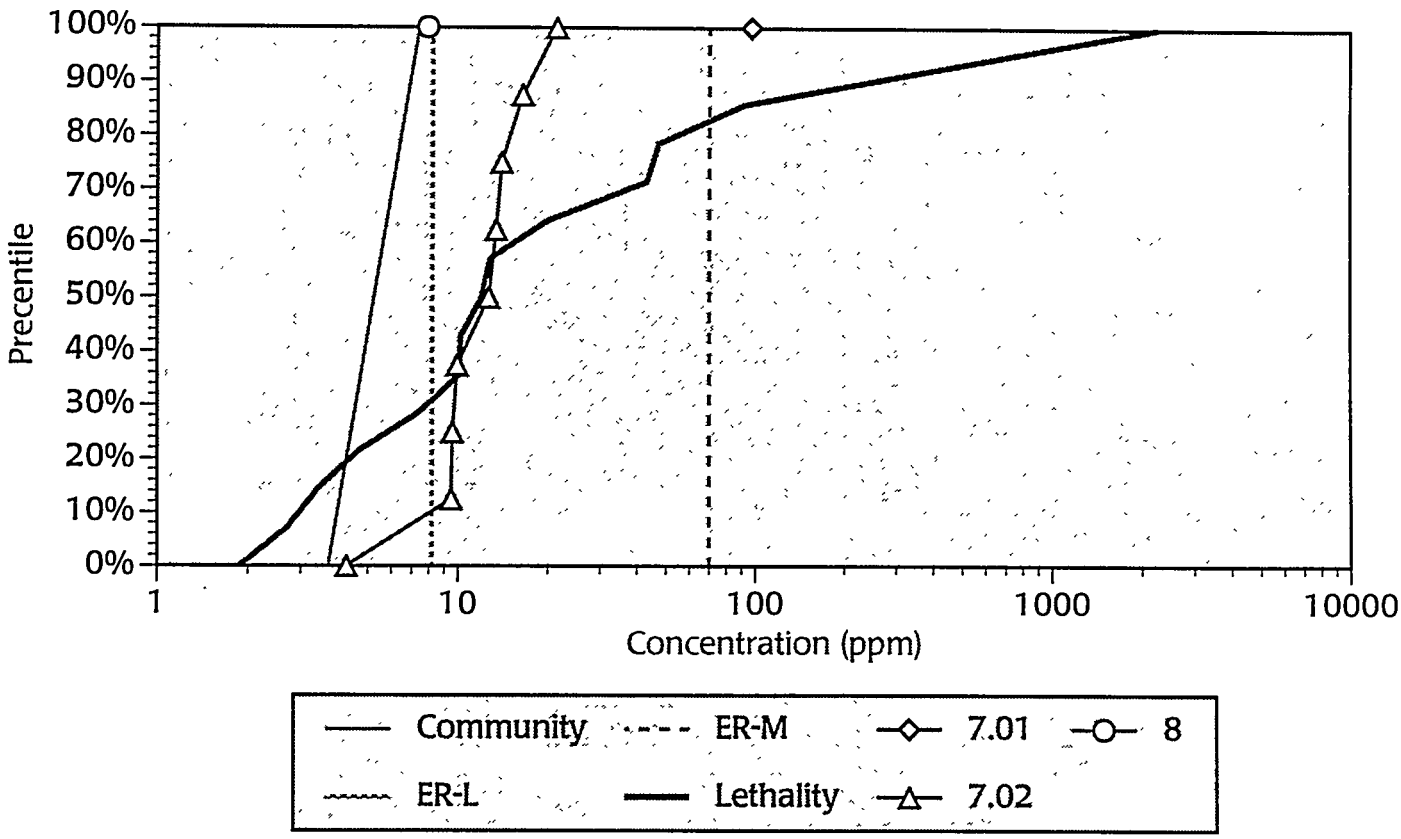
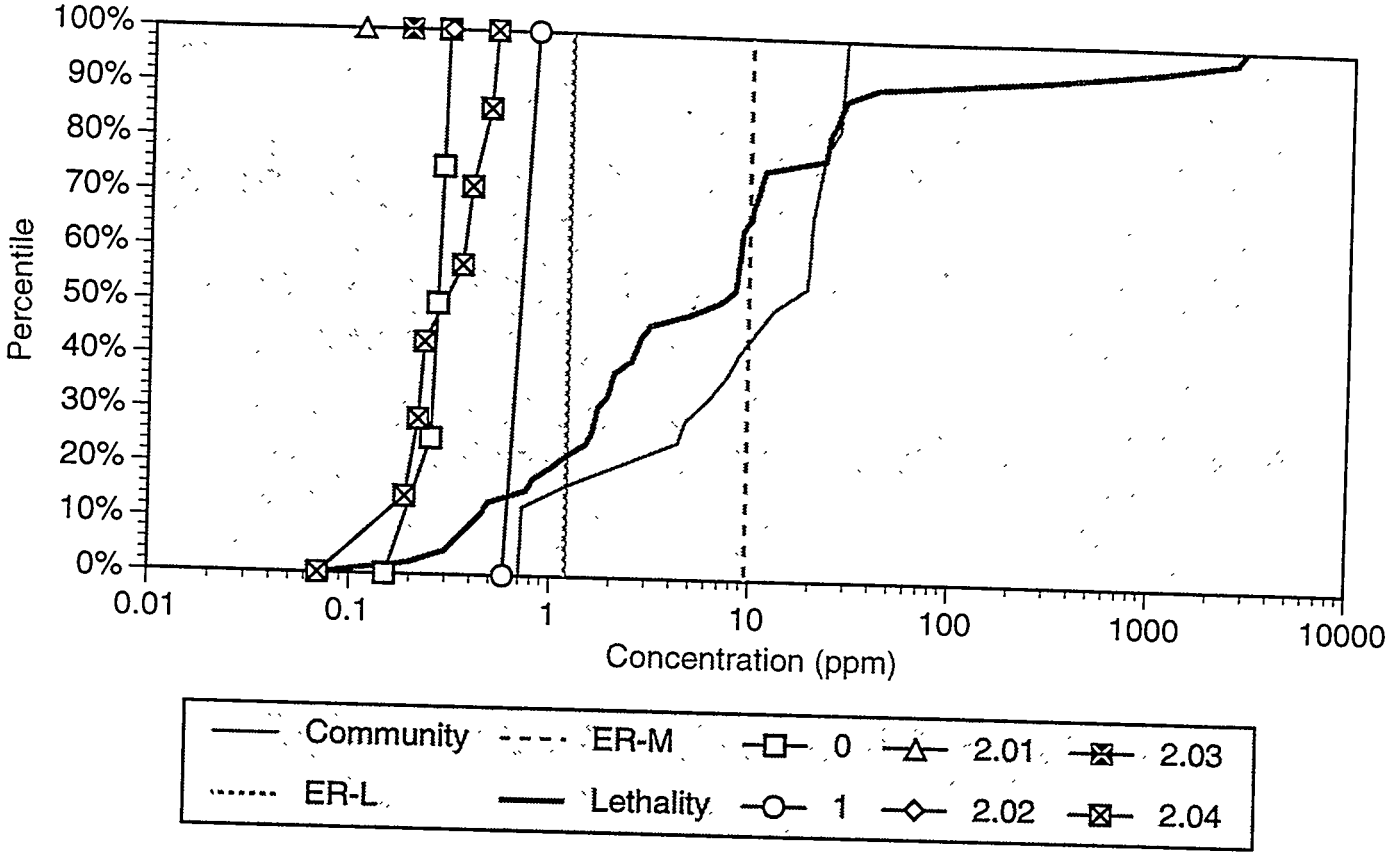


Fig. F3.6(c-d). Empirical distribution functions for sediment toxicity of arsenic to sediment-associated organisms and individual measurements of arsenic in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

Cadmium in Sediments



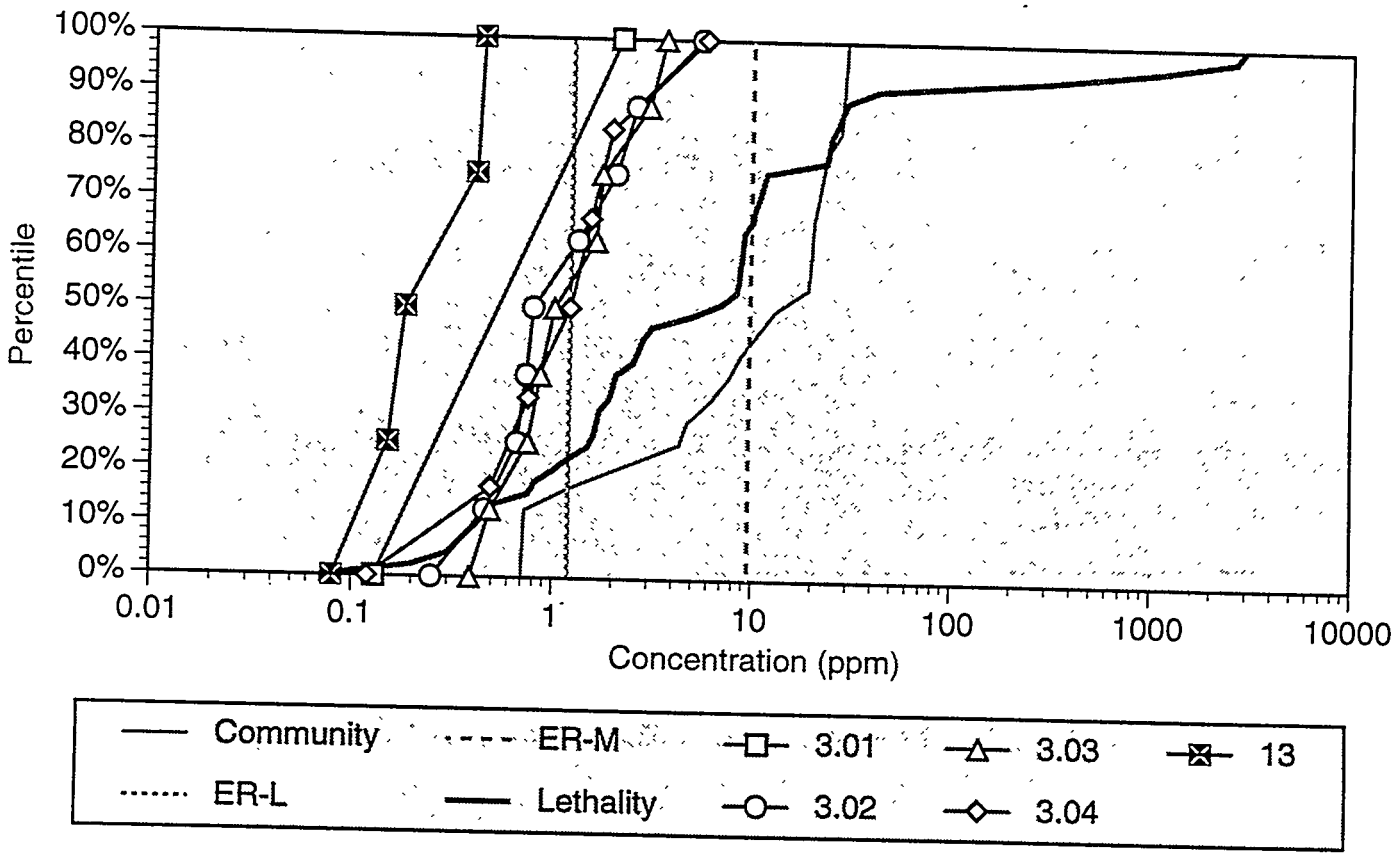
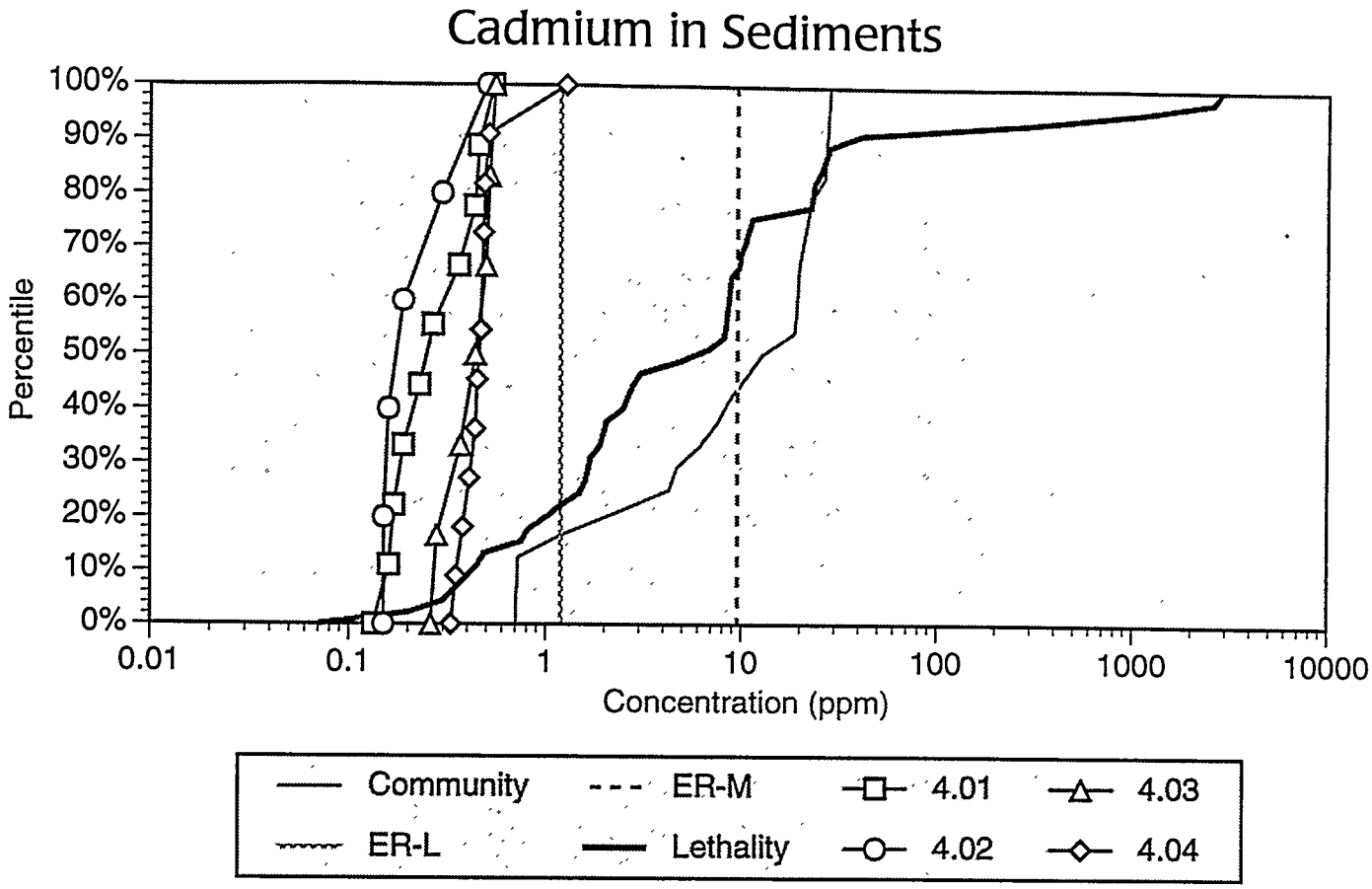


Fig. F3.7(a-b). Empirical distribution functions for sediment toxicity of cadmium to sediment-associated organisms and individual measurements of cadmium in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.



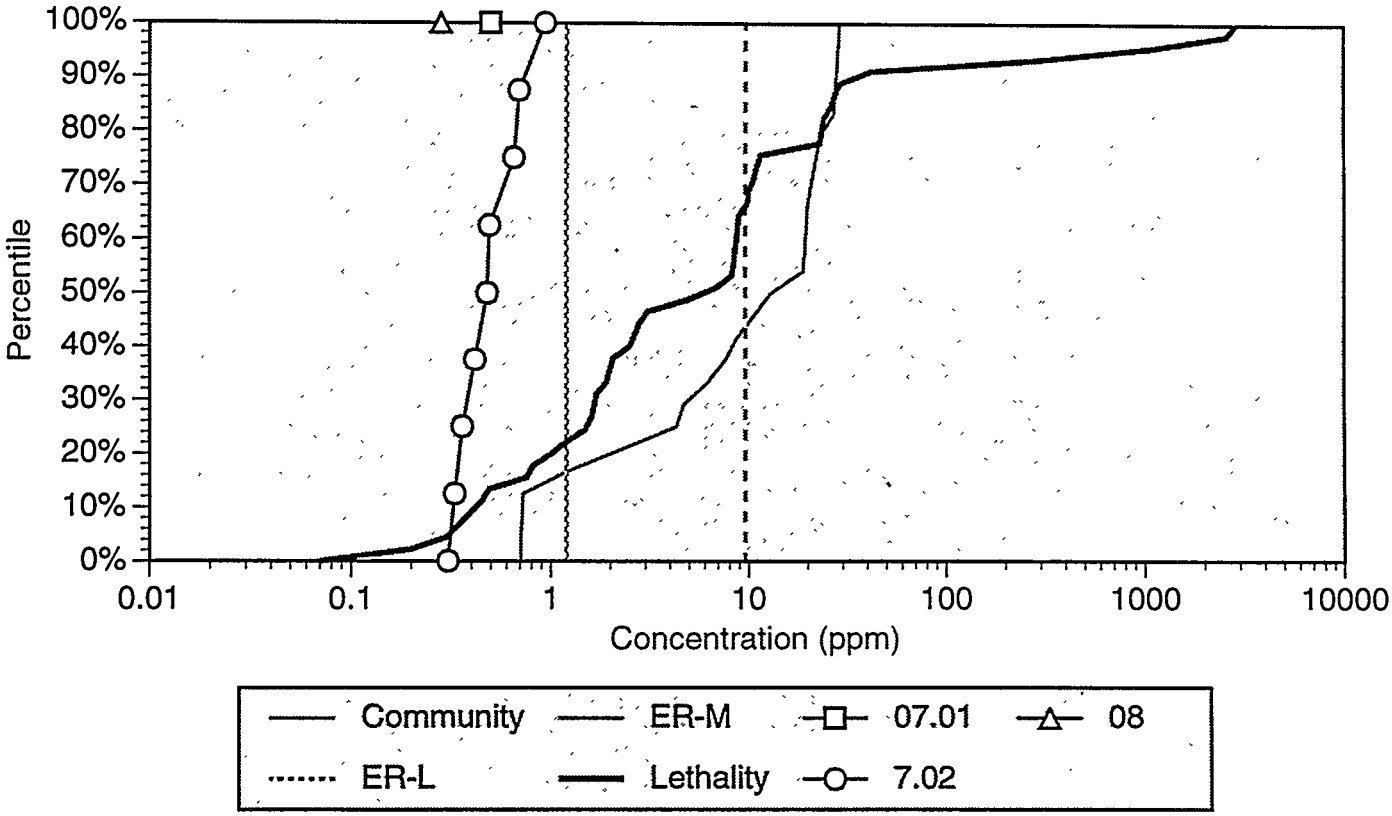
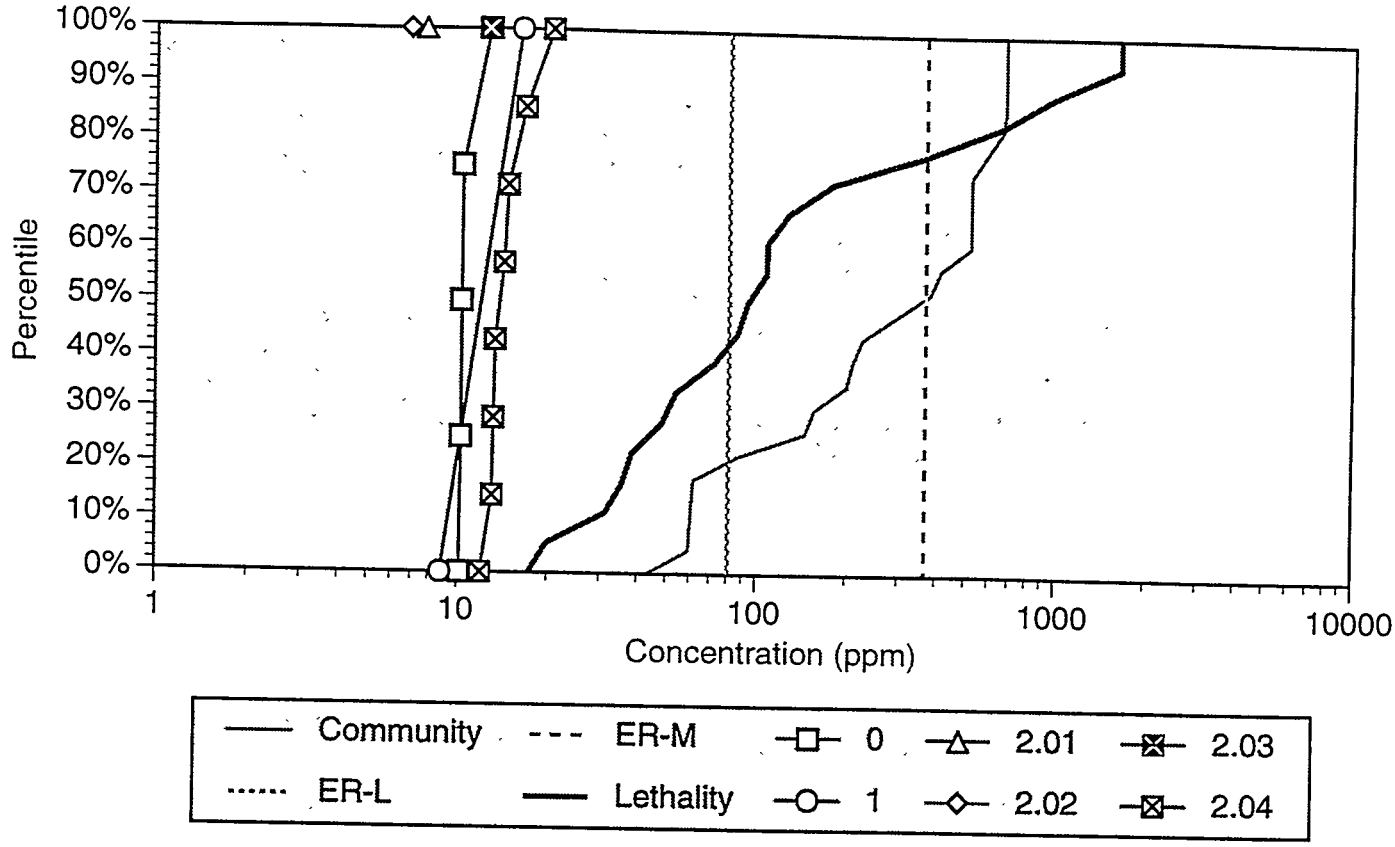


Fig. F3.7(c-d). Empirical distribution functions for sediment toxicity of cadmium to sediment-associated organisms and individual measurements of cadmium in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

Chromium in Sediments



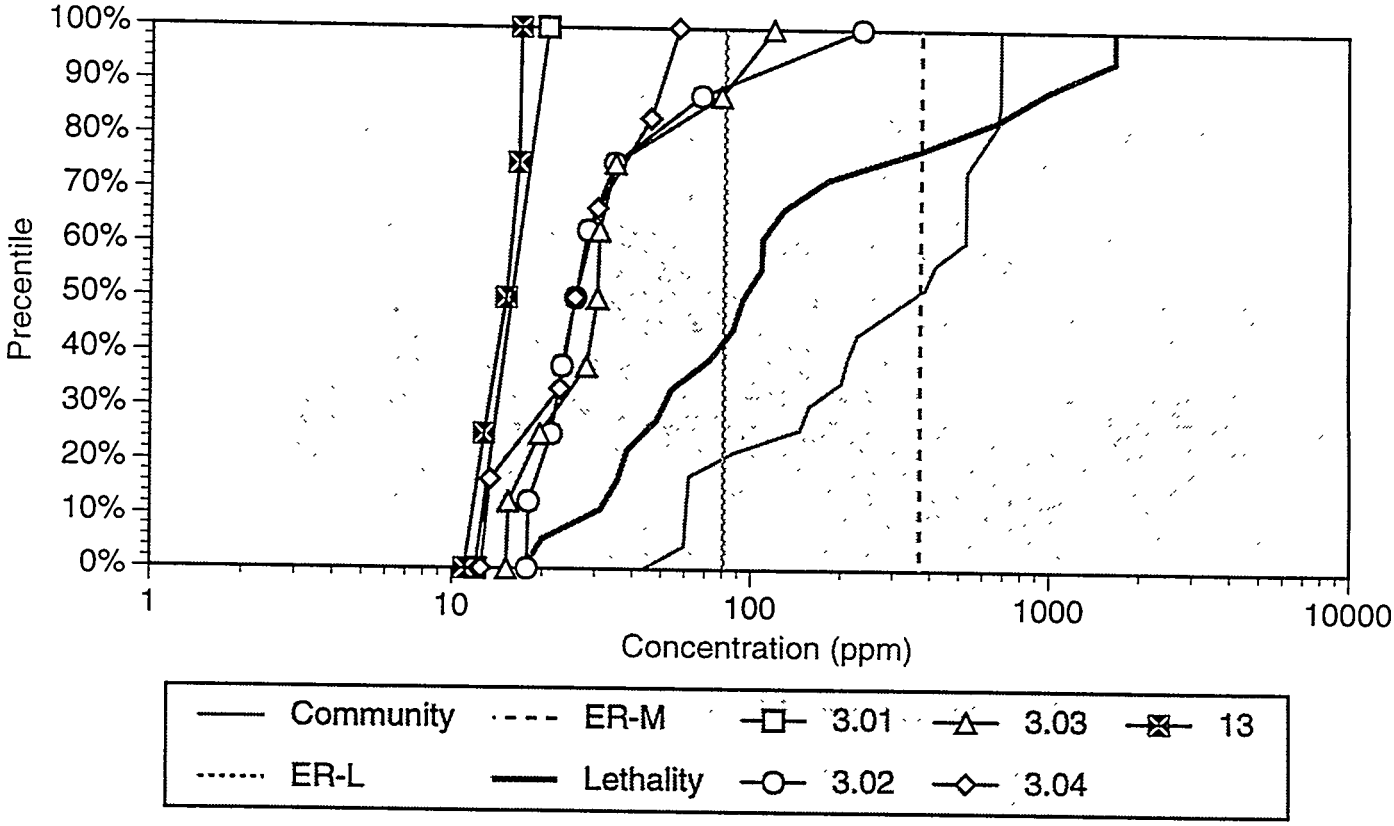
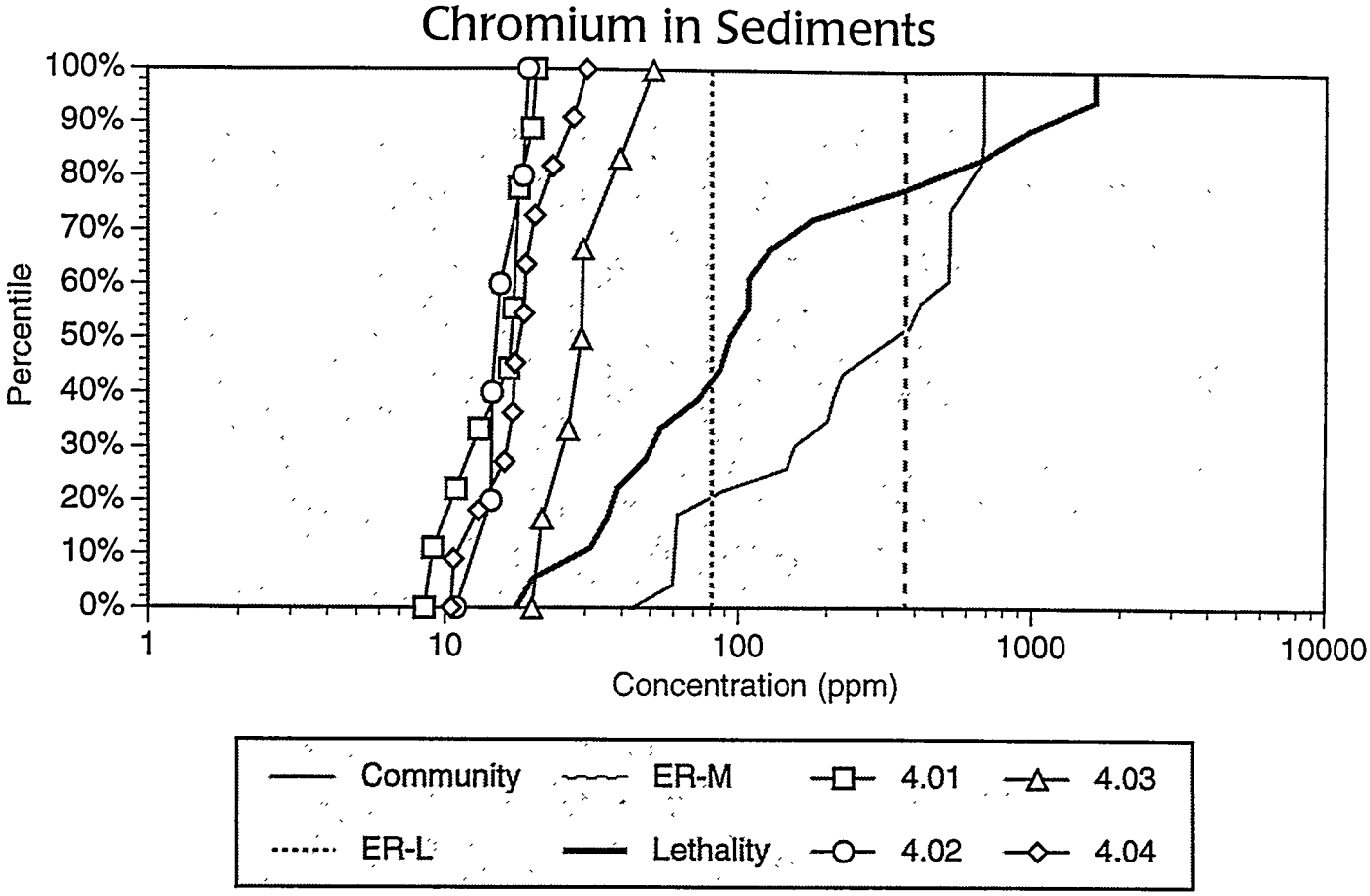


Fig. F3.8(a-b). Empirical distribution functions for sediment toxicity of chromium to sediment-associated organisms and individual measurements of chromium in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.



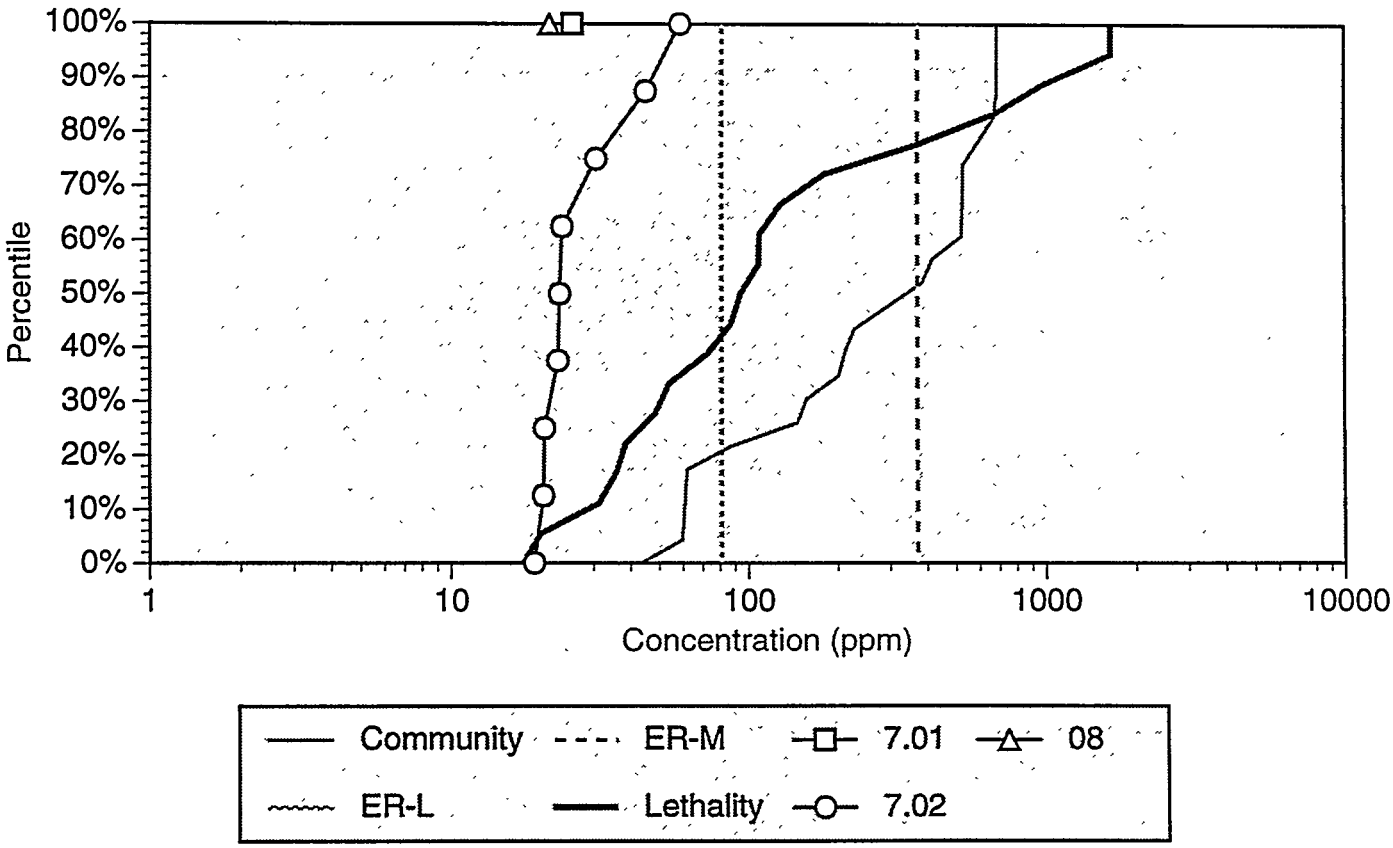


Fig. F3.8(c-d). Empirical distribution functions for sediment toxicity of chromium to sediment-associated organisms and individual measurements of chromium in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

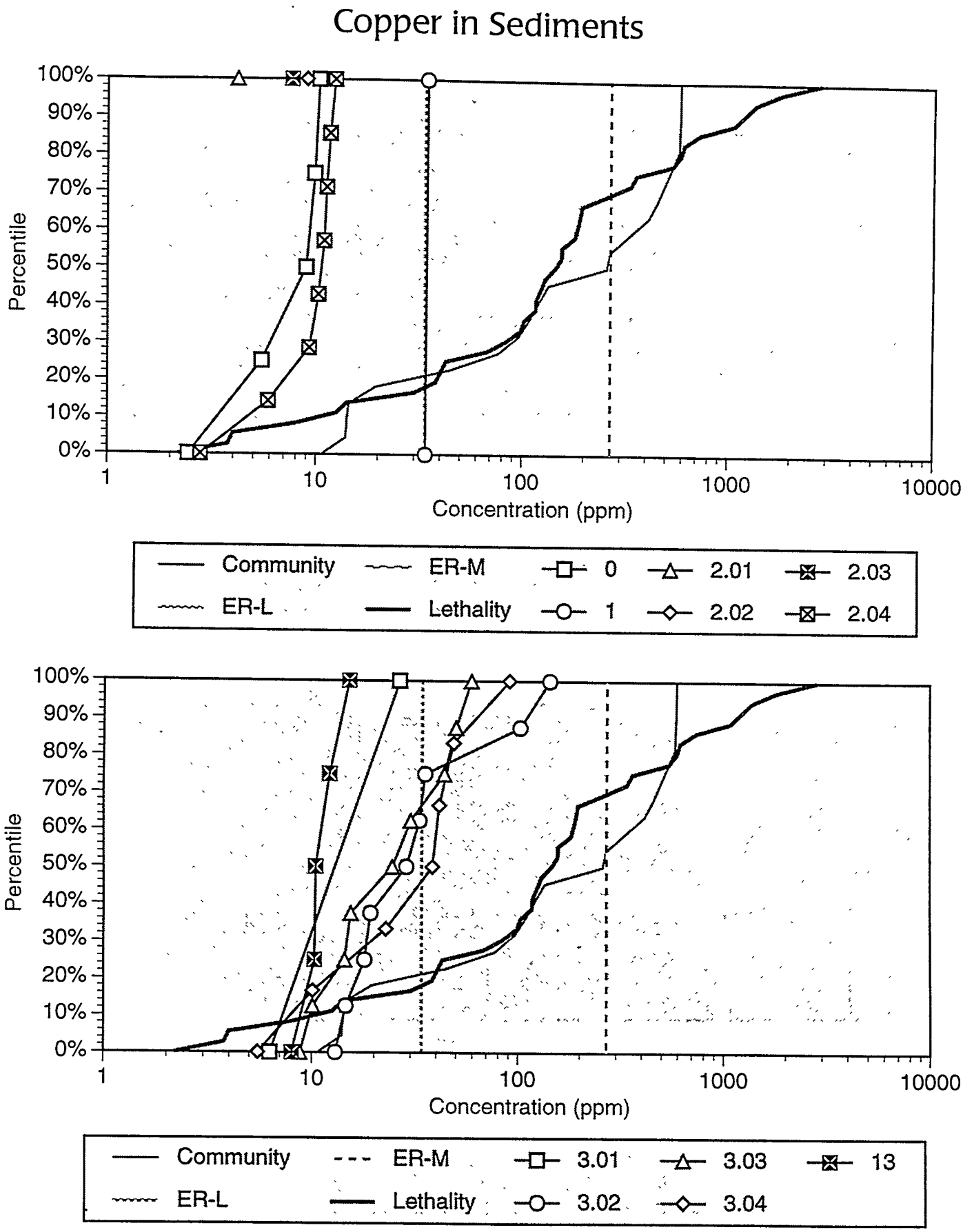


Fig. F3.9(a-b). Empirical distribution functions for sediment toxicity of copper to sediment-associated organisms and individual measurements of copper in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.

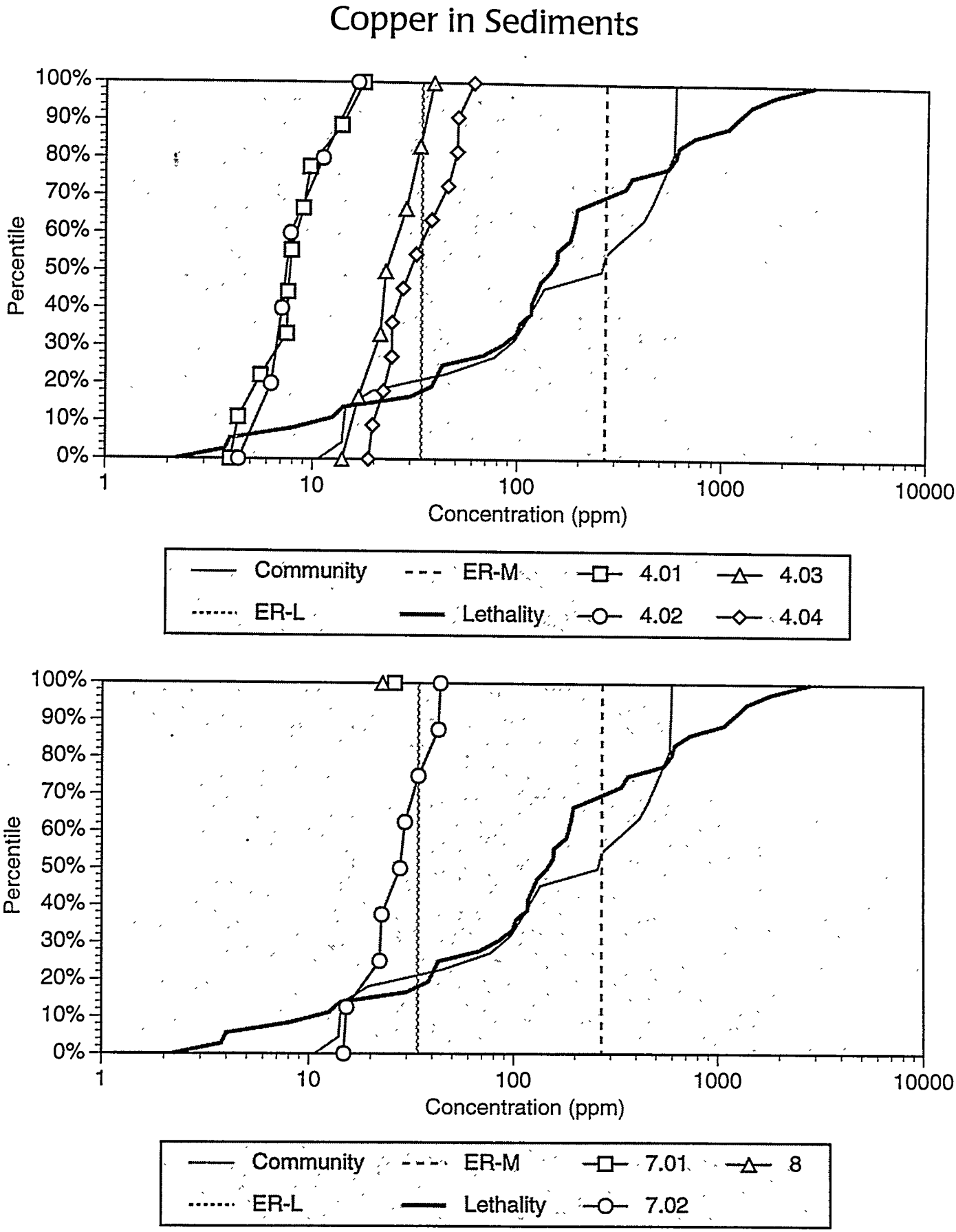


Fig. F3.9(c-d). Empirical distribution functions for sediment toxicity of copper to sediment-associated organisms and individual measurements of copper in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

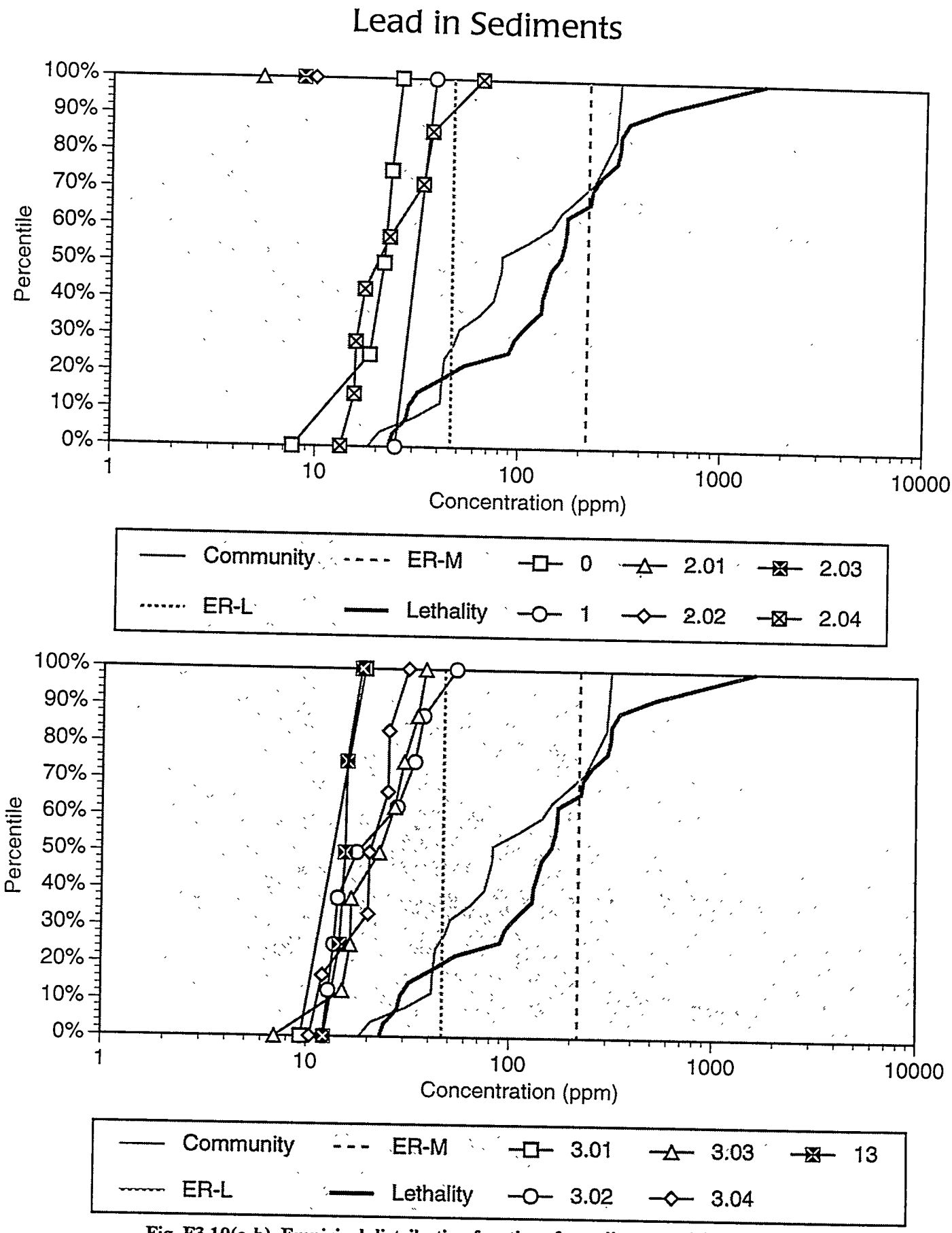
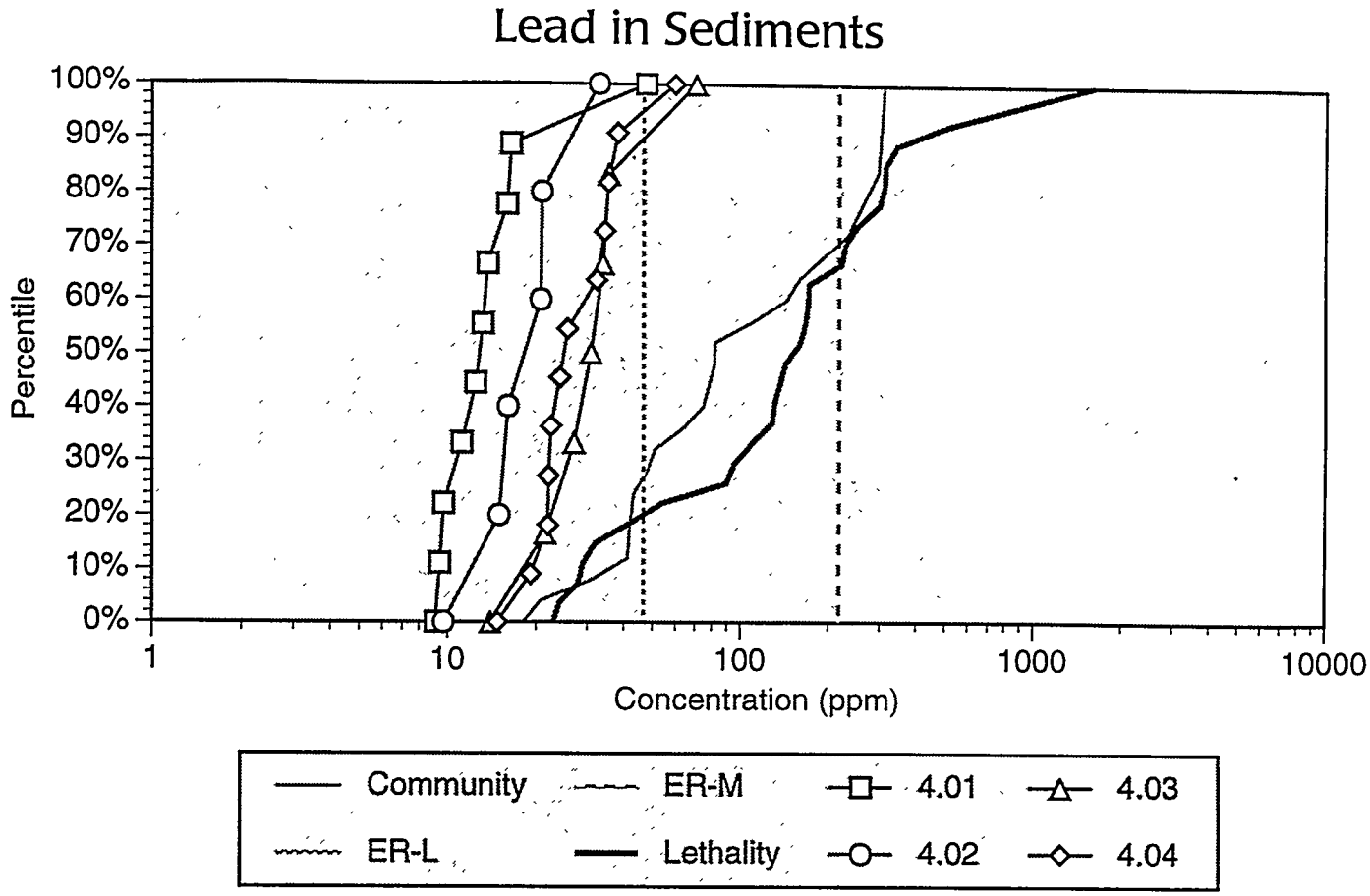


Fig. F3.10(a-b). Empirical distribution functions for sediment toxicity of lead to sediment-associated organisms and individual measurements of lead in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.



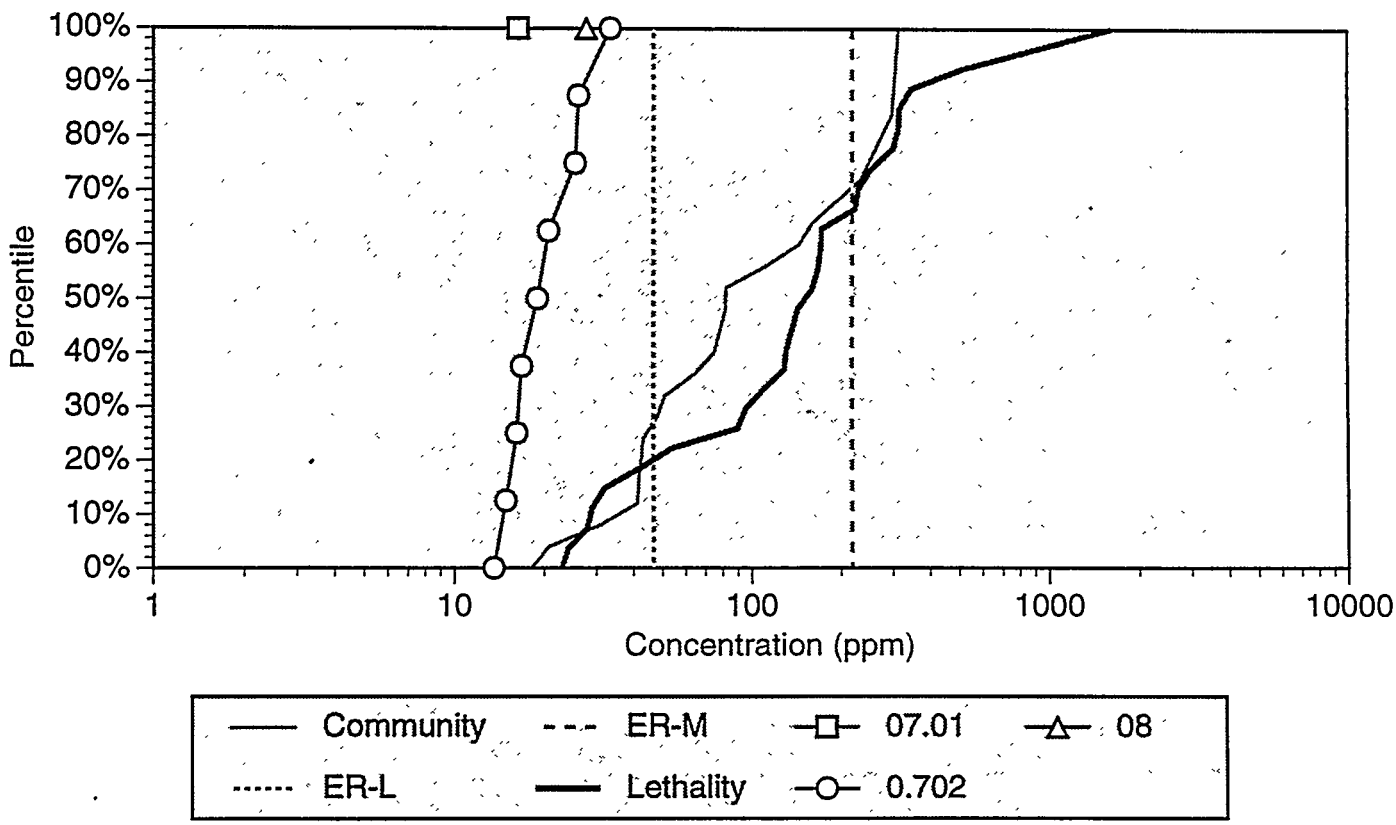
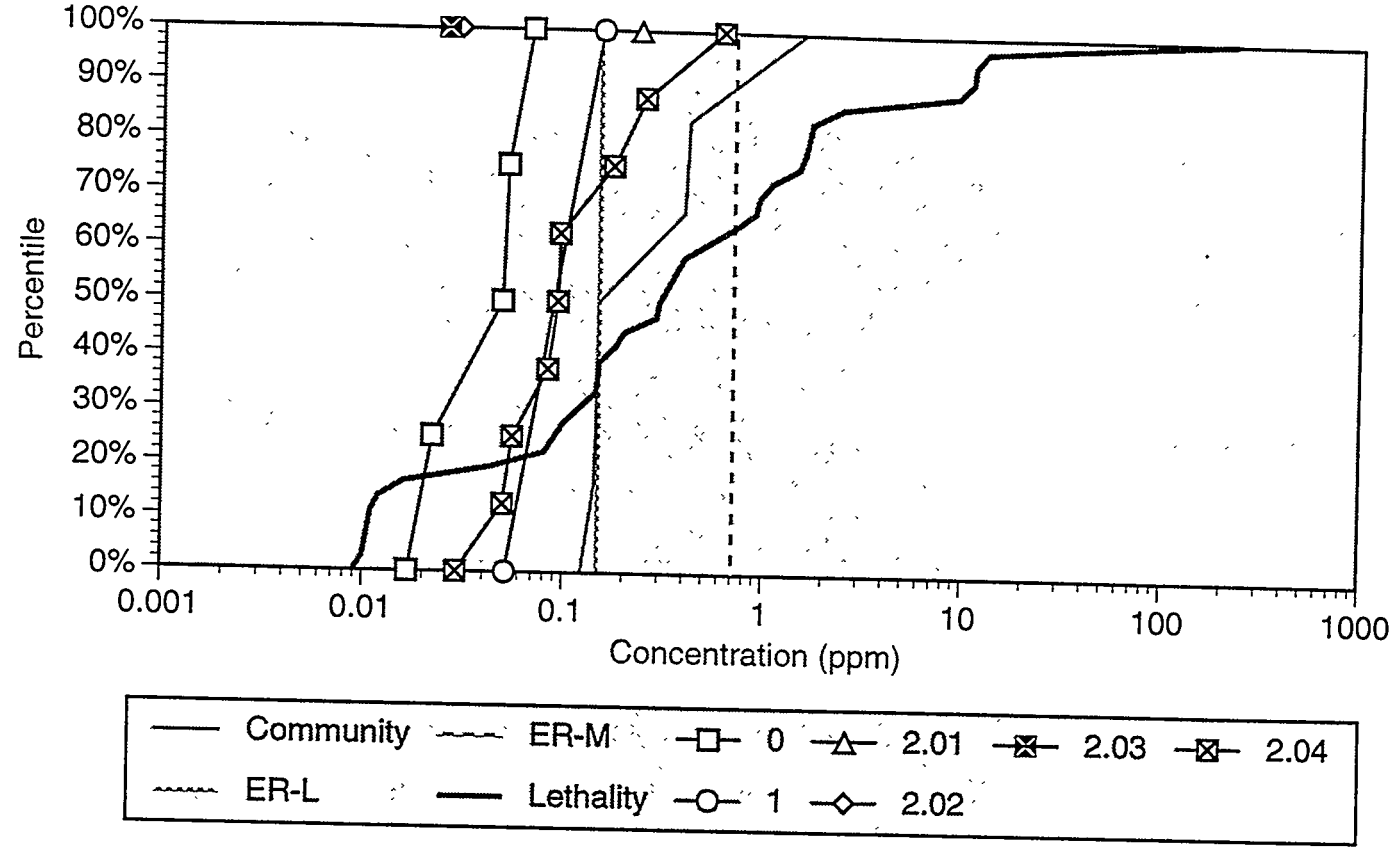


Fig. F3.10(c-d). Empirical distribution functions for sediment toxicity of lead to sediment-associated organisms and individual measurements of lead in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

Mercury in Sediments



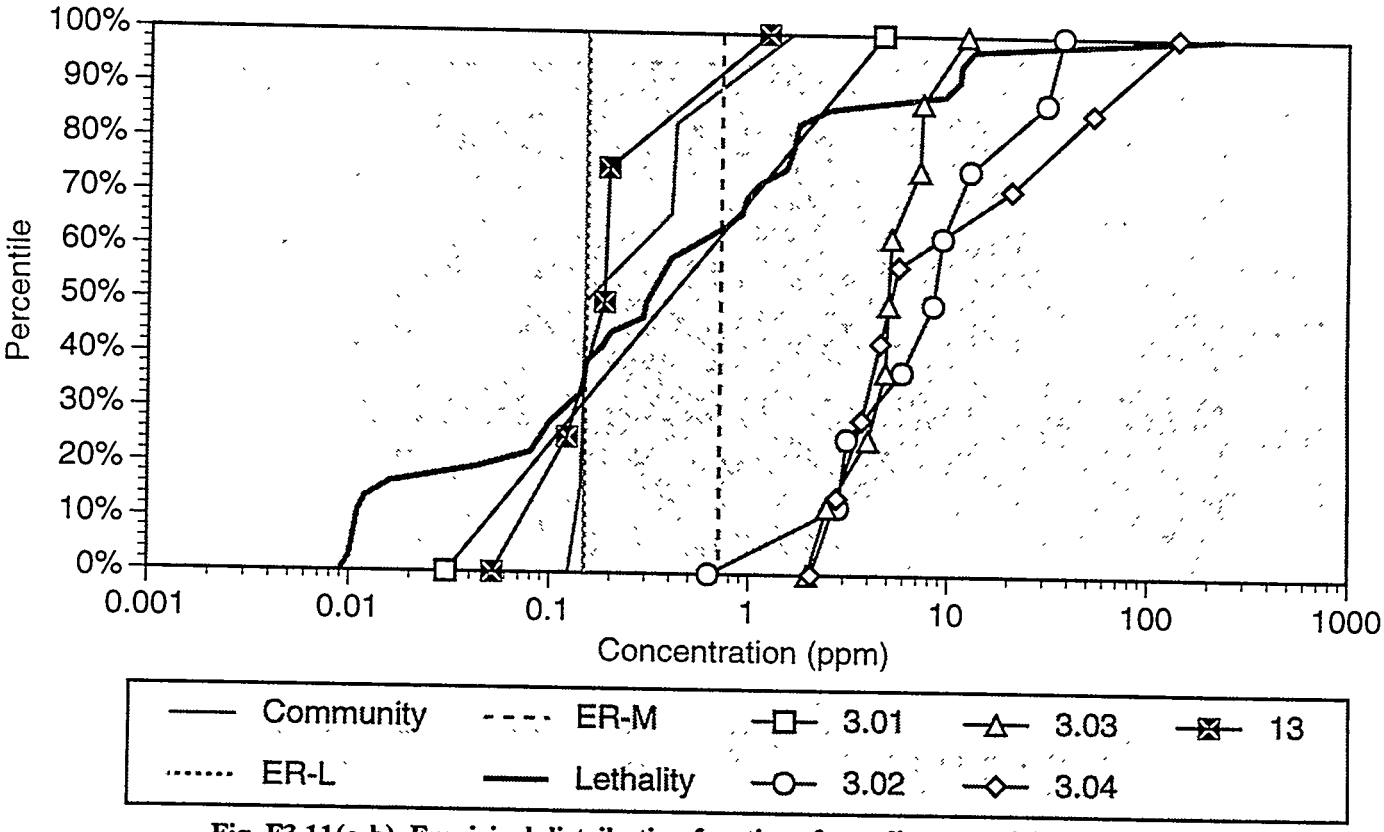


Fig. F3.11(a-b). Empirical distribution functions for sediment toxicity of mercury to sediment-associated organisms and individual measurements of mercury in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.

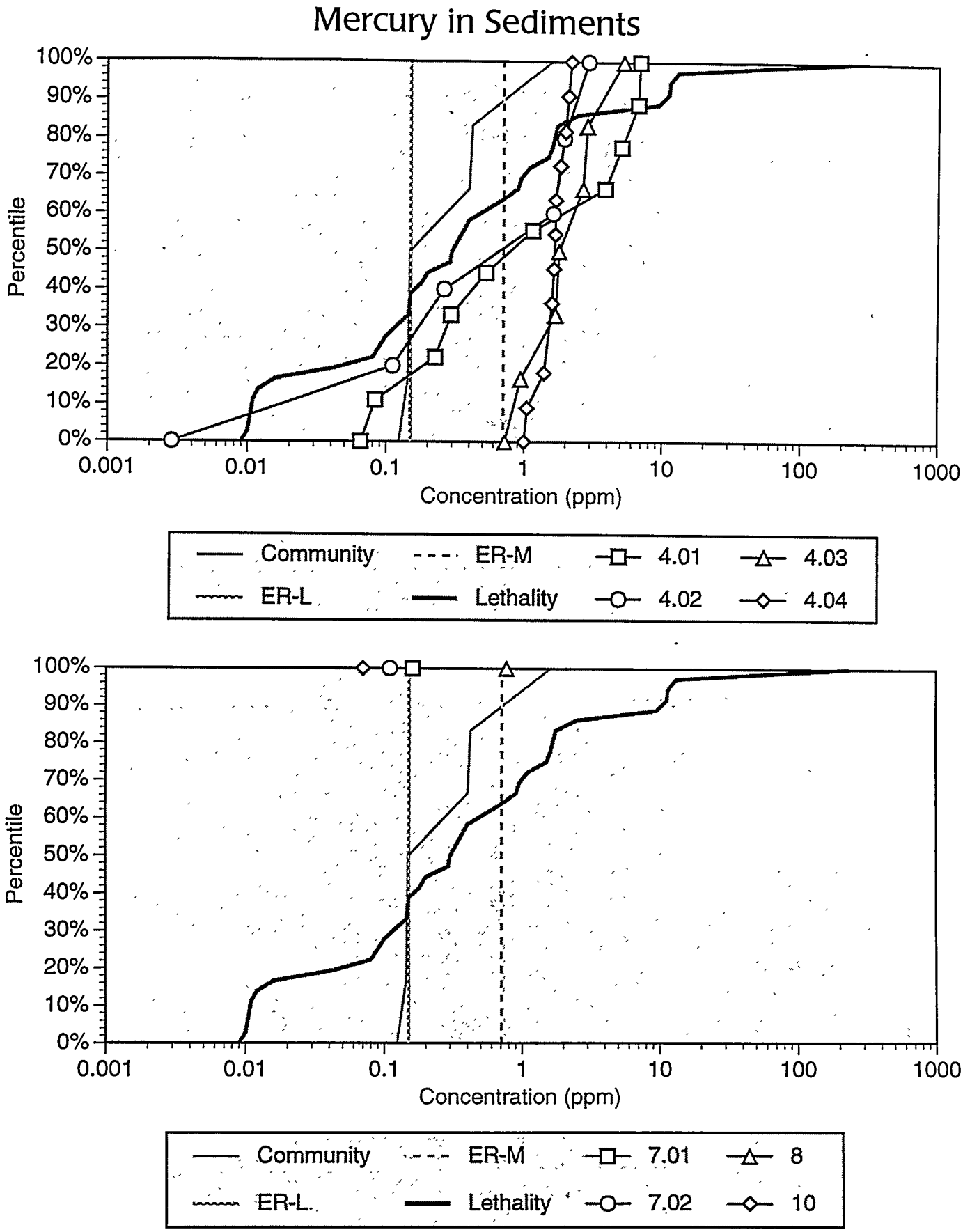


Fig. F3.11(c-d). Empirical distribution functions for sediment toxicity of mercury to sediment-associated organisms and individual measurements of mercury in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

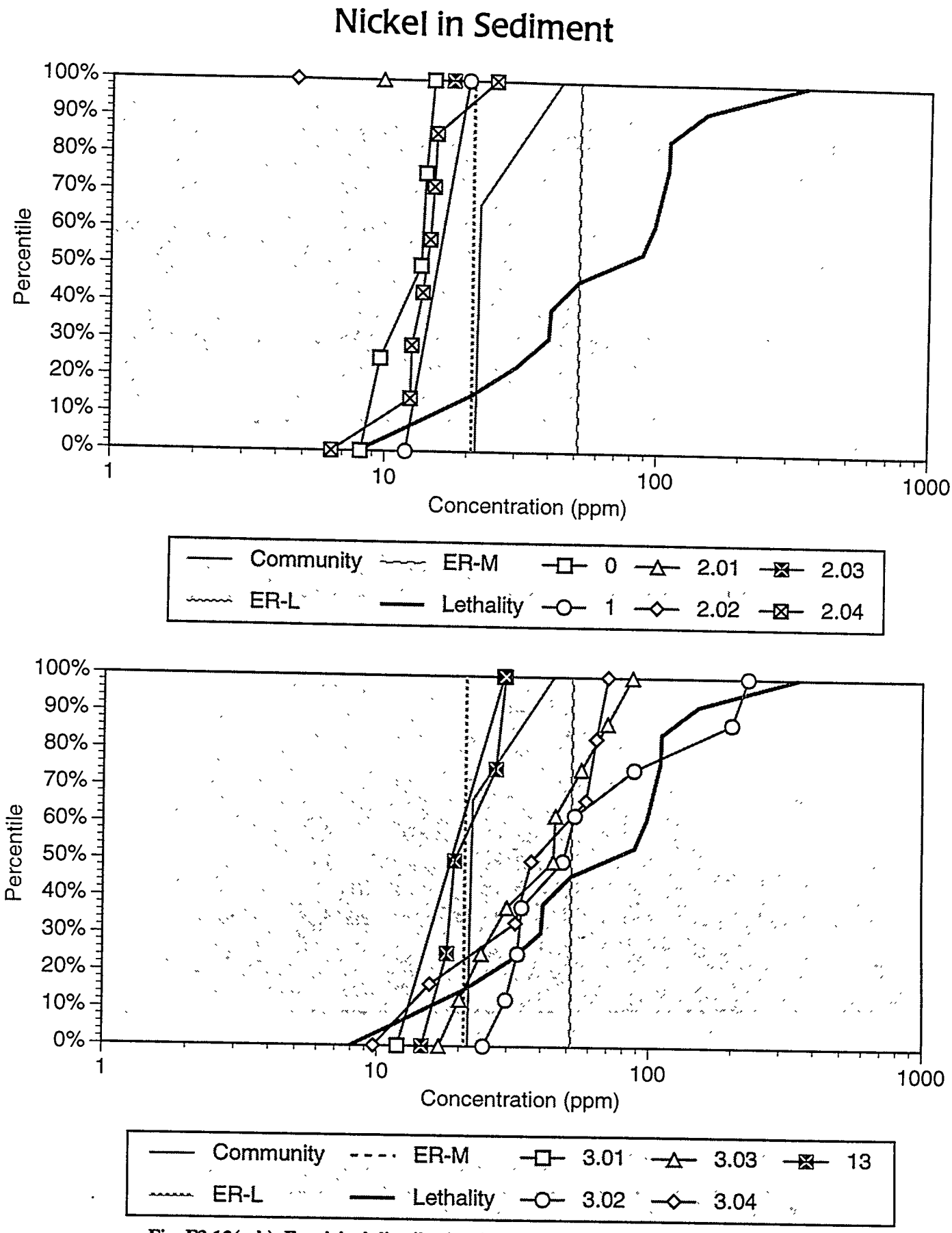
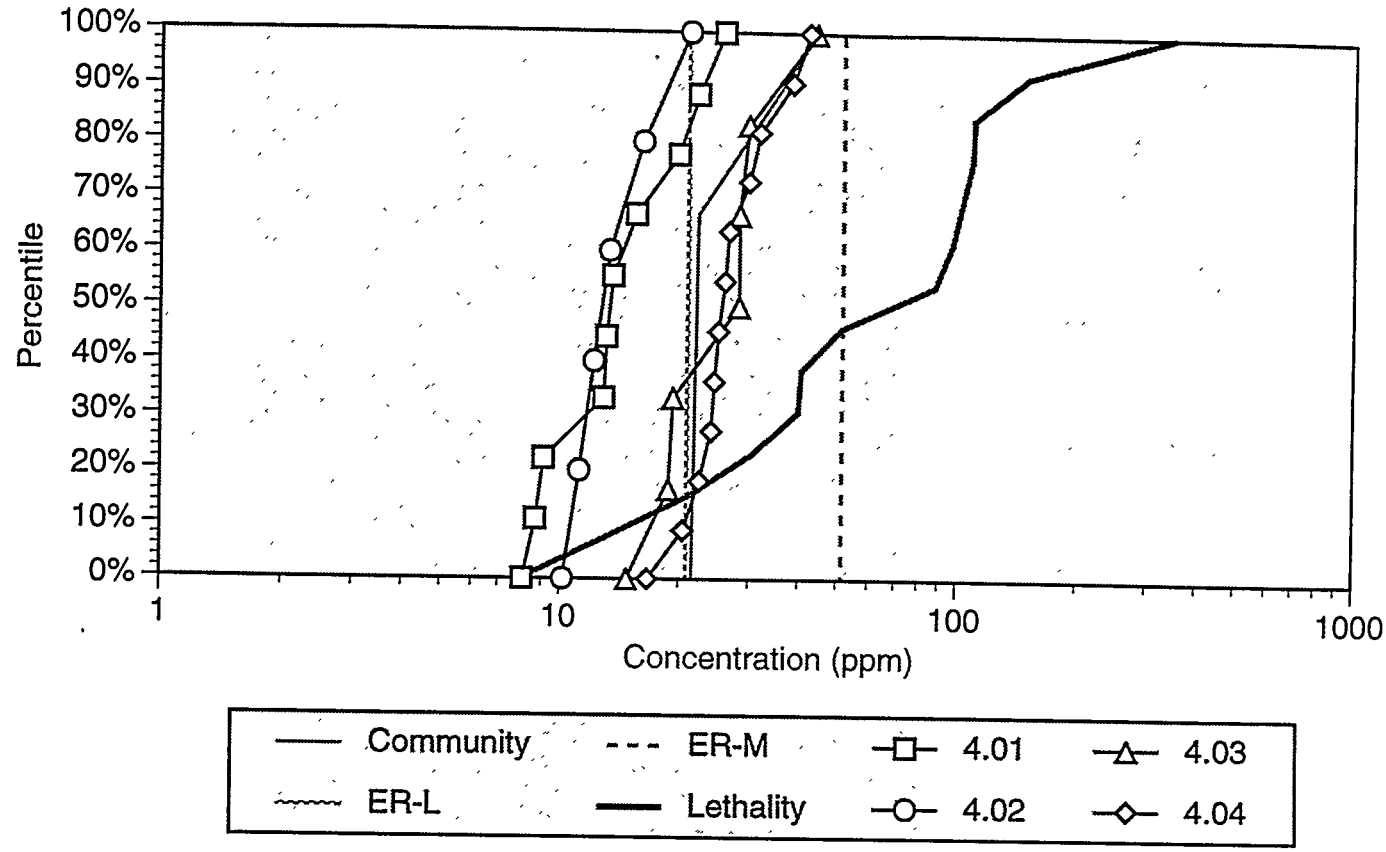


Fig. F3.12(a-b). Empirical distribution functions for sediment toxicity of nickel to sediment-associated organism and individual measurements of nickel in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.

Nickel in Sediment



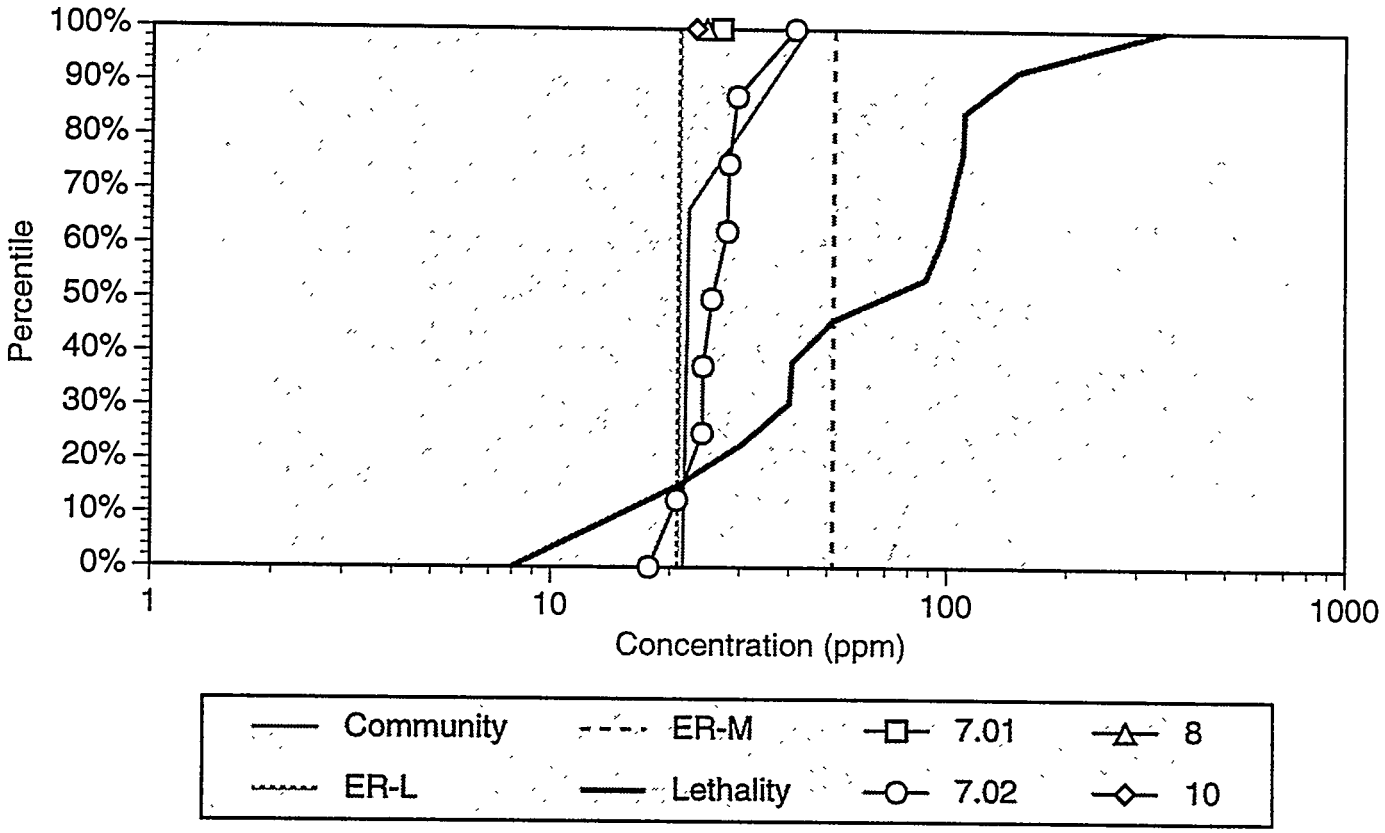
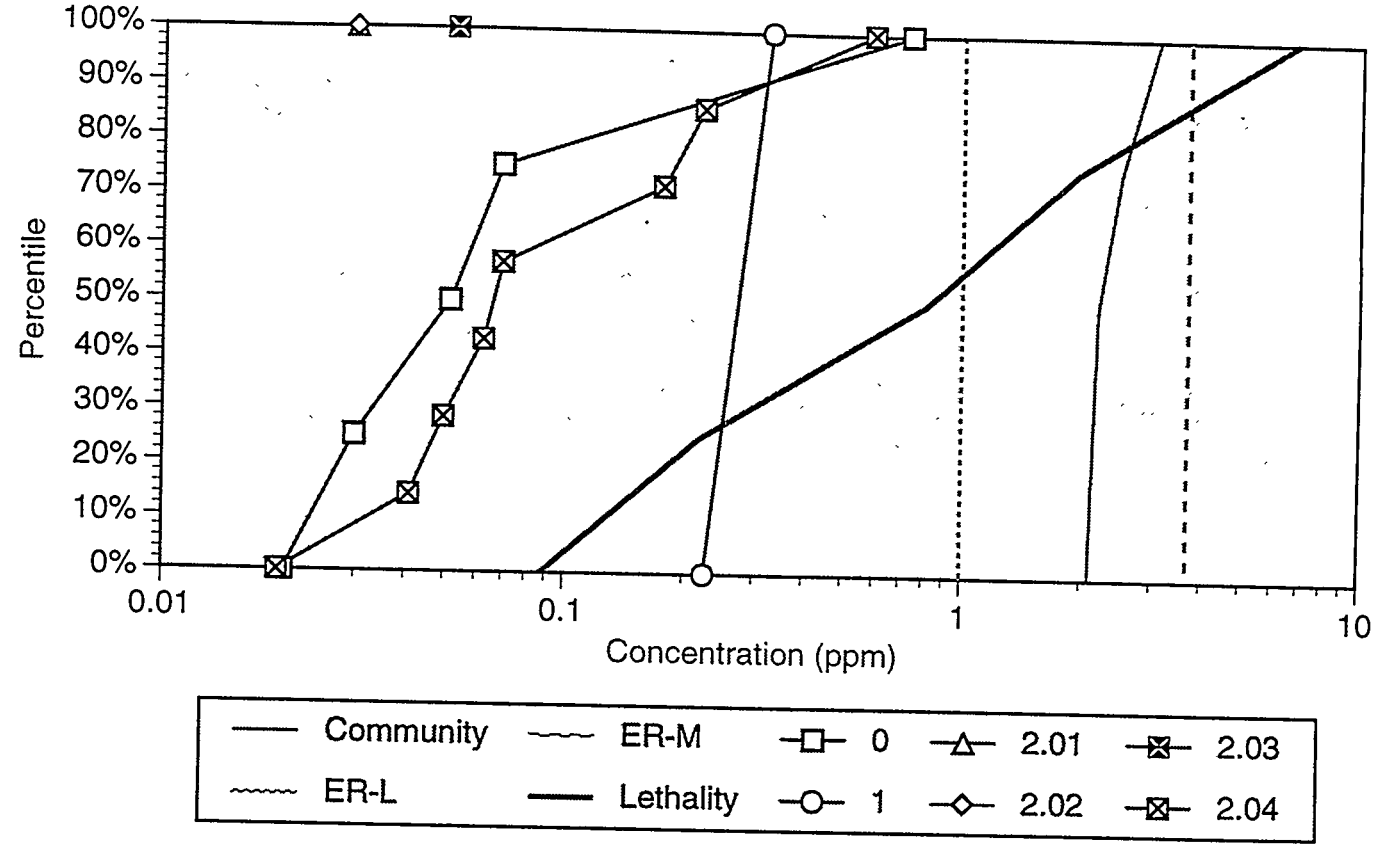


Fig. F3.12(c-d). Empirical distribution functions for sediment toxicity of nickel to sediment-associated organisms and individual measurements of nickel in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

Silver in Sediments



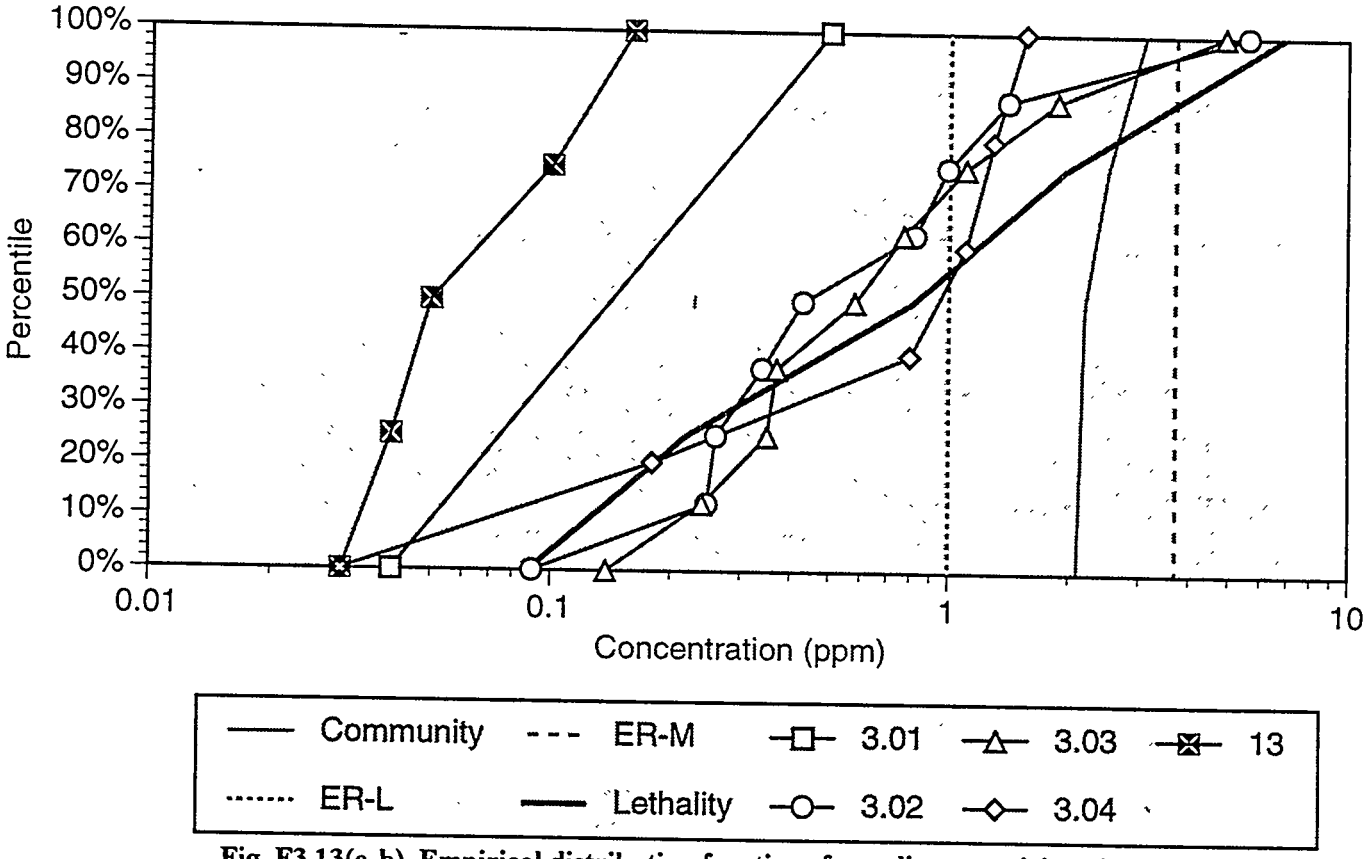
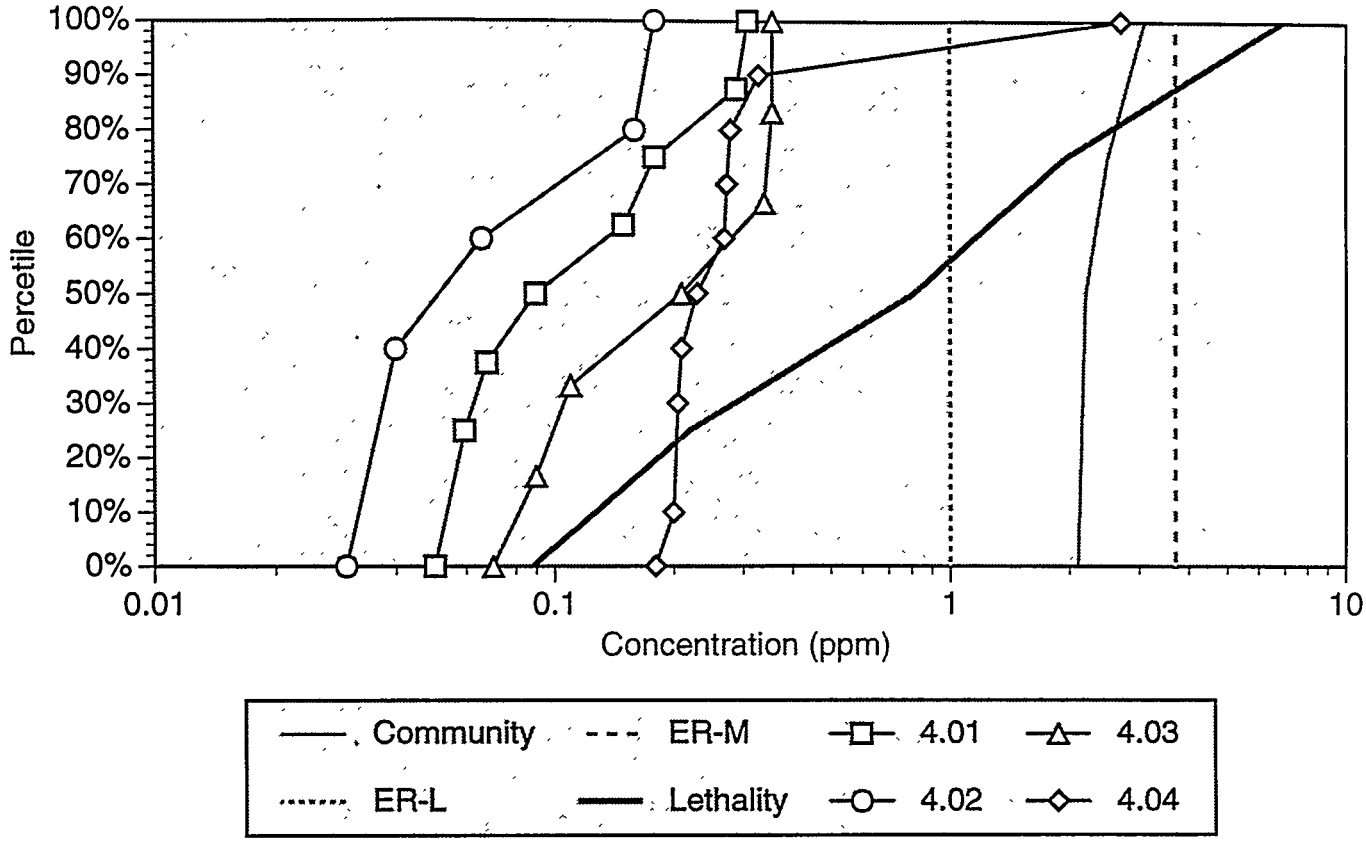


Fig. F3.13(a-b). Empirical distribution functions for sediment toxicity of silver to sediment-associated organisms and individual measurements of silver in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.

Silver in Sediments



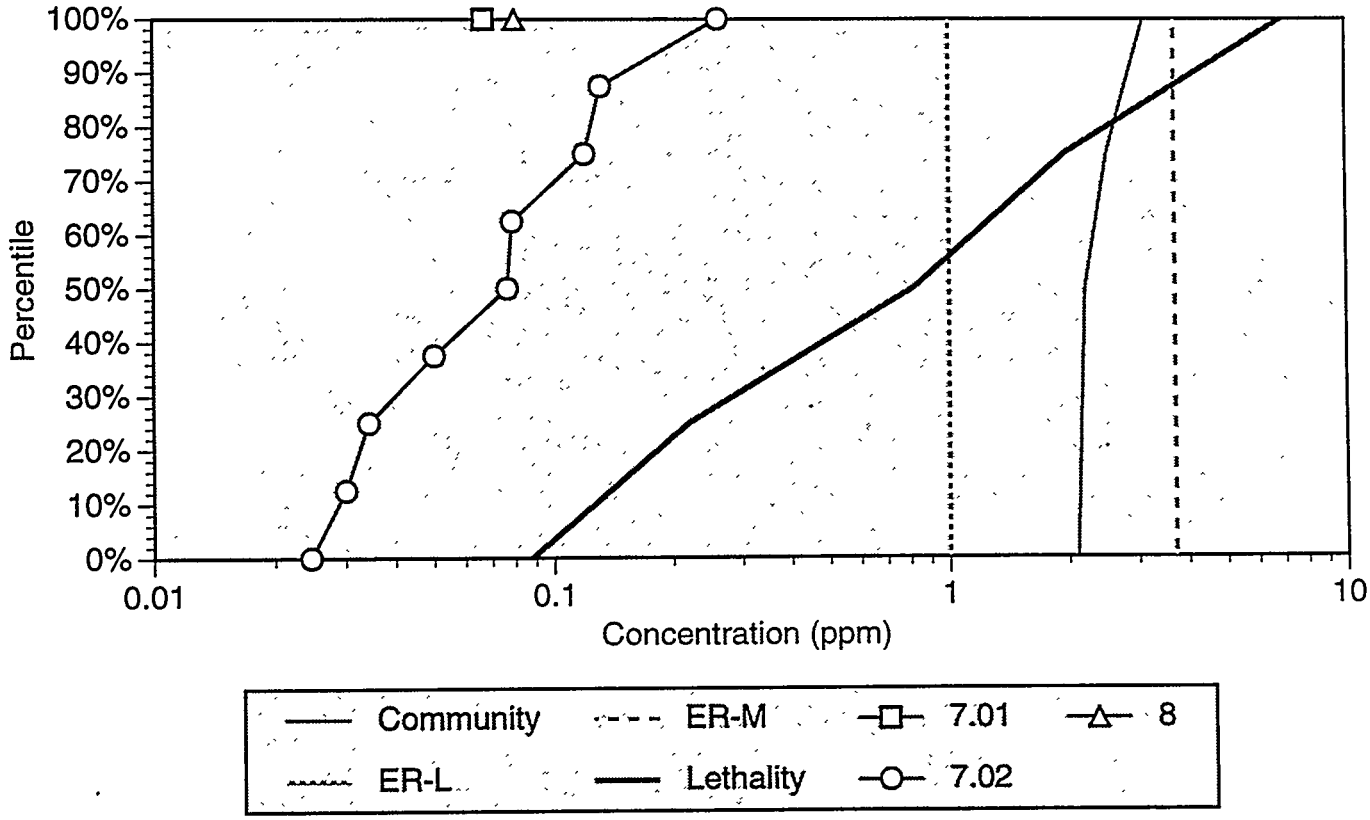


Fig. F3.13(c-d). Empirical distribution functions for sediment toxicity of silver to sediment-associated organisms and individual measurements of silver in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

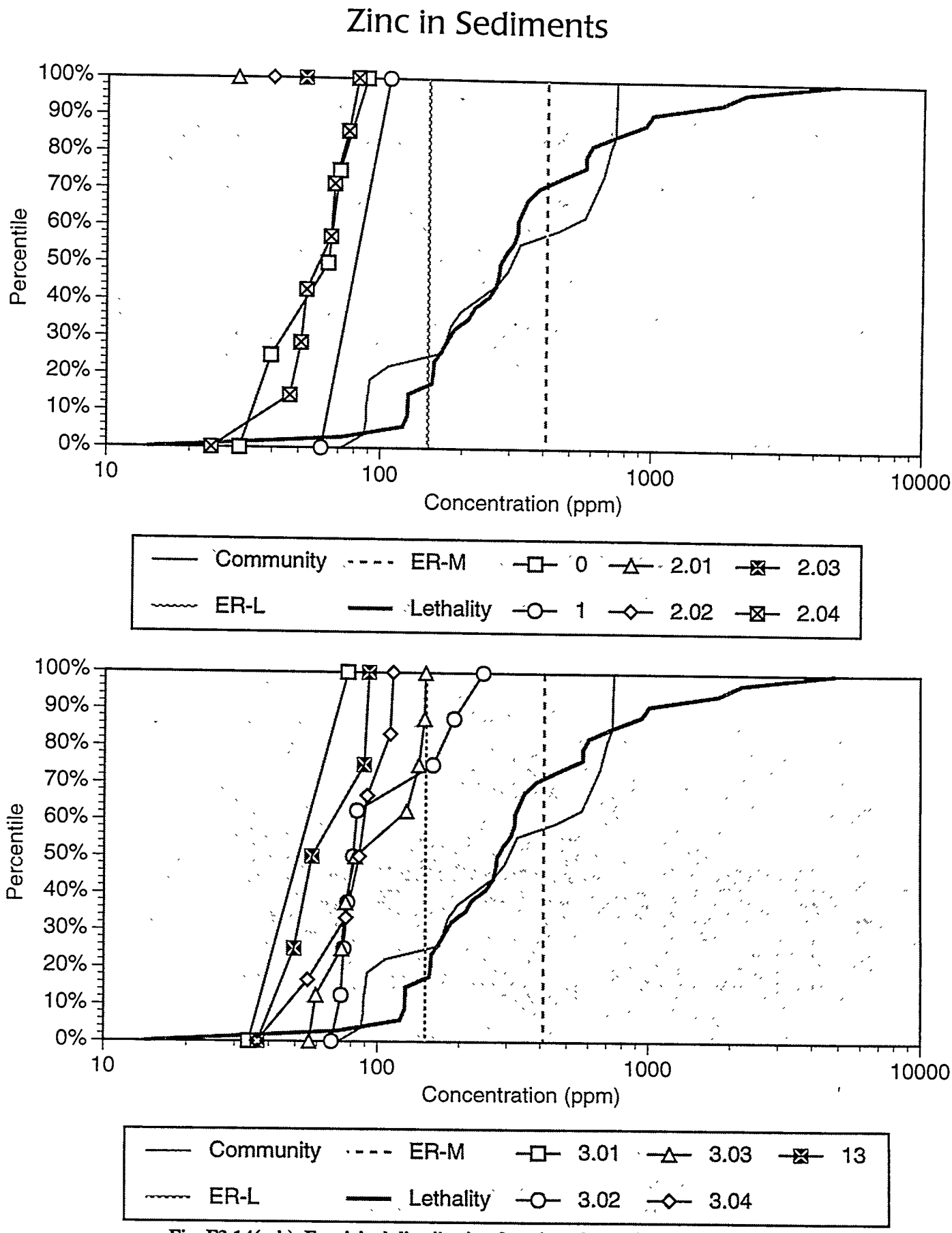
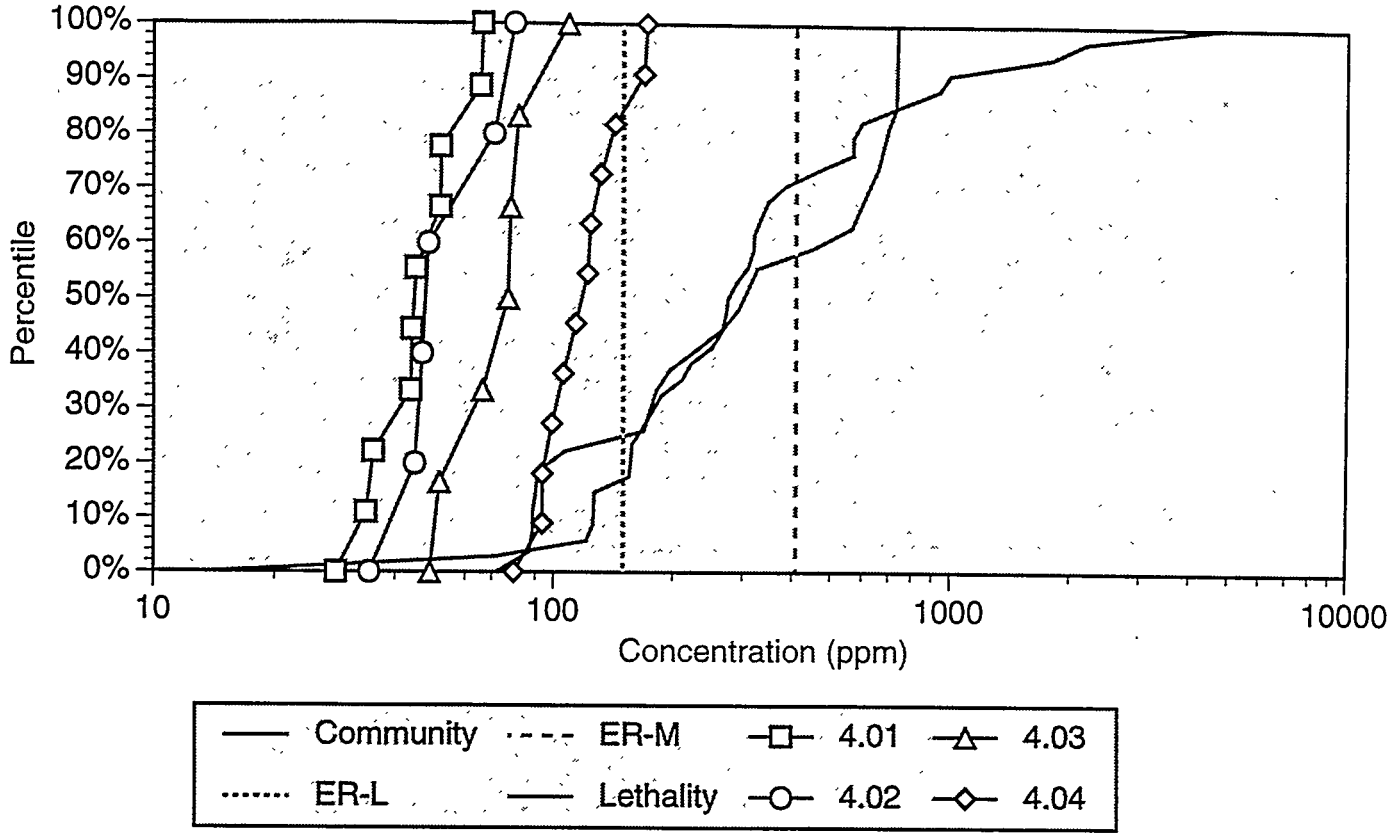


Fig. F3.14(a-b). Empirical distribution functions for sediment toxicity of zinc to sediment-associated organisms and individual measurements of zinc in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.

Zinc in Sediments



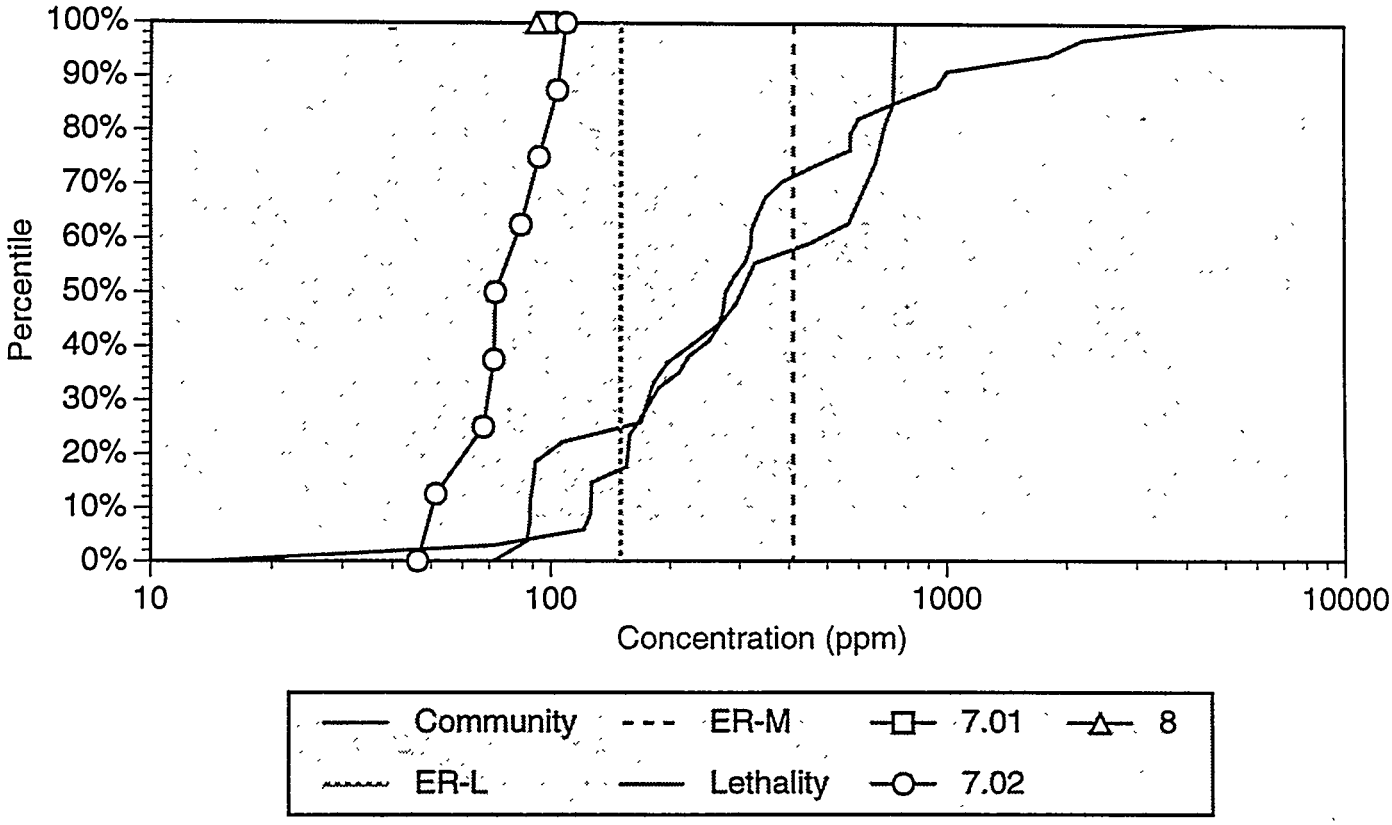


Fig. F3.14(c-d). Empirical distribution functions for sediment toxicity of zinc to sediment-associated organisms and individual measurements of zinc in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

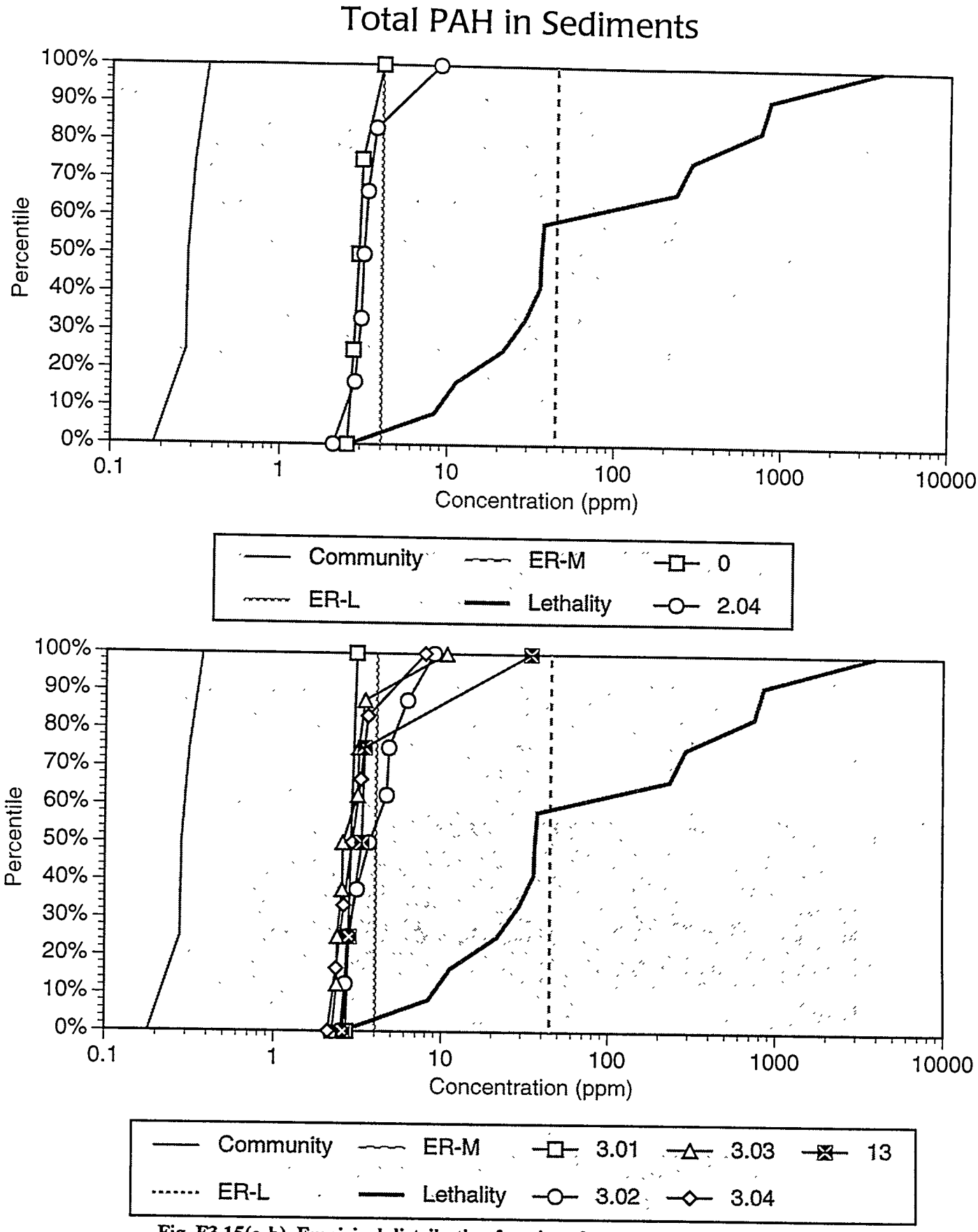
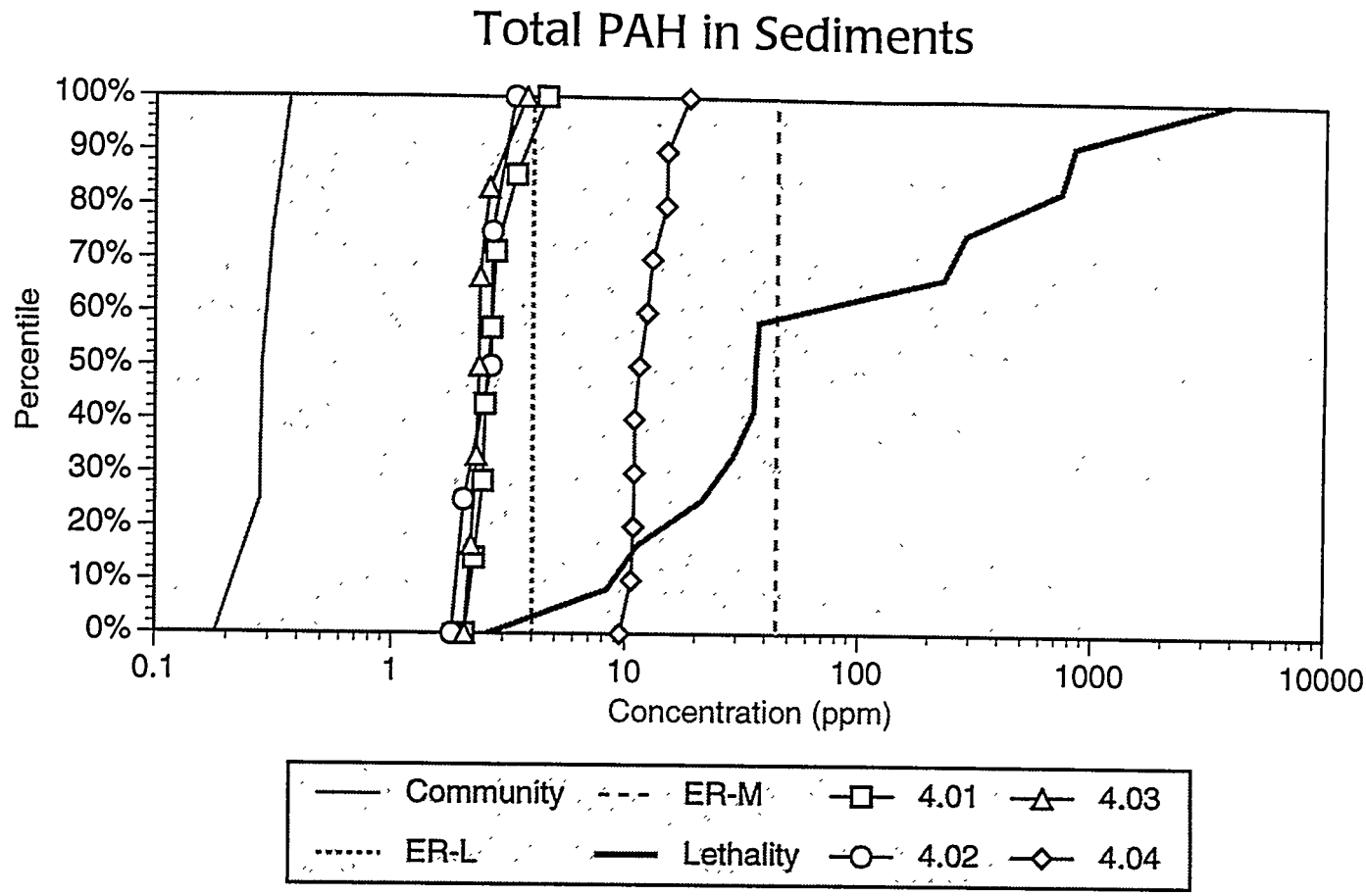


Fig. F3.15(a-b). Empirical distribution functions for sediment toxicity of Total PAH to sediment-associated organisms and individual measurements of 2-methylnaphthalene in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River, bottom graph (b) is Poplar Creek.



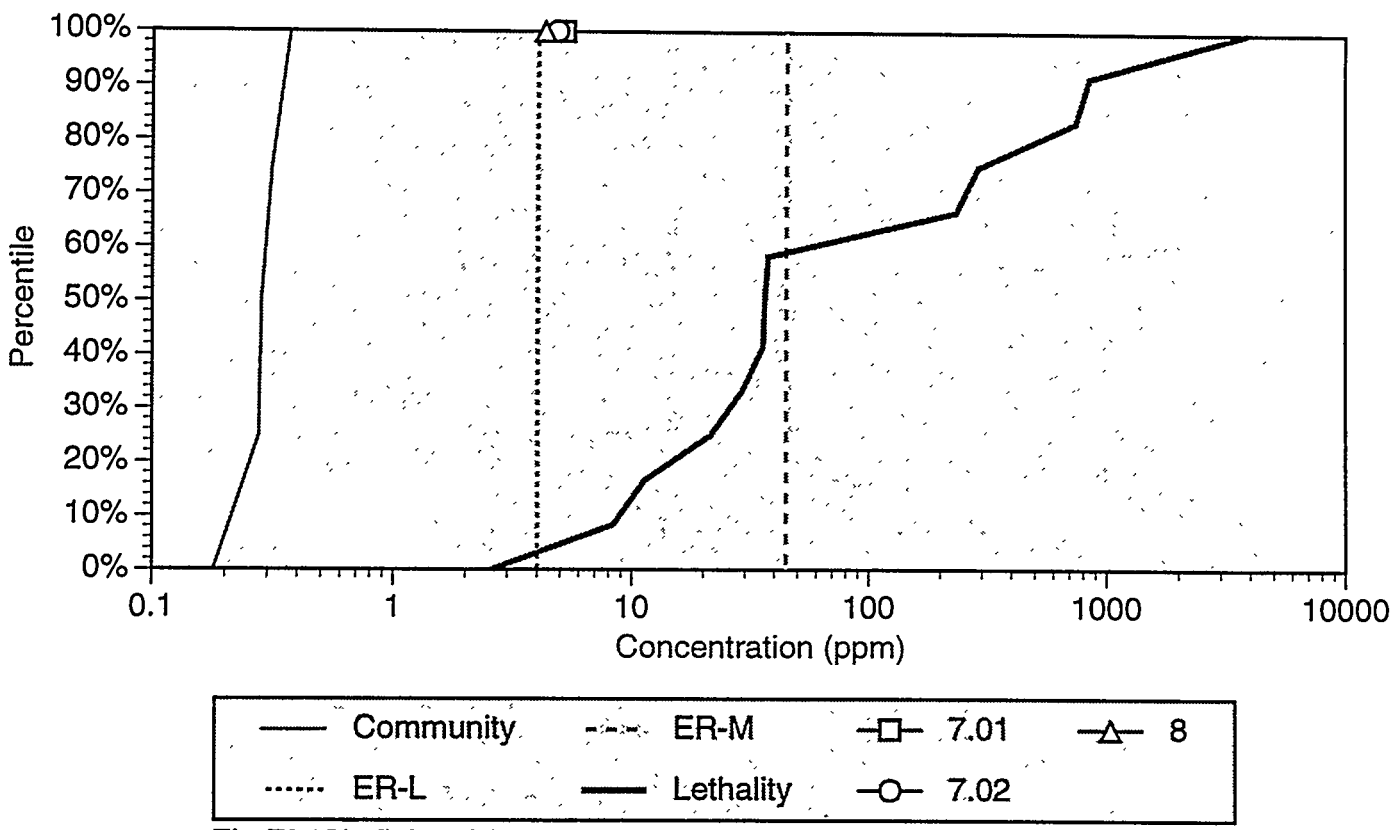


Fig. F3.15(c-d). Empirical distribution functions for sediment toxicity of Total PAH to sediment-associated organisms and individual measurements of 2-methylnaphthalene in sediments from the Clinch River and Poplar Creek System. Top graph (c) is Lower Clinch River bottom graph (d) is McCoy Branch Embayment and Walker Branch Embayment.

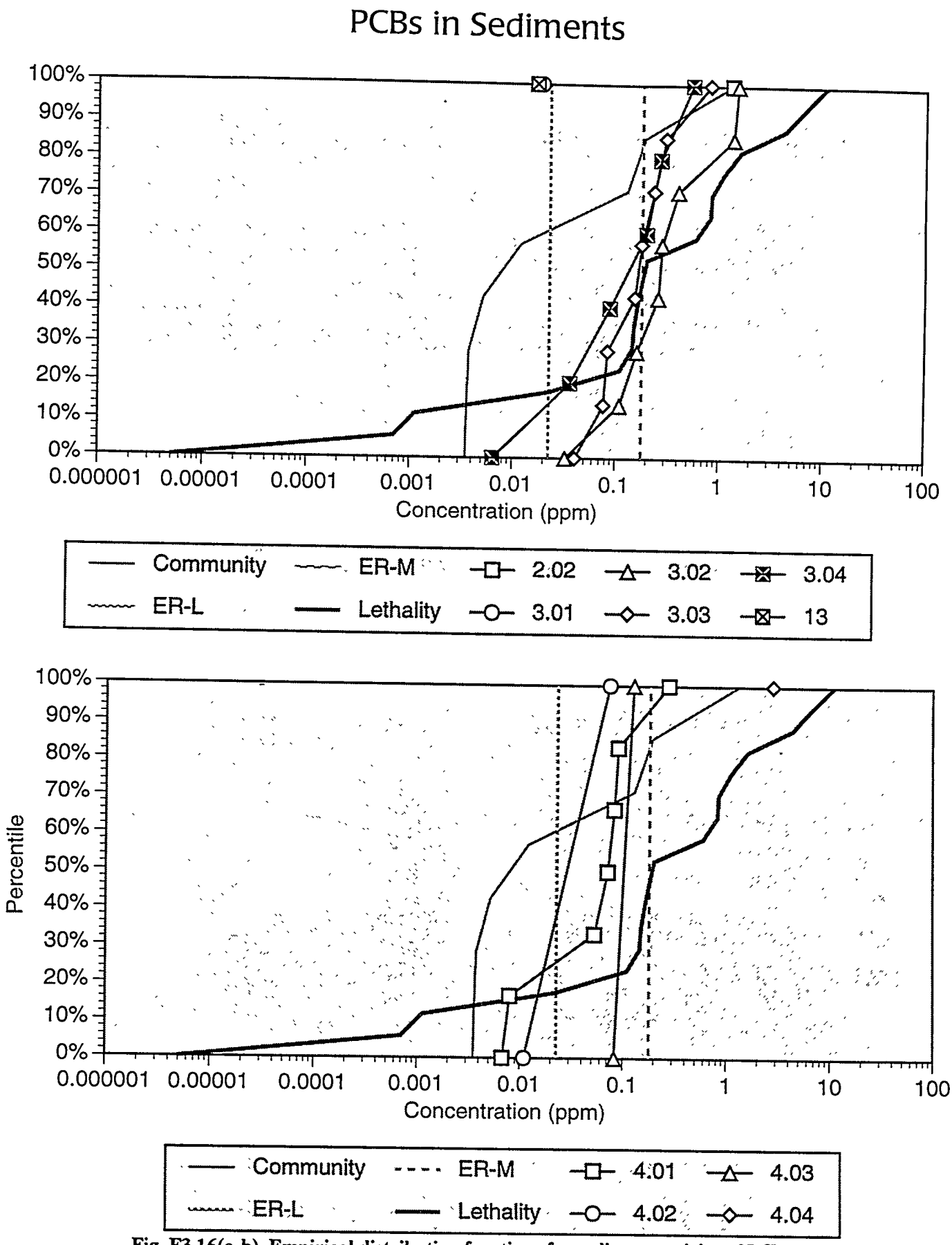


Fig. F3.16(a-b). Empirical distribution functions for sediment toxicity of PCBs to sediment-associated organisms and individual measurements of PCBs in sediments from the Clinch River and Poplar Creek System. Top graph (a) is Upper Clinch River and Poplar Creek, bottom graph (b) is Lower Clinch River.

Appendix F4

PISCIVOROUS WILDLIFE

Table F4.1. Life history parameters for osprey

Parameter	Value	Comments	Reference
Body Weight	1.5 kg (♂+♀)		EPA 1993 (GLWQC)
Food Consumption Rate	0.3 kg/d	fresh weight	EPA 1993 (GLWQC)
Water Consumption Rate	0.077 L/d		EPA 1993 (GLWQC)
Diet Composition	almost 100% fish	all parts of fish consumed except large bones	EPA 1993 (GLWQC)
	fish sizes: 0–10 cm=3.3% 11–20 cm=42.1% 21–30 cm=46.7% 31–40 cm=6.6% >41 cm=1.3%		VanDaele and VanDaele 1982
Home Range (foraging distance from nest site)	10–15 km		VanDaele and VanDaele 1982
Habitat Requirements	Coastal areas plus large rivers and lakes Nesting habitat requires open, shallow water nearby plus abundant fish. Nests atop isolated (often dead) trees and man-made structures		EPA 1993a
Population Density	0.005–0.1 nests/ha		EPA 1993a
Behavior	year-round resident in southern part of range (i.e. Florida) Migratory in Tennessee		EPA 1993a

Table F4.2. Life history parameters for great blue heron

Parameter	Value	Comments	Reference
Body Weight	2.576 kg (♂) 2.204 kg (♀) **2.39** kg (mean♂+♀)		Dunning 1984
Food Consumption Rate	**0.42** kg/d	estimated using allometric equation[a] specific for herons and egrets assuming 2.39 kg bw	Kushlan 1978
Water Consumption Rate	**0.1058** L/d	estimated using allometric equation[b] assuming 2.39 kg bw	After Calder and Braun 1983
Diet Composition	diet predominantly fish but may include crustaceans, insects, snails, amphibians, reptiles, birds, and mammals		Kushlan 1978 Collazo 1985 Hoffman 1978
	fish sizes: 0–10 cm=39.2% 11–20 cm=47.1% 21–30 cm=13.7%		Alexander 1977
Home Range (foraging distance from colony)	3.1 km	up to 24.2 km - S. Dakota - river	EPA 1993a
	7–8 km	N. Carolina - coastal	Short and Cooper 1985
Habitat Requirements	use both coastal and inland water-associated habitats		Short and Cooper 1985
	Foraging: shallow shores of ponds, lakes, streams, wet meadows, wooded swamps, bays, and marshes		DeGraaf et al. 1981
	breeding: trees for rookery sites. In absence of trees will use rock ledges, cliffs, and artificial structures		Short and Cooper 1985

Table F4.2 (continued)

Parameter	Value	Comments	Reference
Population Density	nest colonially, therefore population density depends on availability of nest habitat and suitable foraging habitat		EPA 1993a
Behavior	may or may not defend a feeding territory depending on local population size and food availability		Kushlan 1978
	Migrates in northern U.S. and southern Canada; year round resident from WV, PA south.		National Geographic Society 1987

[a] Allometric equation for estimation of food consumption by herons and egrets is:

$$\log FIR = 0.966 \log bw - 0.640$$

where: FIR = food ingestion rate (g/d)
bw = body weight (g)

[b] Allometric equation for estimation of water consumption by birds is:

$$W=0.059(bw)^{0.67}$$

where: W = water consumption (L/d)
bw = body weight (kg)

Table F4.3. Life history parameters for mink

Parameter	Value	Comments	Reference
Body Weight	**1.0** kg (mean ♂+♀)		EPA 1993b
Food Consumption Rate	**0.137** kg/d (mean ♂+♀)		Bleavins and Aulerich 1981
Water Consumption Rate	**0.099** L/d	estimated using allometric equation[a] assuming 1.0 kg bw	After Calder and Braun 1983
Diet Composition	Diverse diet includes: mammals, fish, aquatic invertebrates, amphibians, and birds		Hamilton 1940, Sealander 1943, Korschgen 1958, Burgess and Bider 1980, Alexander 1977
	Proportion of aquatic prey (fish, amphibians, inverts, etc.) = 0.546±0.21	Proportion represents means of values from five studies	
	fish sizes: 0–10 cm=72% 11–20 cm=28%		
Home Range	2.63 km (♂) 1.85 km (♀)	stream - Sweden	Gerell 1970
	770 ha (♂)	prairie potholes, Manitoba	Arnold and Fritzell 1987
		range size and shape depends on habitat - linear along streams, circular in marshes	EPA 1993a
Habitat Requirements	aquatic habitats - streams, lakes, marshes;		Burt and Grossenheider 1976
Population Density	0.03–0.085 /ha	river - Montana	Mitchell 1961
Behavior	nocturnal active year-round, does not hibernate		EPA 1993a

[a] Allometric equation for estimation of water consumption by mammals is:

$$W=0.099(bw)^{0.90}$$

where: W = water consumption (L/d)
bw = body weight (kg)

Table F4.4. Life history parameters for river otter

Parameter	Value	Comments	Reference
Body Weight	**8.0** kg (mean ♂+♀)		EPA 1993b
Food Consumption Rate	**0.9** kg/d (mean ♂+♀)		EPA 1993b
Water Consumption Rate	**0.64** L/d		EPA 1993b
Diet Composition	Almost exclusively fish 2–50 cm in size; most ≥30 cm.		Melquist and Hornocker 1983
	50% large and 50% small fish		EPA 1993b
Home Range	10–78 km	river-Idaho	Melquist and Hornocker 1983
		range size and shape depends on habitat - linear along streams, circular in marshes	EPA 1993b
Habitat Requirements	aquatic habitats - streams, lakes, marshes;		EPA 1993b
Population Density	0.17–0.37 /km	river-Idaho	Melquist and Hornocker 1983
	0.0094–0.014/ha		EPA 1993b
Behavior	Generally most active morning and evening, but may be active at any time in day.		Melquist and Hornocker 1983
	active year-round, does not hibernate		EPA 1993b

Table F4.5. Fillet-to-whole fish ratios for contaminants detected in fish from the Clinch River

	N	Mean	Standard error	Maximum	Minimum
DDD [a]		3.8	0.32	6.7	1.22
DDE [a]		3.8	0.32	6.7	1.22
DDT [a]		3.8	0.32	6.7	1.22
Aldrin [a]		3.8	0.32	6.7	1.22
Arsenic [c]	12	1.4	0.068	1.8	1.13
Beryllium [b]		1			
Bis(ethylhexyl)phthalate [a]		3.8	0.32	6.7	1.22
Chlordane, total	6	3.9	0.49	5.05	2.2
Copper [c]	12	6.8	3.4	43.5	0.86
Mercury [c]	12	0.68	0.019	0.74	0.54
Aroclor-1016 [a]		3.8	0.32	6.7	1.22
Aroclor-1254	22	3.8	0.32	6.7	1.22
Aroclor-1260	23	5.46	0.87	21.8	3.03
Selenium [c]	12	1.07	0.03	1.3	0.87
Zinc [c]	12	2.46	0.14	3.1	1.68

[a] Specific ratios were not available for these contaminants. Because K_{ow}s for these chemicals are comparable to that for Aroclor 1254, ratios were also assumed to be comparable.
[b] Specific ratio was not available because most inorganics had ratios ~1, assumed 1.
[c] Specific ratio from Clinch River was not available. Data from spotted bass from Southworth (1994).

Table F4.6. Product limit estimate 95% upper confidence bounds for contaminants in fish and water from Clinch River/Poplar Creek system, by subreach

Subreach	Analyte	Contaminant concentration in surface water	Contaminant concentrations in whole fish (by size class)[a]				
			0–10 cm	10–20 cm	20–30 cm	30–40 cm	>40 cm
0	As	0.05	*0.093*	0.093	0.196	0.270	0.424
0	Be	0.0012	*0.004*	0.004	0.000	0.004	0.000
0	Chlordane	0	*0.000*	0.000	0.000	0.107	0.797
0	DDD	0	*0.000*	0.000	0.000	0.000	0.017
0	DDE	0	*0.000*	0.000	0.000	0.011	0.070
0	Hg	0.00003	*0.056*	0.056	0.052	0.244	0.254
0	PCB-1254	0	*0.000*	0.000	0.000	0.114	0.807
0	PCB-1260	0	*0.000*	0.000	0.000	0.764	9.793
0	Se	0	*0.879*	0.879	0.578	1.083	0.791
0	Zn	0.015244	*22.179*	22.179	12.054	14.753	11.970
1	As	0.0012	*0.101*	0.101	0.000	0.550	0.112
1	Be	0.0014	*0.006*	0.006	0.000	0.000	0.000
1	Bis(2ethylhexyl)phthalate	0.002723	*0.000*	0.000	0.000	0.000	0.000
1	Chlordane	0	*0.000*	0.000	0.097	0.000	0.000
1	Hg	0.00001	*0.030*	0.030	0.000	0.081	0.050
1	PCB-1254	0	*0.000*	0.000	0.087	0.000	0.000
1	PCB-1260	0	*0.000*	0.000	0.258	0.000	0.000
1	Se	0	*0.986*	0.986	0.000	1.177	0.952
1	Zn	0.017743	*19.788*	19.788	0.000	22.849	12.546
2.01	As	0	*0.000*	0.000	*0.305*	0.609	0.472
2.01	Be	0	*0.004*	0.004	*0.002*	0.000	0.000
2.01	Chlordane	0	*0.000*	0.000	*0.144*	0.288	0.318
2.01	Cu	0.00741	*132.438*	132.438	*66.219*	0.000	0.000
2.01	Hg	0.00001	*0.000*	0.000	*0.044*	0.088	0.284
2.01	PCB-1254	0	*0.000*	0.000	*0.147*	0.293	0.902
2.01	PCB-1260	0	*0.000*	0.000	*0.177*	0.355	1.659
2.01	Se	0	*0.610*	0.610	*0.566*	0.522	0.424
2.01	Zn	0.019837	*0.000*	0.000	*0.000*	0.000	0.000
2.02	As	0.0011	*0.082*	0.082	0.025	0.415	0.448
2.02	Be	0	*0.002*	0.002	0.000	0.002	0.002
2.02	Bis(2ethylhexyl)phthalate	0.006315	*0.000*	0.000	0.000	0.000	0.000
2.02	Chlordane	0	*0.000*	0.000	0.068	0.331	0.623
2.02	Cu	0.0065	*1.878*	1.878	0.000	6.130	0.000
2.02	Hg	0.00007	*0.068*	0.068	0.068	0.156	0.366
2.02	PCB-1016	0	*0.000*	0.000	0.009	0.000	0.000

Table F4.6 (continued)

Subreach	Analyte	Contaminant concentration in surface water	Contaminant concentrations in whole fish (by size class)[a]				
			0–10 cm	10–20 cm	20–30 cm	30–40 cm	>40 cm
2.02	PCB-1254	0	*0.000*	0.000	0.145	1.198	2.487
2.02	PCB-1260	0	*0.000*	0.000	0.216	1.856	4.649
2.02	Se	0	*0.564*	0.564	0.997	0.494	0.556
2.02	Zn	0.015594	*18.213*	18.213	0.000	18.815	21.212
2.04	Aldrin	0	*0.000*	*0.000*	*0.000*	0.000	0.001
2.04	As	0.0011	*0.000*	*0.000*	*0.000*	0.000	0.000
2.04	Bis(2ethylhexyl)phthalate	0.0375	*0.000*	*0.000*	*0.000*	0.000	0.000
2.04	Chlordane	0	*0.000*	*0.000*	*0.000*	0.000	0.177
2.04	Cu	0.00873	*0.000*	*0.000*	*0.000*	0.000	0.000
2.04	DDE	0	*0.000*	*0.000*	*0.000*	0.000	0.015
2.04	DDT	0	*0.000*	*0.000*	*0.000*	0.000	0.003
2.04	Hg	0.00002	*0.000*	*0.000*	*0.000*	0.000	0.000
2.04	PCB-1254	0	*0.000*	*0.000*	*0.000*	0.000	1.736
2.04	PCB-1260	0	*19.190*	*19.190*	*19.190*	19.190	7.080
2.04	Zn	0.017309	*0.000*	*0.000*	*0.000*	0.000	0.000
3.01	Aldrin	0.00001	*0.000*	0.000	*0.000*	0.000	0.000
3.01	As	0	*0.165*	0.165	*0.082*	0.000	0.168
3.01	Be	0	*0.006*	0.006	*0.006*	0.006	0.008
3.01	Bis(2ethylhexyl)phthalate	0.005	*0.000*	0.000	*0.000*	0.000	0.000
3.01	Chlordane	0	*0.000*	0.000	*0.189*	0.377	0.529
3.01	Cu	0.00429	*6.227*	6.227	*3.114*	0.000	0.000
3.01	DDE	0	*0.000*	0.000	*0.104*	0.208	0.030
3.01	Hg	0.00013	*0.392*	0.392	*0.431*	0.469	1.272
3.01	PCB-1016	0	*0.000*	0.000	*0.000*	0.000	0.381
3.01	PCB-1254	0.00029	*0.000*	0.000	*0.323*	0.645	1.480
3.01	PCB-1260	0	*0.000*	0.000	*1.403*	2.806	3.160
3.01	Se	0	*0.538*	0.538	*0.269*	0.000	0.214
3.01	Zn	0.017248	*14.896*	14.896	*7.448*	0.000	0.000
3.02	As	0.0014	*0.091*	0.091	0.315	0.407	0.083
3.02	Be	0	*0.009*	0.009	0.008	0.006	0.000
3.02	Bis(2ethylhexyl)phthalate	0.004841	*0.000*	0.000	0.000	0.000	0.000
3.02	Chlordane	0	*0.000*	0.000	0.287	0.336	0.558
3.02	Cu	0.00336	*8.184*	8.184	0.000	0.000	0.000
3.02	Hg	0.00012	*0.367*	0.367	0.477	0.533	1.614
3.02	PCB-1254	0	*0.000*	0.000	3.549	1.785	7.853
3.02	PCB-1260	0	*0.000*	0.000	4.539	2.013	8.533

Table F4.6 (continued)

Subreach	Analyte	Contaminant concentration in surface water	Contaminant concentrations in whole fish (by size class)[a]				
			0–10 cm	10–20 cm	20–30 cm	30–40 cm	>40 cm
3.02	Se	0	*0.413*	0.413	0.653	0.214	0.321
3.02	Zn	0.012169	*15.268*	15.268	21.522	10.824	0.000
3.03	As	0.00145	*0.111*	0.111	0.154	0.000	0.205
3.03	Be	0	*0.014*	0.014	0.000	0.000	0.004
3.03	Bis(2ethylhexyl)phthalate	0.002138	*0.000*	0.000	0.000	0.000	0.000
3.03	Chlordane	0	*0.000*	0.000	0.000	0.284	0.231
3.03	Cu	0.00494	*0.000*	0.000	0.000	0.000	0.000
3.03	DDE	0	*0.000*	0.000	0.000	0.003	0.002
3.03	Hg	0.00013	*0.241*	0.241	0.270	0.000	0.554
3.03	PCB-1254	0	*0.000*	0.000	0.000	0.786	1.035
3.03	PCB-1260	0	*0.000*	0.000	0.000	4.158	5.244
3.03	Zn	0.014037	*19.004*	19.004	13.776	0.000	24.480
3.04	As	0.0012	*0.133*	0.133	0.000	0.403	0.329
3.04	Be	0	*0.002*	0.002	0.000	0.003	0.004
3.04	Bis(2ethylhexyl)phthalate	0.005	*0.000*	0.000	0.000	0.000	0.179
3.04	Chlordane	0	*0.000*	0.000	0.079	0.272	0.345
3.04	Cu	0.00496	*0.000*	0.000	0.000	0.000	0.000
3.04	DDE	0	*0.000*	0.000	0.000	0.003	0.003
3.04	Hg	0.00026	*0.251*	0.251	0.000	0.492	0.596
3.04	PCB-1254	0.00014	*0.000*	0.000	0.264	1.213	2.097
3.04	PCB-1260	0	*0.000*	0.000	0.437	2.320	5.175
3.04	Se	0	*0.322*	0.322	0.000	0.329	0.417
3.04	Zn	0.018682	*0.000*	0.000	0.000	0.000	0.000
4.01	As	0.00107	*0.092*	0.092	0.000	0.244	0.404
4.01	Be	0	*0.000*	0.000	0.000	0.004	0.000
4.01	Bis(2ethylhexyl)phthalate	0.005	*0.000*	0.000	0.000	0.000	0.000
4.01	Chlordane	0.00002	*0.000*	0.000	0.063	0.316	0.434
4.01	Cu	0.01781	*3.526*	3.526	0.000	9.009	1.500
4.01	Hg	0.00005	*0.257*	0.257	0.057	0.210	0.447
4.01	PCB-1254	0	*0.000*	0.000	0.272	1.238	2.017
4.01	PCB-1260	0	*0.000*	0.000	0.235	2.380	3.653
4.01	Se	0	*0.757*	0.757	0.000	0.259	0.972
4.01	Zn	0.042085	*16.726*	16.726	0.000	19.328	10.578
4.04	As	0.00169	0.000	0.078	0.000	0.378	0.257
4.04	Be	0	0.000	0.003	0.000	0.000	0.002

Table F4.6 (continued)

Subreach	Analyte	Contaminant concentration in surface water	Contaminant concentrations in whole fish (by size class)[a]				
			0–10 cm	10–20 cm	20–30 cm	30–40 cm	>40 cm
4.04	Bis(2ethylhexyl)phthalate	0.010114	0.000	0.000	0.000	0.000	0.000
4.04	Chlordane	0	0.073	0.000	0.069	0.480	0.468
4.04	Cu	0.00602	0.000	19.096	0.000	60.186	5.433
4.04	DDD	0	0.000	0.000	0.000	0.000	0.060
4.04	DDE	0	0.000	0.000	0.000	0.041	0.220
4.04	Hg	0.00003	0.000	0.075	0.000	0.170	0.230
4.04	PCB-1254	0	0.100	0.000	0.118	0.673	2.049
4.04	PCB-1260	0	0.090	0.000	0.176	1.809	4.336
4.04	Se	0	0.000	0.470	0.000	0.479	0.344
4.04	Zn	0.017114	0.000	18.889	0.000	10.086	10.302
5	Aldrin	0	0.000	0.000	0.000	0.000	0.013
5	As	0	0.000	0.104	0.000	0.257	0.271
5	Be	0	0.000	0.000	0.000	0.003	0.007
5	Chlordane	0	0.069	0.000	0.065	0.242	0.446
5	Cu	0	0.000	86.293	0.000	0.000	3.784
5	DDD	0	0.000	0.000	0.000	0.005	0.031
5	DDE	0	0.000	0.000	0.000	0.035	0.064
5	DDT	0	0.000	0.000	0.000	0.002	0.006
5	Hg	0	0.000	0.043	0.000	0.137	0.200
5	PCB-1254	0	0.060	0.000	0.177	0.459	1.791
5	PCB-1260	0	0.070	0.000	0.144	1.099	4.329
5	Se	0	0.000	0.362	0.000	0.409	0.315
5	Zn	0	0.000	39.510	0.000	9.594	11.542
6	Chlordane	0	*0.060*	*0.060*	0.060	*0.060*	*0.060*
6	PCB-1254	0	*0.167*	*0.167*	0.167	*0.167*	*0.167*
6	PCB-1260	0	*0.173*	*0.173*	0.173	*0.173*	*0.173*
10	As	0	0.000	0.083	0.157	0.420	0.262
10	Be	0	0.000	0.003	0.026	0.003	0.002
10	Bis(2ethylhexyl)phthalate	0.005	0.000	0.000	0.000	0.000	0.000
10	Chlordane	0	0.077	0.000	0.073	0.263	0.280
10	Cu	0	0.000	0.000	1.978	0.000	0.000
10	DDD	0	0.000	0.000	0.000	0.000	0.004
10	DDE	0	0.000	0.000	0.000	0.000	0.011
10	Hg	0	0.000	0.047	0.099	0.184	0.341
10	PCB-1254	0	0.000	0.000	0.052	0.262	0.253
10	PCB-1260	0	0.000	0.000	0.000	0.647	0.905

Table F4.6 (continued)

Subreach	Analyte	Contaminant concentration in surface water	Contaminant concentrations in whole fish (by size class)[a]				
			0–10 cm	10–20 cm	20–30 cm	30–40 cm	>40 cm
10	Se	0	0.000	0.449	0.568	0.507	0.555
10	Zn	0	0.000	14.355	17.475	12.208	18.092
13	Aldrin	0	*0.000*	0.000	*0.002*	0.003	0.004
13	As	0.0037	*0.083*	0.083	*0.041*	0.000	0.000
13	Bis(2ethylhexyl)phthalate	0.007443	*0.000*	0.000	*0.000*	0.000	0.000
13	Chlordane	0.00002	*0.000*	0.000	*0.183*	0.366	0.396
13	Cu	0.00471	*0.000*	0.000	*0.000*	0.000	0.000
13	DDE	0	*0.000*	0.000	*0.013*	0.026	0.008
13	Hg	0.00002	*0.205*	0.205	*0.102*	0.000	0.000
13	PCB-1254	0.00046	*0.000*	0.000	*0.362*	0.724	0.152
13	PCB-1260	0.00102	*0.000*	0.000	*1.717*	3.433	3.435
13	Se	0.0012	*0.000*	0.000	*0.000*	0.000	0.000
13	Zn	0.01308	*16.820*	16.820	*8.410*	0.000	0.000
15	As	0	*0.184*	0.184	*0.165*	0.145	0.200
15	Be	0	*0.000*	0.000	*0.008*	0.016	0.019
15	Chlordane	0	*0.000*	0.000	*0.598*	1.195	2.946
15	DDD	0	*0.000*	0.000	*0.000*	0.000	0.018
15	Hg	0	*0.078*	0.078	*0.114*	0.150	0.511
15	PCB-1254	0	*0.000*	0.000	*0.152*	0.305	0.882
15	PCB-1260	0	*0.000*	0.000	*0.273*	0.546	4.522
15	Se	0	*0.807*	0.807	*0.741*	0.674	0.000
15	Zn	0	*20.360*	20.360	*16.905*	13.450	15.238
18	As	0	0.000	0.038	0.000	0.386	0.379
18	Be	0	0.000	0.003	0.000	0.004	0.004
18	Chlordane	0	0.066	0.000	0.063	0.591	0.533
18	Hg	0.00007	0.000	0.034	0.000	0.172	0.234
18	PCB-1254	0	0.090	0.000	0.143	1.009	1.832
18	PCB-1260	0	0.070	0.000	0.237	2.361	4.309
18	Se	0	0.000	0.307	0.000	0.275	0.266
18	Zn	0.010578	0.000	0.000	0.000	0.000	0.000

[a]Italicized values represent estimated concentrations. No data were available for fish in these size classes. Concentrations were assumed to be equivolent to that in the next higher size class for which contaminants were detected. If contaminants were detected in fish in size classes above and below that in which data are missing, concentrations were estimated to be the mean of the concentrations in the higher and lower size classes.

Table F4.7. Exposure estimates for osprey in the Clinch River/Poplar Creek system

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
As	0	0.003	0.001	0.008	0.018	0.004	0.001	0.034	0.0
Be	0	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Chlordane	0	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.0
DDD	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.1
Hg	0	0.000	0.000	0.005	0.005	0.003	0.001	0.014	2.3
PCB-1254	0	0.000	0.000	0.000	0.000	0.002	0.002	0.004	0.0
PCB-1260	0	0.000	0.000	0.000	0.000	0.010	0.025	0.036	0.2
Se	0	0.000	0.006	0.074	0.054	0.014	0.002	0.150	0.3
Zn	0	0.001	0.146	1.867	1.126	0.195	0.031	3.366	0.2
As	1	0.000	0.001	0.008	0.000	0.007	0.000	0.017	0.0
Be	1	0.000	0.000	0.001	0.000	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	1	0.000	0.000	0.000	0.009	0.000	0.000	0.009	0.0
Hg	1	0.000	0.000	0.003	0.000	0.001	0.000	0.004	0.7
PCB-1254	1	0.000	0.000	0.000	0.008	0.000	0.000	0.008	0.1
PCB-1260	1	0.000	0.000	0.000	0.024	0.000	0.000	0.024	0.2
Se	1	0.000	0.007	0.083	0.000	0.016	0.002	0.108	0.2
Zn	1	0.001	0.131	1.666	0.000	0.302	0.033	2.132	0.1
As	2.01	0.000	0.000	0.000	0.028	0.008	0.001	0.038	0.0
Be	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Chlordane	2.01	0.000	0.000	0.000	0.013	0.004	0.001	0.018	0.0
Cu	2.01	0.000	0.874	11.151	6.185	0.000	0.000	18.211	0.8
Hg	2.01	0.000	0.000	0.000	0.004	0.001	0.001	0.006	1.0
PCB-1254	2.01	0.000	0.000	0.000	0.014	0.004	0.002	0.020	0.1
PCB-1260	2.01	0.000	0.000	0.000	0.017	0.005	0.004	0.026	0.2
Se	2.01	0.000	0.004	0.051	0.053	0.007	0.001	0.116	0.3
Zn	2.01	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
As	2.02	0.000	0.001	0.007	0.002	0.005	0.001	0.016	0.0
Be	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	2.02	0.000	0.000	0.000	0.006	0.004	0.002	0.012	0.0
Cu	2.02	0.000	0.012	0.158	0.000	0.081	0.000	0.252	0.0
Hg	2.02	0.000	0.000	0.006	0.006	0.002	0.001	0.016	2.6
PCB-1016	2.02	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.0
PCB-1254	2.02	0.000	0.000	0.000	0.014	0.016	0.006	0.036	0.2
PCB-1260	2.02	0.000	0.000	0.000	0.020	0.024	0.012	0.057	0.4
Se	2.02	0.000	0.004	0.047	0.093	0.007	0.001	0.152	0.3
Zn	2.02	0.001	0.120	1.534	0.000	0.248	0.055	1.958	0.1

Table F4.7 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
Aldrin	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Bis(2ethylhexyl) phthalate	2.04	0.002	0.000	0.000	0.000	0.000	0.000	0.002	0.0
Chlordane	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDT	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	2.04	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.0
PCB-1260	2.04	0.000	0.127	1.616	1.792	0.253	0.018	3.806	24.2
Zn	2.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Aldrin	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	3.01	0.000	0.001	0.014	0.008	0.000	0.000	0.023	0.0
Be	3.01	0.000	0.000	0.001	0.001	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.01	0.000	0.000	0.000	0.018	0.005	0.001	0.024	0.0
Cu	3.01	0.000	0.041	0.524	0.291	0.000	0.000	0.856	0.0
DDE	3.01	0.000	0.000	0.000	0.010	0.003	0.000	0.013	3.1
Hg	3.01	0.000	0.003	0.033	0.040	0.006	0.003	0.085	14.2
PCB-1016	3.01	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.0
PCB-1254	3.01	0.000	0.000	0.000	0.030	0.009	0.004	0.043	0.3
PCB-1260	3.01	0.000	0.000	0.000	0.131	0.037	0.008	0.176	1.1
Se	3.01	0.000	0.004	0.045	0.025	0.000	0.001	0.075	0.2
Zn	3.01	0.001	0.098	1.254	0.696	0.000	0.000	2.049	0.1
As	3.02	0.000	0.001	0.008	0.029	0.005	0.000	0.043	0.0
Be	3.02	0.000	0.000	0.001	0.001	0.000	0.000	0.002	
Bis(2ethylhexyl) phthalate	3.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.02	0.000	0.000	0.000	0.027	0.004	0.001	0.033	0.0
Cu	3.02	0.000	0.054	0.689	0.000	0.000	0.000	0.743	0.0
Hg	3.02	0.000	0.002	0.031	0.045	0.007	0.004	0.089	14.9
PCB-1254	3.02	0.000	0.000	0.000	0.331	0.024	0.020	0.375	2.4
PCB-1260	3.02	0.000	0.000	0.000	0.424	0.027	0.022	0.473	3.0
Se	3.02	0.000	0.003	0.035	0.061	0.003	0.001	0.102	0.2
Zn	3.02	0.001	0.101	1.286	2.010	0.143	0.000	3.540	0.2
As	3.03	0.000	0.001	0.009	0.014	0.000	0.001	0.025	0.0
Be	3.03	0.000	0.000	0.001	0.000	0.000	0.000	0.001	

Table F4.7 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
Bis(2ethylhexyl) phthalate	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.03	0.000	0.000	0.000	0.000	0.004	0.001	0.004	0.0
Cu	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	3.03	0.000	0.002	0.020	0.025	0.000	0.001	0.049	8.1
PCB-1254	3.03	0.000	0.000	0.000	0.000	0.010	0.003	0.013	0.1
PCB-1260	3.03	0.000	0.000	0.000	0.000	0.055	0.014	0.069	0.4
Zn	3.03	0.001	0.125	1.600	1.287	0.000	0.064	3.077	0.2
As	3.04	0.000	0.001	0.011	0.000	0.005	0.001	0.018	0.0
Be	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	3.04	0.000	0.000	0.000	0.007	0.004	0.001	0.012	0.0
Cu	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	3.04	0.000	0.002	0.021	0.000	0.006	0.002	0.031	5.1
PCB-1254	3.04	0.000	0.000	0.000	0.025	0.016	0.005	0.046	0.3
PCB-1260	3.04	0.000	0.000	0.000	0.041	0.031	0.013	0.085	0.5
Se	3.04	0.000	0.002	0.027	0.000	0.004	0.001	0.035	0.1
Zn	3.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
As	4.01	0.000	0.001	0.008	0.000	0.003	0.001	0.013	0.0
Be	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	4.01	0.000	0.000	0.000	0.006	0.004	0.001	0.011	0.0
Cu	4.01	0.001	0.023	0.297	0.000	0.119	0.004	0.444	0.0
Hg	4.01	0.000	0.002	0.022	0.005	0.003	0.001	0.033	5.4
PCB-1254	4.01	0.000	0.000	0.000	0.025	0.016	0.005	0.047	0.3
PCB-1260	4.01	0.000	0.000	0.000	0.022	0.031	0.010	0.063	0.4
Se	4.01	0.000	0.005	0.064	0.000	0.003	0.003	0.075	0.2
Zn	4.01	0.002	0.110	1.408	0.000	0.255	0.028	1.803	0.1
As	4.04	0.000	0.000	0.007	0.000	0.005	0.001	0.012	0.0
Be	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	4.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	4.04	0.000	0.000	0.000	0.006	0.006	0.001	0.014	0.0
Cu	4.04	0.000	0.000	1.608	0.000	0.794	0.014	2.417	0.1
DDD	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	4.04	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.3
Hg	4.04	0.000	0.000	0.006	0.000	0.002	0.001	0.009	1.5

Table F4.7 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d) Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	NOAEL HQ[a]
PCB-1254	4.04	0.000	0.001	0.000	0.011	0.009	0.005	0.026	0.2
PCB-1260	4.04	0.000	0.001	0.000	0.016	0.024	0.011	0.052	0.3
Se	4.04	0.000	0.000	0.040	0.000	0.006	0.001	0.047	0.1
Zn	4.04	0.001	0.000	1.590	0.000	0.133	0.027	1.751	0.1
Aldrin	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	5	0.000	0.000	0.009	0.000	0.003	0.001	0.013	0.0
Be	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	5	0.000	0.000	0.000	0.006	0.003	0.001	0.011	0.0
Cu	5	0.000	0.000	7.266	0.000	0.000	0.010	7.276	0.3
DDD	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	5	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.2
DDT	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	5	0.000	0.000	0.004	0.000	0.002	0.001	0.006	1.0
PCB-1254	5	0.000	0.000	0.000	0.017	0.006	0.005	0.028	0.2
PCB-1260	5	0.000	0.000	0.000	0.013	0.015	0.011	0.040	0.3
Se	5	0.000	0.000	0.031	0.000	0.005	0.001	0.037	0.1
Zn	5	0.000	0.000	3.327	0.000	0.127	0.030	3.483	0.2
Chlordane	6	0.000	0.000	0.005	0.006	0.001	0.000	0.012	0.0
PCB-1254	6	0.000	0.001	0.014	0.016	0.002	0.000	0.033	0.2
PCB-1260	6	0.000	0.001	0.015	0.016	0.002	0.000	0.035	0.2
As	10	0.000	0.000	0.007	0.015	0.006	0.001	0.028	0.0
Be	10	0.000	0.000	0.000	0.002	0.000	0.000	0.003	
Bis(2ethylhexyl) phthalate	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	10	0.000	0.001	0.000	0.007	0.003	0.001	0.012	0.0
Cu	10	0.000	0.000	0.000	0.185	0.000	0.000	0.185	0.0
DDD	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	10	0.000	0.000	0.004	0.009	0.002	0.001	0.016	2.7
PCB-1254	10	0.000	0.000	0.000	0.005	0.003	0.001	0.009	0.1
PCB-1260	10	0.000	0.000	0.000	0.000	0.009	0.002	0.011	0.1
Se	10	0.000	0.000	0.038	0.053	0.007	0.001	0.099	0.2
Zn	10	0.000	0.000	1.209	1.632	0.161	0.047	3.049	0.2
Aldrin	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	13	0.000	0.001	0.007	0.004	0.000	0.000	0.012	0.0
Bis(2ethylhexyl) phthalate	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	13	0.000	0.000	0.000	0.017	0.005	0.001	0.023	0.0
Cu	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	13	0.000	0.000	0.000	0.001	0.000	0.000	0.002	0.4

Table F4.7 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
Hg	13	0.000	0.001	0.017	0.010	0.000	0.000	0.028	4.7
PCB-1254	13	0.000	0.000	0.000	0.034	0.010	0.000	0.044	0.3
PCB-1260	13	0.000	0.000	0.000	0.160	0.045	0.009	0.215	1.4
Se	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Zn	13	0.001	0.111	1.416	0.785	0.000	0.000	2.313	0.1
As	15	0.000	0.001	0.016	0.015	0.002	0.001	0.035	0.0
Be	15	0.000	0.000	0.000	0.001	0.000	0.000	0.001	
Chlordane	15	0.000	0.000	0.000	0.056	0.016	0.008	0.079	0.1
DDD	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	15	0.000	0.001	0.007	0.011	0.002	0.001	0.021	3.5
PCB-1254	15	0.000	0.000	0.000	0.014	0.004	0.002	0.021	0.1
PCB-1260	15	0.000	0.000	0.000	0.025	0.007	0.012	0.044	0.3
Se	15	0.000	0.005	0.068	0.069	0.009	0.000	0.151	0.3
Zn	15	0.000	0.134	1.714	1.579	0.178	0.040	3.645	0.2
As	18	0.000	0.000	0.003	0.000	0.005	0.001	0.009	0.0
Be	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	18	0.000	0.000	0.000	0.006	0.008	0.001	0.016	0.0
Hg	18	0.000	0.000	0.003	0.000	0.002	0.001	0.006	1.0
PCB-1254	18	0.000	0.001	0.000	0.013	0.013	0.005	0.032	0.2
PCB-1260	18	0.000	0.000	0.000	0.022	0.031	0.011	0.065	0.4
Se	18	0.000	0.000	0.026	0.000	0.004	0.001	0.030	0.1
Zn	18	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0

[a] NOAEL HQ = No observed adverse effect level hazard quotient.

Table F4.8. Exposure estimates for great blue heron in the Clinch River/Poplar Creek system

Analyte	Subreach	Exposure estimate (mg/kg/d) Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	NOAEL HQ[a]
As	0	0.002	0.006	0.008	0.005	0.000	0.000	0.021	0.0
Be	0	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Chlordane	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDD	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	0	0.000	0.004	0.005	0.001	0.000	0.000	0.010	2.0
PCB-1254	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	0	0.000	0.061	0.073	0.014	0.000	0.000	0.147	0.4
Zn	0	0.001	1.528	1.836	0.290	0.000	0.000	3.655	0.3
As	1	0.000	0.007	0.008	0.000	0.000	0.000	0.015	0.0
Be	1	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	1	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.0
Hg	1	0.000	0.002	0.002	0.000	0.000	0.000	0.005	0.9
PCB-1254	1	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.0
PCB-1260	1	0.000	0.000	0.000	0.006	0.000	0.000	0.006	0.0
Se	1	0.000	0.068	0.082	0.000	0.000	0.000	0.150	0.4
Zn	1	0.001	1.363	1.638	0.000	0.000	0.000	3.002	0.2
As	2.01	0.000	0.000	0.000	0.007	0.000	0.000	0.007	0.0
Be	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Chlordane	2.01	0.000	0.000	0.000	0.003	0.000	0.000	0.003	0.0
Cu	2.01	0.000	9.123	10.962	1.594	0.000	0.000	21.680	1.1
Hg	2.01	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.2
PCB-1254	2.01	0.000	0.000	0.000	0.004	0.000	0.000	0.004	0.0
PCB-1260	2.01	0.000	0.000	0.000	0.004	0.000	0.000	0.004	0.0
Se	2.01	0.000	0.042	0.050	0.014	0.000	0.000	0.106	0.3
Zn	2.01	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
As	2.02	0.000	0.006	0.007	0.001	0.000	0.000	0.013	0.0
Be	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	2.02	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.0
Cu	2.02	0.000	0.129	0.155	0.000	0.000	0.000	0.285	0.0
Hg	2.02	0.000	0.005	0.006	0.002	0.000	0.000	0.012	2.4
PCB-1016	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	2.02	0.000	0.000	0.000	0.003	0.000	0.000	0.003	0.0
PCB-1260	2.02	0.000	0.000	0.000	0.005	0.000	0.000	0.005	0.0
Se	2.02	0.000	0.039	0.047	0.024	0.000	0.000	0.110	0.3
Zn	2.02	0.001	1.255	1.507	0.000	0.000	0.000	2.763	0.2

Table F4.8 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
Aldrin	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Bis(2ethylhexyl) phthalate	2.04	0.002	0.000	0.000	0.000	0.000	0.000	0.002	0.0
Chlordane	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDT	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	2.04	0.000	1.322	1.588	0.462	0.000	0.000	3.372	25.0
Zn	2.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Aldrin	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	3.01	0.000	0.011	0.014	0.002	0.000	0.000	0.027	0.0
Be	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.01	0.000	0.000	0.000	0.005	0.000	0.000	0.005	0.0
Cu	3.01	0.000	0.429	0.515	0.075	0.000	0.000	1.020	0.1
DDE	3.01	0.000	0.000	0.000	0.003	0.000	0.000	0.003	0.8
Hg	3.01	0.000	0.027	0.032	0.010	0.000	0.000	0.070	14.0
PCB-1016	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	3.01	0.000	0.000	0.000	0.008	0.000	0.000	0.008	0.1
PCB-1260	3.01	0.000	0.000	0.000	0.034	0.000	0.000	0.034	0.3
Se	3.01	0.000	0.037	0.045	0.006	0.000	0.000	0.088	0.2
Zn	3.01	0.001	1.026	1.233	0.179	0.000	0.000	2.439	0.2
As	3.02	0.000	0.006	0.008	0.008	0.000	0.000	0.022	0.0
Be	3.02	0.000	0.001	0.001	0.000	0.000	0.000	0.002	
Bis(2ethylhexyl) phthalate	3.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.02	0.000	0.000	0.000	0.007	0.000	0.000	0.007	0.0
Cu	3.02	0.000	0.564	0.677	0.000	0.000	0.000	1.241	0.1
Hg	3.02	0.000	0.025	0.030	0.012	0.000	0.000	0.067	13.4
PCB-1254	3.02	0.000	0.000	0.000	0.085	0.000	0.000	0.085	0.6
PCB-1260	3.02	0.000	0.000	0.000	0.109	0.000	0.000	0.109	0.8
Se	3.02	0.000	0.028	0.034	0.016	0.000	0.000	0.078	0.2
Zn	3.02	0.001	1.052	1.264	0.518	0.000	0.000	2.834	0.2
As	3.03	0.000	0.008	0.009	0.004	0.000	0.000	0.021	0.0
Be	3.03	0.000	0.001	0.001	0.000	0.000	0.000	0.002	

Table F4.8 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
Bis(2ethylhexyl) phthalate	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	3.03	0.000	0.017	0.020	0.007	0.000	0.000	0.043	8.6
PCB-1254	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Zn	3.03	0.001	1.309	1.573	0.332	0.000	0.000	3.214	0.2
As	3.04	0.000	0.009	0.011	0.000	0.000	0.000	0.020	0.0
Be	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.04	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.0
Cu	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	3.04	0.000	0.017	0.021	0.000	0.000	0.000	0.038	7.6
PCB-1254	3.04	0.000	0.000	0.000	0.006	0.000	0.000	0.006	0.0
PCB-1260	3.04	0.000	0.000	0.000	0.011	0.000	0.000	0.011	0.1
Se	3.04	0.000	0.022	0.027	0.000	0.000	0.000	0.049	0.1
Zn	3.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
As	4.01	0.000	0.006	0.008	0.000	0.000	0.000	0.014	0.0
Be	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	4.01	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.0
Cu	4.01	0.001	0.243	0.292	0.000	0.000	0.000	0.536	0.0
Hg	4.01	0.000	0.018	0.021	0.001	0.000	0.000	0.040	8.1
PCB-1254	4.01	0.000	0.000	0.000	0.007	0.000	0.000	0.007	0.0
PCB-1260	4.01	0.000	0.000	0.000	0.006	0.000	0.000	0.006	0.0
Se	4.01	0.000	0.052	0.063	0.000	0.000	0.000	0.115	0.3
Zn	4.01	0.002	1.152	1.384	0.000	0.000	0.000	2.538	0.2
As	4.04	0.000	0.000	0.006	0.000	0.000	0.000	0.007	0.0
Be	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	4.04	0.000	0.005	0.000	0.002	0.000	0.000	0.007	0.0
Cu	4.04	0.000	0.000	1.581	0.000	0.000	0.000	1.581	0.1
DDD	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0

Table F4.8 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d) Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	NOAEL HQ[a]
Hg	4.04	0.000	0.000	0.006	0.000	0.000	0.000	0.006	1.2
PCB-1254	4.04	0.000	0.007	0.000	0.003	0.000	0.000	0.010	0.1
PCB-1260	4.04	0.000	0.006	0.000	0.004	0.000	0.000	0.010	0.1
Se	4.04	0.000	0.000	0.039	0.000	0.000	0.000	0.039	0.1
Zn	4.04	0.001	0.000	1.563	0.000	0.000	0.000	1.564	0.1
Aldrin	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	5	0.000	0.000	0.009	0.000	0.000	0.000	0.009	0.0
Be	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	5	0.000	0.005	0.000	0.002	0.000	0.000	0.006	0.0
Cu	5	0.000	0.000	7.142	0.000	0.000	0.000	7.142	0.4
DDD	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDT	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	5	0.000	0.000	0.004	0.000	0.000	0.000	0.004	0.7
PCB-1254	5	0.000	0.004	0.000	0.004	0.000	0.000	0.008	0.1
PCB-1260	5	0.000	0.005	0.000	0.003	0.000	0.000	0.008	0.1
Se	5	0.000	0.000	0.030	0.000	0.000	0.000	0.030	0.1
Zn	5	0.000	0.000	3.270	0.000	0.000	0.000	3.270	0.2
Chlordane	6	0.000	0.004	0.005	0.001	0.000	0.000	0.011	0.0
PCB-1254	6	0.000	0.011	0.014	0.004	0.000	0.000	0.029	0.2
PCB-1260	6	0.000	0.012	0.014	0.004	0.000	0.000	0.030	0.2
As	10	0.000	0.000	0.007	0.004	0.000	0.000	0.011	0.0
Be	10	0.000	0.000	0.000	0.001	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	10	0.000	0.005	0.000	0.002	0.000	0.000	0.007	0.0
Cu	10	0.000	0.000	0.000	0.048	0.000	0.000	0.048	0.0
DDD	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	10	0.000	0.000	0.004	0.002	0.000	0.000	0.006	1.3
PCB-1254	10	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.0
PCB-1260	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	10	0.000	0.000	0.037	0.014	0.000	0.000	0.051	0.1
Zn	10	0.000	0.000	1.188	0.421	0.000	0.000	1.609	0.1
Aldrin	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	13	0.000	0.006	0.007	0.001	0.000	0.000	0.014	0.0
Bis(2ethylhexyl) phthalate	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	13	0.000	0.000	0.000	0.004	0.000	0.000	0.004	0.0

Table F4.8 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d) Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	NOAEL HQ[a]
Cu	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.1
Hg	13	0.000	0.014	0.017	0.002	0.000	0.000	0.033	6.7
PCB-1254	13	0.000	0.000	0.000	0.009	0.000	0.000	0.009	0.1
PCB-1260	13	0.000	0.000	0.000	0.041	0.000	0.000	0.041	0.3
Se	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Zn	13	0.001	1.159	1.392	0.202	0.000	0.000	2.754	0.2
As	15	0.000	0.013	0.015	0.004	0.000	0.000	0.032	0.0
Be	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	15	0.000	0.000	0.000	0.014	0.000	0.000	0.014	0.0
DDD	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	15	0.000	0.005	0.006	0.003	0.000	0.000	0.015	2.9
PCB-1254	15	0.000	0.000	0.000	0.004	0.000	0.000	0.004	0.0
PCB-1260	15	0.000	0.000	0.000	0.007	0.000	0.000	0.007	0.0
Se	15	0.000	0.056	0.067	0.018	0.000	0.000	0.140	0.4
Zn	15	0.000	1.403	1.685	0.407	0.000	0.000	3.495	0.3
As	18	0.000	0.000	0.003	0.000	0.000	0.000	0.003	0.0
Be	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	18	0.000	0.005	0.000	0.002	0.000	0.000	0.006	0.0
Hg	18	0.000	0.000	0.003	0.000	0.000	0.000	0.003	0.6
PCB-1254	18	0.000	0.006	0.000	0.003	0.000	0.000	0.010	0.1
PCB-1260	18	0.000	0.005	0.000	0.006	0.000	0.000	0.011	0.1
Se	18	0.000	0.000	0.025	0.000	0.000	0.000	0.025	0.1
Zn	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0

[a] NOAEL HQ = No observed adverse effect level hazard quotient.

Table F4.9. Exposure estimates for mink in the Clinch River/Poplar Creek system

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
As	0	0.005	0.005	0.002	0.000	0.000	0.000	0.012	0.3
Be	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDD	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	0	0.000	0.003	0.001	0.000	0.000	0.000	0.004	0.3
PCB-1254	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	0	0.000	0.047	0.018	0.000	0.000	0.000	0.066	2.7
Zn	0	0.002	1.195	0.465	0.000	0.000	0.000	1.661	0.0
As	1	0.000	0.005	0.002	0.000	0.000	0.000	0.008	0.2
Be	1	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	1	0.000	0.002	0.001	0.000	0.000	0.000	0.002	0.2
PCB-1254	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	1	0.000	0.053	0.021	0.000	0.000	0.000	0.074	3.1
Zn	1	0.002	1.066	0.414	0.000	0.000	0.000	1.482	0.0
As	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Be	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	2.01	0.001	7.133	2.774	0.000	0.000	0.000	9.907	0.8
Hg	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	2.01	0.000	0.033	0.013	0.000	0.000	0.000	0.046	1.9
Zn	2.01	0.002	0.000	0.000	0.000	0.000	0.000	0.002	0.0
As	2.02	0.000	0.004	0.002	0.000	0.000	0.000	0.006	0.2
Be	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	2.02	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	2.02	0.001	0.101	0.039	0.000	0.000	0.000	0.141	0.0
Hg	2.02	0.000	0.004	0.001	0.000	0.000	0.000	0.005	0.3
PCB-1016	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	2.02	0.000	0.030	0.012	0.000	0.000	0.000	0.042	1.8
Zn	2.02	0.002	0.981	0.381	0.000	0.000	0.000	1.364	0.0

Table F4.9 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
Aldrin	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Bis(2ethylhexyl) phthalate	2.04	0.004	0.000	0.000	0.000	0.000	0.000	0.004	0.0
Chlordane	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	2.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
DDE	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDT	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	2.04	0.000	1.034	0.402	0.000	0.000	0.000	1.435	10.5
Zn	2.04	0.002	0.000	0.000	0.000	0.000	0.000	0.002	0.0
Aldrin	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	3.01	0.000	0.009	0.003	0.000	0.000	0.000	0.012	0.3
Be	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	3.01	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	3.01	0.000	0.335	0.130	0.000	0.000	0.000	0.466	0.0
DDE	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	3.01	0.000	0.021	0.008	0.000	0.000	0.000	0.029	2.0
PCB-1016	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	3.01	0.000	0.029	0.011	0.000	0.000	0.000	0.040	1.7
Zn	3.01	0.002	0.802	0.312	0.000	0.000	0.000	1.116	0.0
As	3.02	0.000	0.005	0.002	0.000	0.000	0.000	0.007	0.2
Be	3.02	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	3.02	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	3.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	3.02	0.000	0.441	0.171	0.000	0.000	0.000	0.613	0.1
Hg	3.02	0.000	0.020	0.008	0.000	0.000	0.000	0.027	1.8
PCB-1254	3.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	3.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	3.02	0.000	0.022	0.009	0.000	0.000	0.000	0.031	1.3
Zn	3.02	0.001	0.822	0.320	0.000	0.000	0.000	1.143	0.0
As	3.03	0.000	0.006	0.002	0.000	0.000	0.000	0.008	0.2
Be	3.03	0.000	0.001	0.000	0.000	0.000	0.000	0.001	

Table F4.9 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
Bis(2ethylhexyl) phthalate	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	3.03	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
DDE	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	3.03	0.000	0.013	0.005	0.000	0.000	0.000	0.018	1.2
PCB-1254	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Zn	3.03	0.001	1.024	0.398	0.000	0.000	0.000	1.423	0.0
As	3.04	0.000	0.007	0.003	0.000	0.000	0.000	0.010	0.3
Be	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	3.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	3.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
DDE	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	3.04	0.000	0.014	0.005	0.000	0.000	0.000	0.019	1.3
PCB-1254	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	3.04	0.000	0.017	0.007	0.000	0.000	0.000	0.024	1.0
Zn	3.04	0.002	0.000	0.000	0.000	0.000	0.000	0.002	0.0
As	4.01	0.000	0.005	0.002	0.000	0.000	0.000	0.007	0.2
Be	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	4.01	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	4.01	0.002	0.190	0.074	0.000	0.000	0.000	0.266	0.0
Hg	4.01	0.000	0.014	0.005	0.000	0.000	0.000	0.019	1.3
PCB-1254	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	4.01	0.000	0.041	0.016	0.000	0.000	0.000	0.057	2.4
Zn	4.01	0.004	0.901	0.350	0.000	0.000	0.000	1.256	0.0
As	4.04	0.000	0.000	0.002	0.000	0.000	0.000	0.002	0.0
Be	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	4.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	4.04	0.000	0.004	0.000	0.000	0.000	0.000	0.004	0.0
Cu	4.04	0.001	0.000	0.400	0.000	0.000	0.000	0.401	0.0
DDD	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	4.04	0.000	0.000	0.002	0.000	0.000	0.000	0.002	0.1

Table F4.9 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d) Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	NOAEL HQ[a]
PCB-1254	4.04	0.000	0.005	0.000	0.000	0.000	0.000	0.005	0.0
PCB-1260	4.04	0.000	0.005	0.000	0.000	0.000	0.000	0.005	0.0
Se	4.04	0.000	0.000	0.010	0.000	0.000	0.000	0.010	0.4
Zn	4.04	0.002	0.000	0.396	0.000	0.000	0.000	0.397	0.0
Aldrin	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	5	0.000	0.000	0.002	0.000	0.000	0.000	0.002	0.1
Be	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	5	0.000	0.004	0.000	0.000	0.000	0.000	0.004	0.0
Cu	5	0.000	0.000	1.807	0.000	0.000	0.000	1.807	0.2
DDD	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDT	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	5	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.1
PCB-1254	5	0.000	0.003	0.000	0.000	0.000	0.000	0.003	0.0
PCB-1260	5	0.000	0.004	0.000	0.000	0.000	0.000	0.004	0.0
Se	5	0.000	0.000	0.008	0.000	0.000	0.000	0.008	0.3
Zn	5	0.000	0.000	0.828	0.000	0.000	0.000	0.828	0.0
Chlordane	6	0.000	0.003	0.001	0.000	0.000	0.000	0.005	0.0
PCB-1254	6	0.000	0.009	0.003	0.000	0.000	0.000	0.012	0.1
PCB-1260	6	0.000	0.009	0.004	0.000	0.000	0.000	0.013	0.1
As	10	0.000	0.000	0.002	0.000	0.000	0.000	0.002	0.0
Be	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	10	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	10	0.000	0.004	0.000	0.000	0.000	0.000	0.004	0.0
Cu	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDD	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	10	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.1
PCB-1254	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	10	0.000	0.000	0.009	0.000	0.000	0.000	0.009	0.4
Zn	10	0.000	0.000	0.301	0.000	0.000	0.000	0.301	0.0
Aldrin	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	13	0.000	0.004	0.002	0.000	0.000	0.000	0.007	0.2
Bis(2ethylhexyl) phthalate	13	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Cu	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0

Table F4.9 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
DDE	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	13	0.000	0.011	0.004	0.000	0.000	0.000	0.015	1.0
PCB-1254	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Zn	13	0.001	0.906	0.352	0.000	0.000	0.000	1.260	0.0
As	15	0.000	0.010	0.004	0.000	0.000	0.000	0.014	0.3
Be	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDD	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	15	0.000	0.004	0.002	0.000	0.000	0.000	0.006	0.4
PCB-1254	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1260	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Se	15	0.000	0.043	0.017	0.000	0.000	0.000	0.060	2.5
Zn	15	0.000	1.097	0.426	0.000	0.000	0.000	1.523	0.0
As	18	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.0
Be	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	18	0.000	0.004	0.000	0.000	0.000	0.000	0.004	0.0
Hg	18	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.0
PCB-1254	18	0.000	0.005	0.000	0.000	0.000	0.000	0.005	0.0
PCB-1260	18	0.000	0.004	0.000	0.000	0.000	0.000	0.004	0.0
Se	18	0.000	0.000	0.006	0.000	0.000	0.000	0.006	0.3
Zn	18	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0

[a] NOAEL HQ = No observed adverse effect level hazard quotient.

Table F4.10. Exposure estimates for river otter in the Clinch River/Poplar Creek system

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
As	0	0.004	0.002	0.002	0.004	0.008	0.012	0.031	1.5
Be	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	0	0.000	0.000	0.000	0.000	0.003	0.022	0.025	0.0
DDD	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	0	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.0
Hg	0	0.000	0.001	0.001	0.001	0.007	0.007	0.017	2.1
PCB-1254	0	0.000	0.000	0.000	0.000	0.003	0.023	0.026	0.4
PCB-1260	0	0.000	0.000	0.000	0.000	0.022	0.275	0.297	4.2
Se	0	0.000	0.017	0.017	0.011	0.030	0.022	0.097	8.0
Zn	0	0.001	0.417	0.417	0.226	0.415	0.337	1.813	0.0
As	1	0.000	0.002	0.002	0.000	0.015	0.003	0.022	1.1
Be	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	1	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.0
Hg	1	0.000	0.001	0.001	0.000	0.002	0.001	0.005	0.6
PCB-1254	1	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.0
PCB-1260	1	0.000	0.000	0.000	0.005	0.000	0.000	0.005	0.1
Se	1	0.000	0.019	0.019	0.000	0.033	0.027	0.097	8.1
Zn	1	0.001	0.372	0.372	0.000	0.643	0.353	1.740	0.0
As	2.01	0.000	0.000	0.000	0.006	0.017	0.013	0.036	1.8
Be	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	2.01	0.000	0.000	0.000	0.003	0.008	0.009	0.020	0.0
Cu	2.01	0.001	2.488	2.488	1.244	0.000	0.000	6.221	1.1
Hg	2.01	0.000	0.000	0.000	0.001	0.002	0.008	0.011	1.4
PCB-1254	2.01	0.000	0.000	0.000	0.003	0.008	0.025	0.036	0.5
PCB-1260	2.01	0.000	0.000	0.000	0.003	0.010	0.047	0.060	0.9
Se	2.01	0.000	0.011	0.011	0.011	0.015	0.012	0.060	5.0
Zn	2.01	0.002	0.000	0.000	0.000	0.000	0.000	0.002	0.0
As	2.02	0.000	0.002	0.002	0.000	0.012	0.013	0.028	1.4
Be	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	2.02	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	2.02	0.000	0.000	0.000	0.001	0.009	0.018	0.028	0.0
Cu	2.02	0.001	0.035	0.035	0.000	0.172	0.000	0.244	0.0
Hg	2.02	0.000	0.001	0.001	0.001	0.004	0.010	0.019	2.3
PCB-1016	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	2.02	0.000	0.000	0.000	0.003	0.034	0.070	0.106	1.5
PCB-1260	2.02	0.000	0.000	0.000	0.004	0.052	0.131	0.187	2.7
Se	2.02	0.000	0.011	0.011	0.019	0.014	0.016	0.069	5.8
Zn	2.02	0.001	0.342	0.342	0.000	0.529	0.597	1.811	0.0

Table F4.10 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
Aldrin	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Bis(2ethylhexyl) phthalate	2.04	0.003	0.000	0.000	0.000	0.000	0.000	0.003	0.0
Chlordane	2.04	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.0
Cu	2.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
DDE	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDT	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
PCB-1254	2.04	0.000	0.000	0.000	0.000	0.000	0.049	0.049	0.7
PCB-1260	2.04	0.000	0.361	0.361	0.361	0.540	0.199	1.820	26.0
Zn	2.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Aldrin	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	3.01	0.000	0.003	0.003	0.002	0.000	0.005	0.012	0.6
Be	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.01	0.000	0.000	0.000	0.004	0.011	0.015	0.029	0.0
Cu	3.01	0.000	0.117	0.117	0.058	0.000	0.000	0.293	0.0
DDE	3.01	0.000	0.000	0.000	0.002	0.006	0.001	0.009	0.0
Hg	3.01	0.000	0.007	0.007	0.008	0.013	0.036	0.072	9.0
PCB-1016	3.01	0.000	0.000	0.000	0.000	0.000	0.011	0.011	0.2
PCB-1254	3.01	0.000	0.000	0.000	0.006	0.018	0.042	0.066	0.9
PCB-1260	3.01	0.000	0.000	0.000	0.026	0.079	0.089	0.194	2.8
Se	3.01	0.000	0.010	0.010	0.005	0.000	0.006	0.031	2.6
Zn	3.01	0.001	0.280	0.280	0.140	0.000	0.000	0.701	0.0
As	3.02	0.000	0.002	0.002	0.006	0.011	0.002	0.023	1.2
Be	3.02	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	3.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.02	0.000	0.000	0.000	0.005	0.009	0.016	0.031	0.0
Cu	3.02	0.000	0.154	0.154	0.000	0.000	0.000	0.308	0.1
Hg	3.02	0.000	0.007	0.007	0.009	0.015	0.045	0.083	10.4
PCB-1254	3.02	0.000	0.000	0.000	0.067	0.050	0.221	0.338	4.8
PCB-1260	3.02	0.000	0.000	0.000	0.085	0.057	0.240	0.382	5.5
Se	3.02	0.000	0.008	0.008	0.012	0.006	0.009	0.043	3.6
Zn	3.02	0.001	0.287	0.287	0.404	0.304	0.000	1.283	0.0
As	3.03	0.000	0.002	0.002	0.003	0.000	0.006	0.013	0.6
Be	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.001	

Table F4.10 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
Bis(2ethylhexyl) phthalate	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	3.03	0.000	0.000	0.000	0.000	0.008	0.007	0.015	0.0
Cu	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	3.03	0.000	0.005	0.005	0.005	0.000	0.016	0.030	3.7
PCB-1254	3.03	0.000	0.000	0.000	0.000	0.022	0.029	0.051	0.7
PCB-1260	3.03	0.000	0.000	0.000	0.000	0.117	0.147	0.264	3.8
Zn	3.03	0.001	0.357	0.357	0.259	0.000	0.688	1.663	0.0
As	3.04	0.000	0.003	0.003	0.000	0.011	0.009	0.026	1.3
Be	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	3.04	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.0
Chlordane	3.04	0.000	0.000	0.000	0.001	0.008	0.010	0.019	0.0
Cu	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	3.04	0.000	0.005	0.005	0.000	0.014	0.017	0.040	5.0
PCB-1254	3.04	0.000	0.000	0.000	0.005	0.034	0.059	0.098	1.4
PCB-1260	3.04	0.000	0.000	0.000	0.008	0.065	0.146	0.219	3.1
Se	3.04	0.000	0.006	0.006	0.000	0.009	0.012	0.033	2.8
Zn	3.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
As	4.01	0.000	0.002	0.002	0.000	0.007	0.011	0.022	1.1
Be	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	4.01	0.000	0.000	0.000	0.001	0.009	0.012	0.022	0.0
Cu	4.01	0.001	0.066	0.066	0.000	0.253	0.042	0.429	0.1
Hg	4.01	0.000	0.005	0.005	0.001	0.006	0.013	0.029	3.7
PCB-1254	4.01	0.000	0.000	0.000	0.005	0.035	0.057	0.097	1.4
PCB-1260	4.01	0.000	0.000	0.000	0.004	0.067	0.103	0.174	2.5
Se	4.01	0.000	0.014	0.014	0.000	0.007	0.027	0.063	5.3
Zn	4.01	0.003	0.314	0.314	0.000	0.544	0.298	1.473	0.0
As	4.04	0.000	0.000	0.001	0.000	0.011	0.007	0.019	1.0
Be	4.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Bis(2ethylhexyl) phthalate	4.04	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	4.04	0.000	0.001	0.000	0.001	0.014	0.013	0.029	0.0
Cu	4.04	0.000	0.000	0.359	0.000	1.693	0.153	2.205	0.4
DDD	4.04	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.0
DDE	4.04	0.000	0.000	0.000	0.000	0.001	0.006	0.007	0.0
Hg	4.04	0.000	0.000	0.001	0.000	0.005	0.006	0.013	1.6

Table F4.10 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d)							NOAEL HQ[a]
		Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	
PCB-1254	4.04	0.000	0.002	0.000	0.002	0.019	0.058	0.081	1.2
PCB-1260	4.04	0.000	0.002	0.000	0.003	0.051	0.122	0.178	2.5
Se	4.04	0.000	0.000	0.009	0.000	0.013	0.010	0.032	2.7
Zn	4.04	0.001	0.000	0.355	0.000	0.284	0.290	0.930	0.0
Aldrin	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	5	0.000	0.000	0.002	0.000	0.007	0.008	0.017	0.8
Be	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	5	0.000	0.001	0.000	0.001	0.007	0.013	0.022	0.0
Cu	5	0.000	0.000	1.621	0.000	0.000	0.106	1.728	0.3
DDD	5	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.0
DDE	5	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.0
DDT	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	5	0.000	0.000	0.001	0.000	0.004	0.006	0.010	1.3
PCB-1254	5	0.000	0.001	0.000	0.003	0.013	0.050	0.068	1.0
PCB-1260	5	0.000	0.001	0.000	0.003	0.031	0.122	0.157	2.2
Se	5	0.000	0.000	0.007	0.000	0.012	0.009	0.027	2.3
Zn	5	0.000	0.000	0.742	0.000	0.270	0.325	1.337	0.0
Chlordane	6	0.000	0.001	0.001	0.001	0.002	0.002	0.007	0.0
PCB-1254	6	0.000	0.003	0.003	0.003	0.005	0.005	0.019	0.3
PCB-1260	6	0.000	0.003	0.003	0.003	0.005	0.005	0.019	0.3
As	10	0.000	0.000	0.002	0.003	0.012	0.007	0.024	1.2
Be	10	0.000	0.000	0.000	0.000	0.000	0.000	0.001	
Bis(2ethylhexyl) phthalate	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Chlordane	10	0.000	0.001	0.000	0.001	0.007	0.008	0.018	0.0
Cu	10	0.000	0.000	0.000	0.037	0.000	0.000	0.037	0.0
DDD	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
DDE	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Hg	10	0.000	0.000	0.001	0.002	0.005	0.010	0.018	2.2
PCB-1254	10	0.000	0.000	0.000	0.001	0.007	0.007	0.015	0.2
PCB-1260	10	0.000	0.000	0.000	0.000	0.018	0.025	0.044	0.6
Se	10	0.000	0.000	0.008	0.011	0.014	0.016	0.049	4.1
Zn	10	0.000	0.000	0.270	0.328	0.343	0.509	1.450	0.0
Aldrin	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
As	13	0.000	0.002	0.002	0.001	0.000	0.000	0.004	0.2
Bis(2ethylhexyl)p hthalate	13	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0
Chlordane	13	0.000	0.000	0.000	0.003	0.010	0.011	0.025	0.0
Cu	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0

Table F4.10 (continued)

Analyte	Subreach	Exposure estimate (mg/kg/d) Water	0–10 cm fish	10–20 cm fish	20–30 cm fish	30–40 cm fish	>40 cm fish	Total	NOAEL HQ[a]
DDE	13	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.0
Hg	13	0.000	0.004	0.004	0.002	0.000	0.000	0.010	1.2
PCB-1254	13	0.000	0.000	0.000	0.007	0.020	0.004	0.031	0.4
PCB-1260	13	0.000	0.000	0.000	0.032	0.097	0.097	0.226	3.2
Se	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
Zn	13	0.001	0.316	0.316	0.158	0.000	0.000	0.791	0.0
As	15	0.000	0.003	0.003	0.003	0.004	0.006	0.020	1.0
Be	15	0.000	0.000	0.000	0.000	0.000	0.001	0.001	
Chlordane	15	0.000	0.000	0.000	0.011	0.034	0.083	0.128	0.2
DDD	15	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.0
Hg	15	0.000	0.001	0.001	0.002	0.004	0.014	0.024	3.0
PCB-1254	15	0.000	0.000	0.000	0.003	0.009	0.025	0.036	0.5
PCB-1260	15	0.000	0.000	0.000	0.005	0.015	0.127	0.148	2.1
Se	15	0.000	0.015	0.015	0.014	0.019	0.000	0.063	5.3
Zn	15	0.000	0.383	0.383	0.318	0.378	0.429	1.889	0.0
As	18	0.000	0.000	0.001	0.000	0.011	0.011	0.022	1.1
Be	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Chlordane	18	0.000	0.001	0.000	0.001	0.017	0.015	0.034	0.0
Hg	18	0.000	0.000	0.001	0.000	0.005	0.007	0.012	1.5
PCB-1254	18	0.000	0.002	0.000	0.003	0.028	0.052	0.084	1.2
PCB-1260	18	0.000	0.001	0.000	0.004	0.066	0.121	0.193	2.8
Se	18	0.000	0.000	0.006	0.000	0.008	0.007	0.021	1.7
Zn	18	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.0

[a] NOAEL HQ = No observed adverse effect level hazard quotient.

Table F4.11. Clinch River subreaches, endpoints, and contaminants where hazard quotients (HQs) >1 were observed and Monte Carlo simulations were performed

Subreach	Subreach Name	Endpoint			
		Osprey	Great Blue Heron	Mink	River Otter
10	Norris Reservoir	Hg	Hg		As, Hg, Se
0	Upper Melton Hill Reservoir	Hg	Hg	Se	As, Hg, PCBs, Se
1	Lower Melton Hill Reservoir			Se	As, Se
2.01	Clinch River: Melton Hill Dam	Hg	Cu	Se	As, Cu, Hg, PCBs, Se
2.02	Clinch River: White Oak Creek	Hg	Hg	Se	As, Hg, PCBs, Se
2.04	Clinch River: Grassy Creek	PCBs	PCBs	PCBs	PCBs
13	Upper Poplar Creek	Hg, PCBs	Hg	Hg	Hg, PCBs
3.01	Poplar Creek: East Fork Poplar Creek	DDE, Hg, PCBs	Hg	Hg, Se	Hg, PCBs, Se
3.02	Poplar Creek: Mitchell Branch	Hg, PCBs	Hg, PCBs	Hg, Se	As, Hg, PCBs, Se
3.03	Poplar Creek: CNF	Hg	Hg	Hg	Hg, PCBs
3.04	Poplar Creek: Mouth	Hg	Hg	Hg, Se	As, Hg, PCBs, Se
4.01	Clinch River: Poplar Creek	Hg	Hg	Hg, Se	As, Hg, PCBs, Se
4.04	Clinch River: Mouth	Hg	Hg		As, Hg, PCBs, Se
18	Tennessee River Arm	Hg			As, Hg, PCBs, Se
5	Lower Watts Bar	Hg			Hg, PCBs, Se
15	Chickamauga Reservoir	Hg	Hg	Se	As, Hg, PCBs, Se

Table F4.12. Mean and standard errors for concentrations of contaminants of concern for piscivorous wildlife in water and fish from the Clinch River/Poplar Creek system

Analyte	Subreach	Water (mg/L)		0–10 cm (mg/kg)		10–20 cm (mg/kg)		20–30 cm (mg/kg)		30–40 cm (mg/kg)		>40 cm (mg/kg)	
		Mean	Standard error	Mean	Standard Error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
As	0	0.046	0.004	0.081	0.006	0.081	0.006	0.196	0.000	0.182	0.014	0.203	0.035
Hg	0	0.000	0.000	0.045	0.006	0.045	0.006	0.052	0.000	0.066	0.028	0.116	0.022
PCB-1254	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.114	0.000	0.324	0.228
PCB-1260	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.764	0.000	5.205	2.277
Se	0	0.000	0.000	0.816	0.044	0.816	0.044	0.578	0.000	0.610	0.075	0.589	0.032
As	1	0.028	0.003	0.087	0.007	0.087	0.007	0.000	0.000	0.196	0.056	0.112	0.000
Se	1	0.000	0.000	0.915	0.039	0.915	0.039	0.000	0.000	1.033	0.144	0.952	0.000
As	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.252	0.022	0.504	0.045	0.336	0.058
Cu	2.01	0.004	0.001	39.376	37.304	39.376	37.304	19.688	18.652	0.000	0.000	0.000	0.000
Hg	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.006	0.063	0.012	0.199	0.036
PCB-1254	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.180	0.011	0.359	0.022	0.733	0.166
PCB-1260	2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.249	0.024	0.498	0.048	0.969	0.273
Se	2.01	0.000	0.000	0.502	0.056	0.502	0.056	0.452	0.053	0.401	0.051	0.321	0.044
As	2.02	0.021	0.005	0.056	0.006	0.056	0.006	0.025	0.000	0.357	0.032	0.338	0.058
Hg	2.02	0.000	0.000	0.062	0.005	0.062	0.005	0.044	0.009	0.125	0.017	0.270	0.050
PCB-1016	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.094	0.006	0.000	0.000	0.000	0.000
PCB-1254	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.118	0.017	0.958	0.201	2.218	0.172
PCB-1260	2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.155	0.037	1.209	0.432	3.836	0.488
Se	2.02	0.000	0.000	0.501	0.042	0.501	0.042	0.321	0.107	0.443	0.037	0.479	0.041

Table F4.12 (continued)

Analyte	Subreach	Water (mg/L)		0–10 cm (mg/kg)		10–20 cm (mg/kg)		20–30 cm (mg/kg)		30–40 cm (mg/kg)		>40 cm (mg/kg)	
		Mean	Standard error	Mean	Standard Error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
PCB-1254	2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.533	0.191
PCB-1260	2.04	0.000	0.000	3.849	2.430	3.849	2.430	3.849	2.430	3.849	2.430	3.604	1.477
DDE	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.043	0.021	0.086	0.042	0.023	0.003
Hg	3.01	0.000	0.000	0.334	0.034	0.334	0.034	0.401	0.017	0.469	0.000	1.272	0.000
PCB-1016	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.381	0.000
PCB-1254	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.237	0.045	0.474	0.089	1.073	0.227
PCB-1260	3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.863	0.286	1.727	0.572	2.548	0.341
Se	3.01	0.000	0.000	0.545	0.028	0.545	0.028	0.273	0.014	0.000	0.000	0.214	0.000
As	3.02	0.002	0.000	0.084	0.008	0.084	0.008	0.207	0.051	0.203	0.082	0.074	0.001
Hg	3.02	0.000	0.000	0.321	0.027	0.321	0.027	0.286	0.090	0.364	0.072	0.884	0.116
PCB-1254	3.02	0.000	0.000	0.000	0.000	0.000	0.000	1.143	0.381	1.143	0.220	1.238	1.048
PCB-1260	3.02	0.000	0.000	0.000	0.000	0.000	0.000	1.092	0.546	1.092	0.315	1.638	1.092
Se	3.02	0.000	0.000	0.487	0.056	0.487	0.056	0.398	0.114	0.216	0.071	0.321	0.000
Hg	3.03	0.000	0.000	0.191	0.027	0.191	0.027	0.270	0.000	0.000	0.000	0.346	0.033
PCB-1254	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.305	0.076	0.579	0.214
PCB-1260	3.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.621	0.527	3.245	1.029
As	3.04	0.001	0.000	0.074	0.016	0.074	0.016	0.000	0.000	0.334	0.039	0.263	0.035
Hg	3.04	0.000	0.000	0.206	0.026	0.206	0.026	0.000	0.000	0.345	0.082	0.451	0.077
PCB-1254	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.206	0.033	0.930	0.162	1.666	0.254

Table F4.12 (continued)

Analyte	Subreach	Water (mg/L)		0–10 cm (mg/kg)		10–20 cm (mg/kg)		20–30 cm (mg/kg)		30–40 cm (mg/kg)		>40 cm (mg/kg)	
		Mean	Standard error	Mean	Standard Error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
PCB-1260	3.04	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.089	1.689	0.364	4.265	0.537
Se	3.04	0.000	0.000	0.290	0.019	0.290	0.019	0.000	0.000	0.294	0.023	0.347	0.039
As	4.01	0.019	0.005	0.073	0.013	0.073	0.013	0.000	0.000	0.164	0.044	0.209	0.087
Hg	4.01	0.000	0.000	0.204	0.031	0.204	0.031	0.051	0.002	0.174	0.024	0.278	0.070
PCB-1254	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.213	0.029	0.971	0.154	1.538	0.264
PCB-1260	4.01	0.000	0.000	0.000	0.000	0.000	0.000	0.157	0.038	1.713	0.388	2.760	0.493
Se	4.01	0.000	0.000	0.642	0.065	0.642	0.065	0.000	0.000	0.192	0.058	0.524	0.183
As	4.04	0.002	0.000	0.000	0.000	0.083	0.008	0.000	0.000	0.295	0.045	0.224	0.024
Hg	4.04	0.000	0.000	0.000	0.000	0.074	0.010	0.000	0.000	0.147	0.021	0.204	0.018
PCB-1254	4.04	0.000	0.000	0.100	0.000	0.000	0.000	0.106	0.008	0.539	0.077	1.840	0.143
PCB-1260	4.04	0.000	0.000	0.090	0.000	0.000	0.000	0.159	0.012	1.267	0.313	3.812	0.322
Se	4.04	0.000	0.000	0.000	0.000	0.477	0.019	0.000	0.000	0.404	0.051	0.312	0.033
Hg	5	0.000	0.000	0.000	0.000	0.048	0.003	0.000	0.000	0.112	0.012	0.178	0.013
PCB-1254	5	0.000	0.000	0.080	0.003	0.000	0.000	0.123	0.029	0.384	0.047	1.606	0.111
PCB-1260	5	0.000	0.000	0.085	0.002	0.000	0.000	0.118	0.016	0.889	0.126	3.889	0.267
Se	5	0.000	0.000	0.000	0.000	0.459	0.023	0.000	0.000	0.394	0.054	0.320	0.024
As	10	0.000	0.000	0.000	0.000	0.073	0.010	0.124	0.017	0.381	0.023	0.200	0.036
Hg	10	0.000	0.000	0.000	0.000	0.045	0.004	0.084	0.007	0.166	0.011	0.299	0.025

Table F4.12 (continued)

Analyte	Subreach	Water (mg/L)		0–10 cm (mg/kg)		10–20 cm (mg/kg)		20–30 cm (mg/kg)		30–40 cm (mg/kg)		>40 cm (mg/kg)	
		Mean	Standard error	Mean	Standard Error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
Se	10	0.000	0.000	0.000	0.000	0.417	0.028	0.476	0.057	0.493	0.020	0.518	0.027
Hg	13	0.000	0.000	0.119	0.047	0.119	0.047	0.059	0.023	0.000	0.000	0.000	0.000
PCB-1254	13	0.000	0.000	0.000	0.000	0.000	0.000	0.362	0.000	0.724	0.000	0.152	0.000
PCB-1260	13	0.000	0.000	0.000	0.000	0.000	0.000	0.683	0.164	1.365	0.328	1.884	0.246
As	15	0.000	0.000	0.130	0.026	0.130	0.026	0.115	0.022	0.100	0.018	0.112	0.014
Hg	15	0.000	0.000	0.060	0.010	0.060	0.010	0.095	0.010	0.131	0.010	0.208	0.048
PCB-1254	15	0.000	0.000	0.000	0.000	0.000	0.000	0.152	0.000	0.305	0.000	0.559	0.111
PCB-1260	15	0.000	0.000	0.000	0.000	0.000	0.000	0.273	0.000	0.546	0.000	2.657	0.639
Se	15	0.000	0.000	0.754	0.029	0.754	0.029	0.657	0.027	0.560	0.025	0.000	0.000
As	18	0.000	0.000	0.000	0.000	0.055	0.005	0.000	0.000	0.301	0.049	0.336	0.024
Hg	18	0.000	0.000	0.000	0.000	0.045	0.003	0.000	0.000	0.149	0.012	0.201	0.018
PCB-1254	18	0.000	0.000	0.090	0.000	0.000	0.000	0.121	0.013	0.780	0.129	1.565	0.159
PCB-1260	18	0.000	0.000	0.070	0.000	0.000	0.000	0.185	0.032	1.462	0.512	3.630	0.404
Se	18	0.000	0.000	0.000	0.000	0.266	0.021	0.000	0.000	0.214	0.034	0.240	0.014

Table F4.13. Results of Monte Carlo simulation of piscivore contaminant exposure estimates in the Clinch River/Poplar Creek system

Endpoint	Subreach	Analyte	Simulation results (mg/kg/d)		
			Mean	Standard deviation	80th percentile
Osprey	10	Hg	0.014	0.001	0.016
Osprey	0	Hg	0.010	0.001	0.011
Osprey	2.01	Hg	0.004	0.001	0.005
Osprey	2.02	Hg	0.012	0.001	0.013
Osprey	13	Hg	0.016	0.005	0.020
Osprey	3.01	Hg	0.075	0.007	0.082
Osprey	3.02	Hg	0.062	0.010	0.070
Osprey	3.03	Hg	0.042	0.004	0.046
Osprey	3.04	Hg	0.024	0.003	0.026
Osprey	4.01	Hg	0.026	0.003	0.028
Osprey	4.04	Hg	0.008	0.001	0.009
Osprey	18	Hg	0.006	0.001	0.007
Osprey	5	Hg	0.006	0.001	0.006
Osprey	15	Hg	0.016	0.002	0.018
Osprey	2.04	PCB	0.756	0.316	1.011
Osprey	13	PCB	0.118	0.011	0.128
Osprey	3.01	PCB	0.080	0.010	0.089
Osprey	3.02	PCB	0.242	0.067	0.297
Osprey	3.01	DDT	0.006	0.001	0.007
Great Blue Heron	10	Hg	0.006	0.001	0.007
Great Blue Heron	0	Hg	0.009	0.002	0.010
Great Blue Heron	2.02	Hg	0.012	0.002	0.013
Great Blue Heron	13	Hg	0.022	0.007	0.027
Great Blue Heron	3.01	Hg	0.068	0.012	0.077
Great Blue Heron	3.02	Hg	0.062	0.011	0.071
Great Blue Heron	3.03	Hg	0.040	0.008	0.045
Great Blue Heron	3.04	Hg	0.035	0.007	0.040
Great Blue Heron	4.01	Hg	0.036	0.008	0.041
Great Blue Heron	4.04	Hg	0.007	0.001	0.008
Great Blue Heron	15	Hg	0.013	0.002	0.014

Table F4.13 (continued)

Endpoint	Subreach	Analyte	Simulation results (mg/kg/d)		
			Mean	Standard deviation	80th percentile
Great Blue Heron	2.04	PCB	0.738	0.329	0.984
Great Blue Heron	3.02	PCB	0.061	0.021	0.079
Great Blue Heron	2.01	Cu	7.354	4.775	11.162
Mink	0	Se	0.067	0.035	0.092
Mink	1	Se	0.074	0.036	0.099
Mink	2.01	Se	0.041	0.020	0.055
Mink	2.02	Se	0.040	0.020	0.055
Mink	3.01	Se	0.044	0.022	0.060
Mink	3.02	Se	0.039	0.019	0.054
Mink	3.04	Se	0.023	0.011	0.032
Mink	4.01	Se	0.052	0.025	0.071
Mink	15	Se	0.063	0.032	0.085
Mink	13	Hg	0.010	0.006	0.014
Mink	3.01	Hg	0.027	0.013	0.037
Mink	3.02	Hg	0.026	0.013	0.035
Mink	3.03	Hg	0.015	0.008	0.021
Mink	3.04	Hg	0.017	0.008	0.022
Mink	4.01	Hg	0.017	0.008	0.023
Mink	2.04	PCB	0.311	0.223	0.475
River Otter	10	As	0.020	0.003	0.022
River Otter	0	As	0.021	0.003	0.024
River Otter	1	As	0.014	0.002	0.016
River Otter	2.01	As	0.028	0.004	0.032
River Otter	2.02	As	0.024	0.004	0.027
River Otter	3.02	As	0.015	0.003	0.018
River Otter	3.04	As	0.020	0.003	0.022
River Otter	4.01	As	0.015	0.003	0.017
River Otter	4.04	As	0.016	0.002	0.018
River Otter	18	As	0.019	0.003	0.021
River Otter	15	As	0.013	0.002	0.015
River Otter	10	Hg	0.016	0.002	0.017
River Otter	0	Hg	0.007	0.001	0.008
River Otter	2.01	Hg	0.008	0.001	0.009
River Otter	2.02	Hg	0.014	0.002	0.016
River Otter	13	Hg	0.006	0.002	0.007
River Otter	3.01	Hg	0.070	0.008	0.077

Table F4.13 (continued)

Endpoint	Subreach	Analyte	Simulation results (mg/kg/d)		
			Mean	Standard deviation	80th percentile
River Otter	3.02	Hg	0.053	0.008	0.059
River Otter	3.03	Hg	0.022	0.003	0.025
River Otter	3.04	Hg	0.030	0.005	0.035
River Otter	4.01	Hg	0.021	0.003	0.024
River Otter	4.04	Hg	0.011	0.002	0.013
River Otter	18	Hg	0.011	0.001	0.012
River Otter	5	Hg	0.009	0.001	0.010
River Otter	15	Hg	0.014	0.002	0.015
River Otter	10	Se	0.045	0.005	0.050
River Otter	0	Se	0.064	0.008	0.071
River Otter	1	Se	0.063	0.008	0.070
River Otter	2.01	Se	0.049	0.006	0.055
River Otter	2.02	Se	0.051	0.007	0.056
River Otter	3.01	Se	0.032	0.004	0.035
River Otter	3.02	Se	0.041	0.006	0.045
River Otter	3.04	Se	0.029	0.004	0.032
River Otter	4.01	Se	0.045	0.008	0.051
River Otter	4.04	Se	0.029	0.004	0.032
River Otter	18	Se	0.018	0.002	0.019
River Otter	5	Se	0.029	0.004	0.032
River Otter	15	Se	0.056	0.007	0.062
River Otter	0	PCB	0.161	0.066	0.215
River Otter	2.01	PCB	0.081	0.013	0.092
River Otter	2.02	PCB	0.240	0.035	0.269
River Otter	2.04	PCB	0.445	0.121	0.547
River Otter	13	PCB	0.139	0.020	0.156
River Otter	3.01	PCB	0.193	0.031	0.219
River Otter	3.02	PCB	0.185	0.052	0.228
River Otter	3.03	PCB	0.191	0.040	0.223
River Otter	3.04	PCB	0.253	0.037	0.283
River Otter	4.01	PCB	0.205	0.031	0.231
River Otter	4.04	PCB	0.220	0.029	0.245
River Otter	18	PCB	0.220	0.033	0.249
River Otter	5	PCB	0.199	0.025	0.222
River Otter	15	PCB	0.124	0.024	0.142
River Otter	2.01	Cu	1.681	1.023	2.518

Table F4.14. Estimated NOAELs[a] and LOAELs[a] for osprey and great blue heron

			Experimental information				Estimated NOAEL (mg/kg/d)		Estimated LOAEL (mg/kg/d)	
Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation	Osprey	Great Blue Heron	Osprey	Great Blue Heron
Arsenic	arsenite	mallard duck	5.14 128d	12.84 128d	mortality	USFWS 1964	4.49	3.9	11.2	9.6
Copper	oxide	chicken	33.2 10 wk	46.97 10 wk	growth/ mortality	Mehring et al. 1960	23.6	20.25	33.4	28.6
Mercury	methyl	mallard duck	0.0064[b] 3 gen.	0.064 3 gen.	reproduction	Heinz 1979	0.006	0.005	0.056	0.048
Selenium	selenite	mallard duck	0.5 10 wk	1.0 10 wk	reproduction	Heinz et al. 1987	0.44	0.38	0.87	0.75
Zinc	zinc sulfate	chicken	14.5 44 wk	130.9 44 wk	reproduction	Stahl et al. 1990	15.8	13.5	138.2	118.5
Aldrin	dieldrin	barn owl	0.077 2 yr		reproduction	Mendenhall et al. 1983	0.05	0.045		
Bis(2-ethylhexyl) Phthalate		ring dove	1.11 4 wk		reproduction	Peakall 1974	0.53	0.45		
Chlordane		redwinged blackbird	2.14 84 d	10.7 84 d	mortality	Stickel et al. 1983	0.76	0.65	3.8	3.2
DDT and metabolites		Brown Pelican	0.0028[c] >1 yr	0.028[c] >1 yr	reproduction	Anderson et al. 1975	0.004	0.003	0.037	0.03

Table F4.14 (continued)

Contaminant	Experimental information						Estimated NOAEL (mg/kg/d)		Estimated LOAEL (mg/kg/d)	
	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation	Osprey	Great Blue Heron	Osprey	Great Blue Heron
PCBs	Aroclor 1254	Ring-necked Pheasant	0.18[b] 17 wk	0.18 17 wk	reproduction	Dahlgren et al. 1972	0.16	0.14	1.6	1.4

[a] NOAEL = No observed adverse effect level; LOAEL = Lowest observed adverse effect level.
[b] Estimated NOAEL: LOAEL to NOAEL factor of 10 applied.
[c] NOAEL and LOAEL as determined in EPA 1993b.

Table F4.15. Estimated NOAELs[a] and LOAELs[a] for mink and river otter

Contaminant	Experimental information						Estimated NOAEL (mg/kg/d)		Estimated LOAEL (mg/kg/d)	
	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation	Mink	River Otter	Mink	River Otter
Arsenic	As+3	mouse	0.126[b] 3 gen.	1.26 3 gen.	reproduction	Schroeder and Mitchner 1971	0.04	0.02	0.4	0.2
Beryllium	sulfate	rat	0.66 1126 d		longevity/ wt. loss	Schroeder and Mitchner 1975	0.47	0.24		
Copper	sulfate	mink	11.71 1 yr	15.14 1 yr	reproduction	Aulerich et al. 1982	11.7	5.9	15.1	7.6
Mercury	methyl	mink	0.015[c] 93 d		mortality	Wobeser et al. 1976	0.015	0.008		
Mercury	methyl	rat		0.16 3 gen.	reproduction	Verschuuren et al. 1976			0.11	0.06
Selenium	selenate	mouse	0.075[b] 3 gen	0.75 3 gen	reproduction	Schroeder and Mitchner 1971	0.024	0.012	0.24	0.12
Zinc	oxide	rat	160 gestation	320 gestation	reproduction	Schlicker and Cox 1968	113.2	57	226.3	114
Aldrin		rat	0.2 3 gen	1.0 3 gen	reproduction	Treon and Cleveland 1955	0.14	0.07	0.7	0.36
Bis(2-ethylhexyl) Phthalate		mouse	18.33 105 d	183.3 105 d	reproduction	Lamb et al. 1987	5.76	2.88	57.6	28.8

Table F4.15 (continued)

Contaminant	Experimental information						Estimated NOAEL (mg/kg/d)		Estimated LOAEL (mg/kg/d)	
	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation	Mink	River Otter	Mink	River Otter
Chlordane		mouse	4.6 6 gen	9.2 6 gen	reproduction	WHO 1984	1.4	0.73	2.9	1.5
DDT and metabolites		rat	0.8 2 yr	4.0 2 yr	reproduction	Fitzhugh 1948	0.57	0.29	2.8	1.4
PCB's	Aroclor 1254	mink	0.137 4.5 mo.	0.685 4.5 mo.	reproduction	Aulerich and Ringer 1987	0.14	0.07	0.69	0.35

[a] NOAEL = No observed adverse effect level; LOAEL = Lowest observed adverse effect level.
[b] Estimated NOAEL: LOAEL to NOAEL factor of 10 applied.
[c] Estimated NOAEL: subchronic to chronic factor of 10 applied.

Table F4.16. Water benchmarks for osprey, great blue heron, and mink[a]

Analyte	Water benchmark (mg/L)			
	Osprey	Great Blue Heron	Mink	River Otter
1,1-Dichloroethane	-	-	-	
1,2-Dichloroethene	-	-	143.5	89.4
Acetone	-	-	71.4	44.5
Aluminum	1026.1	1020.3	6.1	3.8
Antimony	-	-	0.4	0.25
Arsenic	87.5	87.0	0.4	0.25
Barium	177.1	176.1	38.8	24.4
Beryllium	-	-	4.7	2.9
Bis(2-ethylhexyl)phthalate	10.2	10.2	58.2	36.2
Cadmium	25.9	25.8	0.6	0.36
Chlordane, total	14.7	14.6	14.5	9.1
Chloroform	-	-	107.2	66.8
Chromium	18.3	18.2	23.4	14.6
Cobalt	-	-	-	
Copper	460.1	457.5	118.3	73.6
Di-n-butylphthalate	1.1	1.1	1746.6	1088
Diethylphthalate	-	-	14553	9067
Endosulfan sulfate	125.9	125.2	1.1	0.67
Endrin ketone	5.4	5.3	0.3	0.18
Fluoride	75.6	75.2	316.9	197
Lead	33.5	33.3	57.1	35.6
Manganese	-	-	628.6	391
Mercury	0.11	0.11	0.15	0.09
Methoxychlor	-	-	28.6	17.8
Methyl Mercury	0.11	0.11	0.15	0.09
Methylene chloride	-	-	41.8	26
Nickel	1216.2	1209.3	285.7	178
Nitrate	-	-	4872.6	3035
PCB-1254	3.1	3.1	1.4	0.88

Table F4.16 (continued)

Analyte	Water benchmark (mg/L)			
	Osprey	Great Blue Heron	Mink	River Otter
Selenium	8.5	8.5	0.24	0.15
Tetrachloroethene	-	-	4.45	2.8
Thallium	-	-	0.05	0.033
Toluene	-	-	82.5	51.4
Trichloroethene	-	-	2.2	1.4
Uranium	293.5	291.8	9.5	5.9
Vanadium	204.2	203.1	1.4	0.85
Vinyl chloride	-	-	1.2	0.76
Zinc	51.1	50.8	1.2	712
alpha-BHC	5.1	5.1	0.14	0.09

[a] Water benchmarks for great blue heron and mink from Opresko et al. (1984). Benchmarks for osprey and river otter calculated using methods and data presented in Opresko et al. (1984) and body weight and water ingestion rates presented in Sect. 6.4.1.1.

Table F4.17. Surface water concentrations and hazard assessment for mink, great blue heron, and osprey

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
1,1-Dichloroethane	21	0.0012	-[c]	-	-	-
1,2-Dichloroethene	21	0.02002	-	-	0.0001	0.0002
Acetone	0	0.0097	-	-	0.0001	0.0002
Acetone	1	0.007	-	-	0.0001	0.0002
Acetone	2.02	0.014	-	-	0.0002	0.0003
Acetone	3.03	0.013	-	-	0.0002	0.0003
Acetone	13	0.045	-	-	0.0006	0.0010
Acetone	18	0.003	-	-	0.0000	0.0001
Acetone	20.02	0.003	-	-	0.0000	0.0001
Acetone	22	0.0078	-	-	0.0001	0.0002
Aluminum	0	0.50129	0.0005	0.0005	0.0818	0.1319
Aluminum	1	0.33313	0.0003	0.0003	0.0544	0.0877
Aluminum	2.01	0.29901	0.0003	0.0003	0.0488	0.0787
Aluminum	2.02	0.34387	0.0003	0.0003	0.0561	0.0905
Aluminum	2.03	0.32668	0.0003	0.0003	0.0533	0.0860
Aluminum	2.04	0.30986	0.0003	0.0003	0.0506	0.0815
Aluminum	3.01	0.53873	0.0005	0.0005	0.0879	0.1418
Aluminum	3.02	0.47787	0.0005	0.0005	0.0780	0.1258
Aluminum	3.03	0.65273	0.0006	0.0006	0.1065	0.1718
Aluminum	3.04	0.48615	0.0005	0.0005	0.0793	0.1279
Aluminum	4.01	0.43062	0.0004	0.0004	0.0703	0.1133
Aluminum	4.02	0.26664	0.0003	0.0003	0.0435	0.0702
Aluminum	4.04	0.29473	0.0003	0.0003	0.0481	0.0776
Aluminum	7.01	0.23407	0.0002	0.0002	0.0382	0.0616
Aluminum	7.02	0.19494	0.0002	0.0002	0.0318	0.0513
Aluminum	8	0.25849	0.0003	0.0003	0.0422	0.0680
Aluminum	13	0.491	0.0005	0.0005	0.0801	0.1292
Aluminum	18	0.93591	0.0009	0.0009	0.1527	0.2463

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Aluminum	20.01	0.347	0.0003	0.0003	0.0566	0.0913
Aluminum	20.02	0.30419	0.0003	0.0003	0.0496	0.0801
Aluminum	21	2.1069	0.0021	0.0021	0.3438	0.5544
Aluminum	22	1.41099	0.0014	0.0014	0.2302	0.3713
Antimony	2.01	0.0013	-	-	0.0033	0.0052
Antimony	3.01	0.00142	-	-	0.0036	0.0057
Antimony	3.02	0.0012	-	-	0.0030	0.0048
Antimony	3.04	0.00175	-	-	0.0044	0.0070
Antimony	4.01	0.00176	-	-	0.0044	0.0070
Antimony	4.02	0.00166	-	-	0.0042	0.0066
Antimony	7.02	0.0012	-	-	0.0030	0.0048
Antimony	13	0.00118	-	-	0.0030	0.0047
Arsenic	0	0.05	0.0006	0.0006	0.1645	0.2000
Arsenic	1	0.0012	0.0000	0.0000	0.0039	0.0048
Arsenic	2.02	0.0011	0.0000	0.0000	0.0036	0.0044
Arsenic	2.04	0.0012	0.0000	0.0000	0.0039	0.0048
Arsenic	3.02	0.0014	0.0000	0.0000	0.0046	0.0056
Arsenic	3.03	0.00145	0.0000	0.0000	0.0048	0.0058
Arsenic	3.04	0.0012	0.0000	0.0000	0.0039	0.0048
Arsenic	4.01	0.00107	0.0000	0.0000	0.0035	0.0043
Arsenic	4.02	0.0013	0.0000	0.0000	0.0043	0.0052
Arsenic	4.04	0.00166	0.0000	0.0000	0.0055	0.0066
Arsenic	7.01	0.00523	0.0001	0.0001	0.0172	0.0209
Arsenic	7.02	0.00129	0.0000	0.0000	0.0042	0.0052
Arsenic	13	0.00366	0.0000	0.0000	0.0120	0.0146
Arsenic	20.01	0.0545	0.0006	0.0006	0.1793	0.2180
Barium	0	0.07445	0.0004	0.0004	0.0019	0.0031
Barium	1	0.03457	0.0002	0.0002	0.0009	0.0014

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Barium	2.01	0.03561	0.0002	0.0002	0.0009	0.0015
Barium	2.02	0.03178	0.0002	0.0002	0.0008	0.0013
Barium	2.03	0.03045	0.0002	0.0002	0.0008	0.0012
Barium	2.04	0.03302	0.0002	0.0002	0.0009	0.0014
Barium	3.01	0.03636	0.0002	0.0002	0.0009	0.0015
Barium	3.02	0.040289	0.0002	0.0002	0.0010	0.0017
Barium	3.03	0.037231	0.0002	0.0002	0.0010	0.0015
Barium	3.04	0.03642	0.0002	0.0002	0.0009	0.0015
Barium	4.01	0.03123	0.0002	0.0002	0.0008	0.0013
Barium	4.02	0.028902	0.0002	0.0002	0.0007	0.0012
Barium	4.04	0.028776	0.0002	0.0002	0.0007	0.0012
Barium	7.01	0.037219	0.0002	0.0002	0.0010	0.0015
Barium	7.02	0.028599	0.0002	0.0002	0.0007	0.0012
Barium	8	0.029057	0.0002	0.0002	0.0007	0.0012
Barium	13	0.045121	0.0003	0.0003	0.0012	0.0018
Barium	18	0.030569	0.0002	0.0002	0.0008	0.0013
Barium	20.01	0.034383	0.0002	0.0002	0.0009	0.0014
Barium	20.02	0.090238	0.0005	0.0005	0.0023	0.0037
Barium	21	0.061382	0.0003	0.0003	0.0016	0.0025
Barium	22	0.079053	0.0004	0.0004	0.0020	0.0032
Beryllium	0	0.0012	-	-	0.0003	0.0004
Beryllium	1	0.0014	-	-	0.0003	0.0005
Beryllium	20.02	0.001	-	-	0.0002	0.0003
Bis(2-ethylhexyl)phthalate	1	0.002239	0.0002	0.0002	0.0000	0.0001
Bis(2-ethylhexyl)phthalate	2.02	0.004322	0.0004	0.0004	0.0001	0.0001
Bis(2-ethylhexyl)phthalate	2.03	0.001	0.0001	0.0001	0.0000	0.0000
Bis(2-ethylhexyl)phthalate	2.04	0.07	0.0068	0.0069	0.0012	0.0019
Bis(2-ethylhexyl)phthalate	3.01	0.002391	0.0002	0.0002	0.0000	0.0001

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a] Osprey	Heron	Mink	River Otter
Bis(2-ethylhexyl)phthalate	3.02	0.004339	0.0004	0.0004	0.0001	0.0001
Bis(2-ethylhexyl)phthalate	3.03	0.002391	0.0002	0.0002	0.0000	0.0001
Bis(2-ethylhexyl)phthalate	3.04	0.00169	0.0002	0.0002	0.0000	0.0000
Bis(2-ethylhexyl)phthalate	4.01	0.001	0.0001	0.0001	0.0000	0.0000
Bis(2-ethylhexyl)phthalate	4.02	0.00301	0.0003	0.0003	0.0001	0.0001
Bis(2-ethylhexyl)phthalate	4.04	0.007913	0.0008	0.0008	0.0001	0.0002
Bis(2-ethylhexyl)phthalate	7.01	0.001	0.0001	0.0001	0.0000	0.0000
Bis(2-ethylhexyl)phthalate	7.02	0.002342	0.0002	0.0002	0.0000	0.0001
Bis(2-ethylhexyl)phthalate	10	0.005	0.0005	0.0005	0.0001	0.0001
Bis(2-ethylhexyl)phthalate	13	0.004208	0.0004	0.0004	0.0001	0.0001
Cadmium	22	0.00036	0.0000	0.0000	0.0006	0.0010
Chlordane, total	13	0.000002	0.0000	0.0000	0.0000	0.0000
Chloroform	3.03	0.004	-	-	0.0000	0.0001
Chloroform	21	0.002863	-	-	0.0000	0.0000
Chromium	0	0.006217	0.0003	0.0003	0.0003	0.0004
Chromium	1	0.003127	0.0002	0.0002	0.0001	0.0002
Chromium	2.01	0.003926	0.0002	0.0002	0.0002	0.0003
Chromium	2.02	0.005427	0.0003	0.0003	0.0002	0.0004
Chromium	2.03	0.002622	0.0001	0.0001	0.0001	0.0002
Chromium	2.04	0.0017	0.0001	0.0001	0.0001	0.0001
Chromium	3.01	0.002072	0.0001	0.0001	0.0001	0.0001
Chromium	3.02	0.001851	0.0001	0.0001	0.0001	0.0001
Chromium	3.03	0.002601	0.0001	0.0001	0.0001	0.0002
Chromium	3.04	0.002291	0.0001	0.0001	0.0001	0.0002
Chromium	4.01	0.001873	0.0001	0.0001	0.0001	0.0001
Chromium	4.02	0.001895	0.0001	0.0001	0.0001	0.0001
Chromium	4.04	0.003832	0.0002	0.0002	0.0002	0.0003
Chromium	7.01	0.001812	0.0001	0.0001	0.0001	0.0001

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Chromium	7.02	0.001777	0.0001	0.0001	0.0001	0.0001
Chromium	8	0.001	0.0001	0.0001	0.0000	0.0001
Chromium	13	0.002523	0.0001	0.0001	0.0001	0.0002
Chromium	18	0.005493	0.0003	0.0003	0.0002	0.0004
Chromium	20.02	0.011603	0.0006	0.0006	0.0005	0.0008
Chromium	21	0.008189	0.0004	0.0004	0.0003	0.0006
Chromium	22	0.016961	0.0009	0.0009	0.0007	0.0012
Cobalt	1	0.0045	-	-	-	-
Cobalt	2.02	0.0045	-	-	-	-
Cobalt	3.01	0.0012	-	-	-	-
Cobalt	3.03	0.0019	-	-	-	-
Cobalt	3.04	0.00117	-	-	-	-
Cobalt	13	0.00123	-	-	-	-
Cobalt	18	0.0052	-	-	-	-
Cobalt	21	0.00629	-	-	-	-
Cobalt	22	0.0077	-	-	-	-
Copper	0	0.0023	0.0000	0.0000	0.0000	0.0000
Copper	1	0.00807	0.0000	0.0000	0.0001	0.0001
Copper	2.01	0.00741	0.0000	0.0000	0.0001	0.0001
Copper	2.02	0.0065	0.0000	0.0000	0.0001	0.0001
Copper	2.03	0.01329	0.0000	0.0000	0.0001	0.0002
Copper	2.04	0.00873	0.0000	0.0000	0.0001	0.0001
Copper	3.01	0.00425	0.0000	0.0000	0.0000	0.0001
Copper	3.02	0.00336	0.0000	0.0000	0.0000	0.0000
Copper	3.03	0.00494	0.0000	0.0000	0.0000	0.0001
Copper	3.04	0.00529	0.0000	0.0000	0.0000	0.0001
Copper	4.01	0.01784	0.0000	0.0000	0.0002	0.0002
Copper	4.02	0.00366	0.0000	0.0000	0.0000	0.0000

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Copper	4.04	0.00597	0.0000	0.0000	0.0001	0.0001
Copper	7.01	0.01614	0.0000	0.0000	0.0001	0.0002
Copper	7.02	0.01263	0.0000	0.0000	0.0001	0.0002
Copper	8	0.0187	0.0000	0.0000	0.0002	0.0003
Copper	13	0.0047	0.0000	0.0000	0.0000	0.0001
Copper	21	0.01341	0.0000	0.0000	0.0001	0.0002
Di-n-butylphthalate	0	0.002	0.0020	0.0020	0.0000	0.0000
Di-n-butylphthalate	1	0.00241	0.0024	0.0024	0.0000	0.0000
Di-n-butylphthalate	2.02	0.00309	0.0030	0.0030	0.0000	0.0000
Di-n-butylphthalate	2.03	0.00396	0.0039	0.0039	0.0000	0.0000
Di-n-butylphthalate	3.01	0.00364	0.0036	0.0036	0.0000	0.0000
Di-n-butylphthalate	3.02	0.00304	0.0030	0.0030	0.0000	0.0000
Di-n-butylphthalate	3.03	0.00201	0.0020	0.0020	0.0000	0.0000
Di-n-butylphthalate	3.04	0.00355	0.0035	0.0035	0.0000	0.0000
Di-n-butylphthalate	4.01	0.00189	0.0018	0.0019	0.0000	0.0000
Di-n-butylphthalate	4.04	0.002	0.0020	0.0020	0.0000	0.0000
Di-n-butylphthalate	7.01	0.003	0.0029	0.0029	0.0000	0.0000
Di-n-butylphthalate	7.02	0.00294	0.0029	0.0029	0.0000	0.0000
Di-n-butylphthalate	8	0.004	0.0039	0.0039	0.0000	0.0000
Di-n-butylphthalate	13	0.00259	0.0025	0.0025	0.0000	0.0000
Diethylphthalate	2.02	0.001	-	-	0.0000	0.0000
Diethylphthalate	3.03	0.002	-	-	0.0000	0.0000
Diethylphthalate	13	0.00167	-	-	0.0000	0.0000
Endosulfan sulfate	13	0	0.0000	0.0000	0.0000	0.0000
Endrin ketone	13	0	0.0000	0.0000	0.0000	0.0000
Fluoride	0	0.11755	0.0016	0.0016	0.0004	0.0006
Fluoride	1	0.13308	0.0018	0.0018	0.0004	0.0007
Fluoride	2.02	0.11421	0.0015	0.0015	0.0004	0.0006

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Fluoride	2.04	0.1135	0.0015	0.0015	0.0004	0.0006
Fluoride	3.03	0.24979	0.0033	0.0033	0.0008	0.0013
Fluoride	4.01	0.10336	0.0014	0.0014	0.0003	0.0005
Fluoride	13	0.16039	0.0021	0.0021	0.0005	0.0008
Fluoride	18	0.29294	0.0039	0.0039	0.0009	0.0015
Fluoride	20.01	6.46241	0.0855	0.0859	0.0204	0.0328
Fluoride	20.02	0.25661	0.0034	0.0034	0.0008	0.0013
Fluoride	21	0.28813	0.0038	0.0038	0.0009	0.0015
Fluoride	22	0.80315	0.0106	0.0107	0.0025	0.0041
Lead	0	0.001	0.0000	0.0000	0.0000	0.0000
Lead	1	0.00173	0.0001	0.0001	0.0000	0.0000
Lead	2.01	0.00348	0.0001	0.0001	0.0001	0.0001
Lead	2.02	0.00136	0.0000	0.0000	0.0000	0.0000
Lead	2.03	0.002	0.0001	0.0001	0.0000	0.0001
Lead	3.01	0.00172	0.0001	0.0001	0.0000	0.0000
Lead	3.02	0.00131	0.0000	0.0000	0.0000	0.0000
Lead	3.03	0.00193	0.0001	0.0001	0.0000	0.0001
Lead	3.04	0.00186	0.0001	0.0001	0.0000	0.0001
Lead	4.01	0.00176	0.0001	0.0001	0.0000	0.0000
Lead	4.02	0.0028	0.0001	0.0001	0.0000	0.0001
Lead	4.04	0.00133	0.0000	0.0000	0.0000	0.0000
Lead	7.01	0.00155	0.0000	0.0000	0.0000	0.0000
Lead	7.02	0.0015	0.0000	0.0000	0.0000	0.0000
Lead	8	0.0023	0.0001	0.0001	0.0000	0.0001
Lead	13	0.00162	0.0000	0.0000	0.0000	0.0000
Manganese	0	0.10362	-	-	0.0002	0.0003
Manganese	1	0.06231	-	-	0.0001	0.0002
Manganese	2.01	0.05211	-	-	0.0001	0.0001

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Manganese	2.02	0.05545	-	-	0.0001	0.0001
Manganese	2.03	0.05192	-	-	0.0001	0.0001
Manganese	2.04	0.14384	-	-	0.0002	0.0004
Manganese	3.01	0.0908	-	-	0.0001	0.0002
Manganese	3.02	0.08856	-	-	0.0001	0.0002
Manganese	3.03	0.08943	-	-	0.0001	0.0002
Manganese	3.04	0.08827	-	-	0.0001	0.0002
Manganese	4.01	0.0578	-	-	0.0001	0.0001
Manganese	4.02	0.06947	-	-	0.0001	0.0002
Manganese	4.04	0.07159	-	-	0.0001	0.0002
Manganese	7.01	0.05739	-	-	0.0001	0.0001
Manganese	7.02	0.07628	-	-	0.0001	0.0002
Manganese	8	0.10297	-	-	0.0002	0.0003
Manganese	13	0.13031	-	-	0.0002	0.0003
Manganese	18	0.08551	-	-	0.0001	0.0002
Manganese	20.01	0.03178	-	-	0.0001	0.0001
Manganese	20.02	0.03272	-	-	0.0001	0.0001
Manganese	21	0.40127	-	-	0.0006	0.0010
Manganese	22	0.15068	-	-	0.0002	0.0004
Mercury	0	0.00003	0.0003	0.0003	0.0007	0.0003
Mercury	1	0.00001	0.0001	0.0001	0.0002	0.0001
Mercury	2.01	0.00001	0.0001	0.0001	0.0002	0.0001
Mercury	2.02	0.00007	0.0006	0.0006	0.0015	0.0008
Mercury	2.03	0.00001	0.0001	0.0001	0.0002	0.0001
Mercury	2.04	0.00002	0.0002	0.0002	0.0004	0.0002
Mercury	3.01	0.00013	0.0012	0.0012	0.0028	0.0014
Mercury	3.02	0.00012	0.0011	0.0011	0.0026	0.0013
Mercury	3.03	0.00013	0.0012	0.0012	0.0028	0.0014

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Mercury	3.04	0.00025	0.0023	0.0023	0.0054	0.0028
Mercury	4.01	0.00005	0.0005	0.0005	0.0011	0.0006
Mercury	4.02	0.00004	0.0004	0.0004	0.0009	0.0004
Mercury	4.04	0.00003	0.0003	0.0003	0.0007	0.0003
Mercury	7.01	0.00001	0.0001	0.0001	0.0002	0.0001
Mercury	7.02	0	0.0000	0.0000	0.0000	0.0000
Mercury	8	0.00001	0.0001	0.0001	0.0002	0.0001
Mercury	13	0.00002	0.0002	0.0002	0.0004	0.0002
Mercury	18	0.00007	0.0006	0.0006	0.0015	0.0008
Mercury	20.01	0.00009	0.0008	0.0008	0.0020	0.0010
Mercury	20.02	0.00008	0.0007	0.0007	0.0017	0.0009
Mercury	21	0.00007	0.0006	0.0006	0.0015	0.0008
Mercury	22	0.00013	0.0012	0.0012	0.0028	0.0014
Methoxychlor	13	0	-	-	0.0000	0.0000
Methyl Mercury	0	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	1	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	2.01	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	2.03	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	2.04	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	3.01	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	3.02	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	3.03	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	3.04	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	4.01	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	4.02	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	4.04	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	7.01	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	7.02	0	0.0000	0.0000	0.0000	0.0000

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Methyl Mercury	8	0	0.0000	0.0000	0.0000	0.0000
Methyl Mercury	13	0	0.0000	0.0000	0.0000	0.0000
Methylene chloride	20.02	0.0026	-	-	0.0001	0.0001
Nickel	0	0.0055	0.0000	0.0000	0.0000	0.0000
Nickel	1	0.0036	0.0000	0.0000	0.0000	0.0000
Nickel	2.01	0.0139	0.0000	0.0000	0.0000	0.0001
Nickel	2.02	0.0045	0.0000	0.0000	0.0000	0.0000
Nickel	2.03	0.0051	0.0000	0.0000	0.0000	0.0000
Nickel	2.04	0.0021	0.0000	0.0000	0.0000	0.0000
Nickel	3.01	0.0047	0.0000	0.0000	0.0000	0.0000
Nickel	3.02	0.0042	0.0000	0.0000	0.0000	0.0000
Nickel	3.03	0.0042	0.0000	0.0000	0.0000	0.0000
Nickel	3.04	0.0042	0.0000	0.0000	0.0000	0.0000
Nickel	4.01	0.0027	0.0000	0.0000	0.0000	0.0000
Nickel	4.02	0.0029	0.0000	0.0000	0.0000	0.0000
Nickel	4.04	0.0034	0.0000	0.0000	0.0000	0.0000
Nickel	7.01	0.0046	0.0000	0.0000	0.0000	0.0000
Nickel	7.02	0.0042	0.0000	0.0000	0.0000	0.0000
Nickel	8	0.0029	0.0000	0.0000	0.0000	0.0000
Nickel	13	0.0045	0.0000	0.0000	0.0000	0.0000
Nickel	21	0.0219	0.0000	0.0000	0.0001	0.0001
Nitrate	0	2.8427	-	-	0.0006	0.0009
Nitrate	1	4.9984	-	-	0.0010	0.0016
Nitrate	2.02	3.7003	-	-	0.0008	0.0012
Nitrate	2.04	3.6173	-	-	0.0007	0.0012
Nitrate	3.03	5.0741	-	-	0.0010	0.0017
Nitrate	4.01	4.3661	-	-	0.0009	0.0014
Nitrate	13	2.3615	-	-	0.0005	0.0008

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Nitrate	18	4.634	-	-	0.0010	0.0015
Nitrate	20.01	23.9563	-	-	0.0049	0.0079
Nitrate	20.02	14.9497	-	-	0.0031	0.0049
Nitrate	21	2.5481	-	-	0.0005	0.0008
Nitrate	22	2.0365	-	-	0.0004	0.0007
PCB-1254	3.01	0.0003	0.0001	0.0001	0.0002	0.0003
PCB-1254	3.04	0.0001	0.0000	0.0000	0.0001	0.0001
PCB-1254	13	0.0005	0.0002	0.0002	0.0004	0.0006
PCB-1254	13	0.001	0.0003	0.0003	0.0007	0.0011
Selenium	7.02	0.0011	0.0001	0.0001	0.0046	0.0073
Selenium	13	0.0012	0.0001	0.0001	0.0050	0.0080
Tetrachloroethene	21	0.0013	-	-	0.0003	0.0005
Thallium	1	1.1	-	-	20.3704	33.3333
Thallium	3.03	0.007	-	-	0.1296	0.2121
Thallium	20.02	0.0056	-	-	0.1037	0.1697
Toluene	2.04	0.001	-	-	0.0000	0.0000
Trichloroethene	2.02	0.003	-	-	0.0013	0.0021
Trichloroethene	21	0.0256	-	-	0.0115	0.0183
Uranium	0	0.0003	0.0000	0.0000	0.0000	0.0001
Uranium	1	0.0004	0.0000	0.0000	0.0000	0.0001
Uranium	2.02	0.0009	0.0000	0.0000	0.0001	0.0002
Uranium	2.04	0.0004	0.0000	0.0000	0.0000	0.0001
Uranium	3.01	0.0033	0.0000	0.0000	0.0003	0.0006
Uranium	3.02	0.0027	0.0000	0.0000	0.0003	0.0005
Uranium	3.03	0.0031	0.0000	0.0000	0.0003	0.0005
Uranium	3.04	0.00223	0.0000	0.0000	0.0002	0.0004
Uranium	4.01	0.00071	0.0000	0.0000	0.0001	0.0001
Uranium	7.01	0.0021	0.0000	0.0000	0.0002	0.0004

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Uranium	7.02	0.0054	0.0000	0.0000	0.0006	0.0009
Uranium	13	0.00026	0.0000	0.0000	0.0000	0.0000
Uranium	18	0.00052	0.0000	0.0000	0.0001	0.0001
Uranium	20.01	0.01031	0.0000	0.0000	0.0011	0.0017
Uranium	20.02	0.02658	0.0001	0.0001	0.0028	0.0045
Uranium	21	0.00933	0.0000	0.0000	0.0010	0.0016
Uranium	22	0.00491	0.0000	0.0000	0.0005	0.0008
Vanadium	0	0.00868	0.0000	0.0000	0.0064	0.0102
Vanadium	1	0.00281	0.0000	0.0000	0.0021	0.0033
Vanadium	2.02	0.00173	0.0000	0.0000	0.0013	0.0020
Vanadium	2.04	0.0024	0.0000	0.0000	0.0018	0.0028
Vanadium	3.01	0.00139	0.0000	0.0000	0.0010	0.0016
Vanadium	3.02	0.00127	0.0000	0.0000	0.0009	0.0015
Vanadium	3.03	0.00185	0.0000	0.0000	0.0014	0.0022
Vanadium	3.04	0.00154	0.0000	0.0000	0.0011	0.0018
Vanadium	4.01	0.00162	0.0000	0.0000	0.0012	0.0019
Vanadium	4.02	0.0012	0.0000	0.0000	0.0009	0.0014
Vanadium	4.04	0.00138	0.0000	0.0000	0.0010	0.0016
Vanadium	7.01	0.00155	0.0000	0.0000	0.0011	0.0018
Vanadium	7.02	0.00103	0.0000	0.0000	0.0008	0.0012
Vanadium	13	0.00133	0.0000	0.0000	0.0010	0.0016
Vanadium	18	0.0066	0.0000	0.0000	0.0049	0.0078
Vanadium	20.01	0.002	0.0000	0.0000	0.0015	0.0024
Vanadium	20.02	0.00959	0.0000	0.0000	0.0071	0.0113
Vanadium	21	0.00534	0.0000	0.0000	0.0039	0.0063
Vanadium	22	0.00311	0.0000	0.0000	0.0023	0.0037
Vinyl chloride	21	0.00498	-	-	0.0041	0.0066
Zinc	0	0.01524	0.0003	0.0003	0.0126	0.0000

Table F4.17 (continued)

Analyte	Subreach	Water 95% UCL[b] (mg/L)	Hazard quotients[a]			
			Osprey	Heron	Mink	River Otter
Zinc	1	0.01774	0.0003	0.0003	0.0146	0.0000
Zinc	2.01	0.01984	0.0004	0.0004	0.0163	0.0000
Zinc	2.02	0.01559	0.0003	0.0003	0.0128	0.0000
Zinc	2.03	0.01938	0.0004	0.0004	0.0160	0.0000
Zinc	2.04	0.01656	0.0003	0.0003	0.0136	0.0000
Zinc	3.01	0.01718	0.0003	0.0003	0.0142	0.0000
Zinc	3.02	0.01217	0.0002	0.0002	0.0100	0.0000
Zinc	3.03	0.01404	0.0003	0.0003	0.0116	0.0000
Zinc	3.04	0.01882	0.0004	0.0004	0.0155	0.0000
Zinc	4.01	0.04214	0.0008	0.0008	0.0347	0.0001
Zinc	4.02	0.00844	0.0002	0.0002	0.0070	0.0000
Zinc	4.04	0.0161	0.0003	0.0003	0.0133	0.0000
Zinc	7.01	0.02273	0.0004	0.0004	0.0187	0.0000
Zinc	7.02	0.01407	0.0003	0.0003	0.0116	0.0000
Zinc	8	0.11776	0.0023	0.0023	0.0970	0.0002
Zinc	13	0.01312	0.0003	0.0003	0.0108	0.0000
Zinc	18	0.01058	0.0002	0.0002	0.0087	0.0000
Zinc	20.01	0.0152	0.0003	0.0003	0.0125	0.0000
Zinc	20.02	0.0297	0.0006	0.0006	0.0245	0.0000
Zinc	21	0.03175	0.0006	0.0006	0.0262	0.0000
Zinc	22	0.02649	0.0005	0.0005	0.0218	0.0000

[a] Hazard quotient = water concentration/water benchmark (from Table F4.16).
[b] UCL = Upper confidence limit.
[c] - = no water benchmark available.

Table F4.18. Comparison of Monte Carlo simulation of piscivore contaminant exposure estimates to literature-based NOAELs[a] and LOAELs[a]

			Within subreach exposure estimate	
Endpoint	Subreach	Analyte	% > NOAEL	% > LOAEL
Osprey	10	Hg	>99%	<1%
Osprey	0	Hg	>99%	<1%
Osprey	2.01	Hg	<1%	<1%
Osprey	2.02	Hg	>99%	<1%
Osprey	13	Hg	>99%	<1%
Osprey	3.01	Hg	>99%	>99%
Osprey	3.02	Hg	>99%	70%
Osprey	3.03	Hg	>99%	1%
Osprey	3.04	Hg	>99%	<1%
Osprey	4.01	Hg	>99%	<1%
Osprey	4.04	Hg	>99%	<1%
Osprey	18	Hg	>99%	<1%
Osprey	5	Hg	>99%	<1%
Osprey	15	Hg	>99%	<1%
Osprey	2.04	PCB	>99%	<1%
Osprey	13	PCB	<1%	<1%
Osprey	3.01	PCB	<1%	<1%
Osprey	3.02	PCB	90%	<1%
Osprey	3.01	DDT	>99%	<1%
Great Blue Heron	10	Hg	95%	<1%
Great Blue Heron	0	Hg	>99%	<1%
Great Blue Heron	2.02	Hg	>99%	<1%
Great Blue Heron	13	Hg	>99%	<1%
Great Blue Heron	3.01	Hg	>99%	>99%
Great Blue Heron	3.02	Hg	>99%	90–95%
Great Blue Heron	3.03	Hg	>99%	10%
Great Blue Heron	3.04	Hg	>99%	5%
Great Blue Heron	4.01	Hg	>99%	5%
Great Blue Heron	4.04	Hg	95%	<1%
Great Blue Heron	15	Hg	>99%	<1%
Great Blue Heron	2.04	PCB	>99%	<1%
Great Blue Heron	3.02	PCB	<1%	<1%
Great Blue Heron	2.01	Cu	<1%	<1%
Mink	0	Se	90–95%	<1%
Mink	1	Se	90–95%	<1%
Mink	2.01	Se	80%	<1%
Mink	2.02	Se	80%	<1%
Mink	3.01	Se	85%	<1%
Mink	3.02	Se	75–80%	<1%
Mink	3.04	Se	40%	<1%
Mink	4.01	Se	85%	<1%

Table F4.18 (continued)

Endpoint	Subreach	Analyte	Within subreach exposure estimate % > NOAEL	% > LOAEL
Mink	15	Se	90–95%	<1%
Mink	13	Hg	15%	<1%
Mink	3.01	Hg	85%	<1%
Mink	3.02	Hg	80%	<1%
Mink	3.03	Hg	45–50%	<1%
Mink	3.04	Hg	50–55%	<1%
Mink	4.01	Hg	50–55%	<1%
Mink	2.04	PCB	75–80%	5%
River Otter	10	As	45%	<1%
River Otter	0	As	65%	<1%
River Otter	1	As	<5%	<1%
River Otter	2.01	As	>99%	<1%
River Otter	2.02	As	90%	<1%
River Otter	3.02	As	5%	<1%
River Otter	3.04	As	45%	<1%
River Otter	4.01	As	10%	<1%
River Otter	4.04	As	10%	<1%
River Otter	18	As	30%	<1%
River Otter	15	As	<1%	<1%
River Otter	10	Hg	>99%	<1%
River Otter	0	Hg	10–15%	<1%
River Otter	2.01	Hg	45–50%	<1%
River Otter	2.02	Hg	>99%	<1%
River Otter	13	Hg	5%	<1%
River Otter	3.01	Hg	>99%	85%
River Otter	3.02	Hg	>99%	15%
River Otter	3.03	Hg	>99%	<1%
River Otter	3.04	Hg	>99%	<1%
River Otter	4.01	Hg	>99%	<1%
River Otter	4.04	Hg	>99%	<1%
River Otter	18	Hg	>99%	<1%
River Otter	5	Hg	80%	<1%
River Otter	15	Hg	>99%	<1%
River Otter	10	Se	>99%	<1%
River Otter	0	Se	>99%	<1%
River Otter	1	Se	>99%	<1%
River Otter	2.01	Se	>99%	<1%
River Otter	2.02	Se	>99%	<1%
River Otter	3.01	Se	>99%	<1%
River Otter	3.02	Se	>99%	<1%

Table F4.18 (continued)

Endpoint	Subreach	Analyte	Within subreach exposure estimate	
			% > NOAEL	% > LOAEL
River Otter	3.04	Se	>99%	<1%
River Otter	4.01	Se	>99%	<1%
River Otter	4.04	Se	>99%	<1%
River Otter	18	Se	>99%	<1%
River Otter	5	Se	>99%	<1%
River Otter	15	Se	>99%	<1%
River Otter	0	PCB	90–95%	<1%
River Otter	2.01	PCB	80%	<1%
River Otter	2.02	PCB	99%	<1%
River Otter	2.04	PCB	>99%	80%
River Otter	13	PCB	>99%	<1%
River Otter	3.01	PCB	>99%	<1%
River Otter	3.02	PCB	>99%	<1%
River Otter	3.03	PCB	>99%	<1%
River Otter	3.04	PCB	>99%	<1%
River Otter	4.01	PCB	>99%	<1%
River Otter	4.04	PCB	>99%	<1%
River Otter	18	PCB	>99%	<1%
River Otter	5	PCB	>99%	<1%
River Otter	15	PCB	>99%	<1%
River Otter	2.01	Cu	<1%	<1%

[a] NOAEL = No observed adverse effect level; LOAEL = Lowest observed adverse effect level.

Table F4.19. Summary of number of individuals of piscivore endpoint species estimated to be experiencing adverse effects within Clinch River/Poplar Creek subreaches

Subreach	Endpoint	Analyte	%>LOAEL[a]	Number in subreach	Number adversely affected	Percent adversely affected
2.02	Great Blue Heron	Hg	<1	24	0	0
3.01	Great Blue Heron	Hg	99	7	7	100
3.02	Great Blue Heron	Hg	95	13	13	100
3.03	Great Blue Heron	Hg	10	22	0	0
3.04	Great Blue Heron	Hg	5	10	0	0
4.01	Great Blue Heron	Hg	5	44	0	0
4.04	Great Blue Heron	Hg	1	17	0	0
Total	Great Blue Heron	Hg		360	20	6
2.04	Great Blue Heron	PCB	1	53	0	0
3.02	Great Blue Heron	PCB	1	13	0	0
2.01	Great Blue Heron	Cu	1	18	0	0
2.01	Mink	Se	1	5	0	0
2.02	Mink	Se	1	6	0	0
3.01	Mink	Se	1	2	0	0
3.02	Mink	Se	1	3	0	0
3.04	Mink	Se	1	3	0	0
4.01	Mink	Se	1	12	0	0
3.01	Mink	Hg	1	2	0	0
3.02	Mink	Hg	1	3	0	0
3.03	Mink	Hg	1	6	0	0

Table F4.19 (continued)

Subreach	Endpoint	Analyte	%>LOAEL[a]	Number in subreach	Number adversely affected	Percent adversely affected
3.04	Mink	Hg	1	3	0	0
4.01	Mink	Hg	1	12	0	0
2.04	Mink	PCB	5	14	0	0
2.01	Otter	As	1	3	0	0
2.02	Otter	As	1	4	0	0
3.02	Otter	As	1	2	0	0
3.04	Otter	As	1	2	0	0
4.01	Otter	As	1	7	0	0
4.04	Otter	As	1	7	0	0
2.01	Otter	Hg	1	3	0	0
2.02	Otter	Hg	1	4	0	0
3.01	Otter	Hg	85	1	1	100
3.02	Otter	Hg	15	2	0	0
3.03	Otter	Hg	1	4	0	0
3.04	Otter	Hg	1	2	0	0
4.01	Otter	Hg	1	7	0	0
4.04	Otter	Hg	1	3	0	0
2.01	Otter	Se	1	3	0	0
2.02	Otter	Se	1	4	0	0
3.01	Otter	Se	1	1	0	0
3.02	Otter	Se	1	2	0	0
3.04	Otter	Se	1	2	0	0
4.01	Otter	Se	1	7	0	0
4.04	Otter	Se	1	3	0	0
2.01	Otter	PCB	1	3	0	0
2.02	Otter	PCB	1	4	0	0
2.04	Otter	PCB	80	9	9	100
3.01	Otter	PCB	1	1	0	0

Table F4.19 (continued)

Subreach	Endpoint	Analyte	%>LOAEL[a]	Number in subreach	Number adversely affected	Percent adversely affected
3.02	Otter	PCB	1	2	0	0
3.03	Otter	PCB	1	4	0	0
3.04	Otter	PCB	1	2	0	0
4.01	Otter	PCB	1	7	0	0
4.04	Otter	PCB	1	3	0	0
2.01	Otter	Cu	1	3	0	0

[a] LOAEL = Lowest observed adverse effect level.

Table F4.20. Simulation of exposure of mink to mercury and PCBs in toxicity test diets

Diet	Analyte	Concentration in diet				Distribution used in simulation	Modeled exposure (mg/kg/d)			% > NOAEL[b]	% > LOAEL[b]
		Mean	STD[a]	Min	Max		Mean	STD	80th Percentile		
A	Mercury	0.02	0	0.02	0.03	Triangular	0.0034	0.0009	0.0042	<1%	0%
B	Mercury	0.05	0	0.04	0.06	Triangular	0.0074	0.0019	0.0088	1–5%	<0.01%
C	Mercury	0.09	0	0.08	0.11	Triangular	0.0138	0.0035	0.016	30%	<0.01%
D	Mercury	0.15	0.01			Normal	0.022	0.0059	0.026	90–95%	<0.01%
E	Mercury	0.22	0.01			Normal	0.033	0.008	0.038	>99%	<1%
A	Aroclor 1260	0.169	0.002			Normal	0.025	0.0063	0.029	<1%	<1%
B	Aroclor 1260	11.44	0.327			Normal	1.70	0.43	1.97	>99%	>99%
C	Aroclor 1260	4.697	0.174			Normal	0.698	0.18	0.82	>99%	40–45%
D	Aroclor 1260	10.41	0.25			Normal	1.54	0.39	1.79	>99%	>99%
E	Aroclor 1260	20.67	0.458			Normal	3.07	0.77	3.55	>99%	>99%

[a] STD = standard deviation.
[b] Aroclor 1260 evaluated by comparison to NOAEL and LOAEL for Aroclor 1254. NOAEL = No observed adverse effect level; LOAEL = Lowest observed adverse effect level.

Appendix F5

INSECTIVOROUS WILDLIFE

Table F5.1. Life history parameters for rough-winged swallows (*Stelgidopteryx serripennis*)

Parameter	Value[a]	Comments	Reference
Body Weight	**0.0159 ± 0.00058 kg**		Dunning 1984
Food Consumption Rate	**0.012 kg/d**	0.0042 kg/d (dry; calculation according to Nagy 1987); adjusted to wet weight using 65% water content reported for terrestrial insects in EPA 1993a	Nagy 1987
Water Consumption Rate	**0.0037 L/d**	estimated using allometric equation [b] assuming 0.0159 kg bw	Calder and Braun 1983
Soil Consumption Rate	as an aerial insectivore, assumed to be negligible		
Diet Composition	Diptera (32.89%) Hymenoptera (30.9%), Hemiptera (14.9%), Coleoptera (14.83%), Lepidoptera (1.11%), Ephemeroptera (5.04%), Orthoptera (.12%) and vegetation (.21%)	percent occurence in 136 stomachs collected from 15 states, the District of Columbia, and Canada	Beal 1918
Home Range	≤ .5 mile from nesting site		Stoner and Stoner 1941
Habitat Requirements	during breeding season: abandoned burrows along river banks migration south in fall foraging habitat: primarily over water, forests and field,		Lunk 1962
Population Density	no data		

[a] Suggested values for use in exposure assessment are in bold.
[b] Allometric equation for estimation of water consumption for rough-winged swallows is:

$$WIR = 0.059(BW)^{0.67}$$

where: WIR= water ingestion rate (L water/individual/day).

Table F5.2. Life history parameters for little brown bats (*Myotis lucifugus*)[a]

Parameter	Value[b]	Comments	Reference
Body Weight	**0.0075** kg		Gould 1955
Food Consumption Rate	**0.0025** kg/d	pregnant ♂ (field)	Anthony and Kunz 1977
	0.0037 kg/d	lactating ♂ (field)	
	0.0018 kg/d	juvenile (field)	
Water Consumption Rate	**0.0012** L/d	estimated using allometric equation[c] assuming 0.0075 kg bw	
Soil Consumption Rate	as an aerial insectivore, assumed to be negligible		
Diet Composition	highly variable; mostly flying insects, taken opportunistically as available.		Fenton and Barclay 1980
	Chironomidae 39.5% Trichoptera 31.5% Lepidoptera 11.0% Misc. Insects 9.4% Coleoptera 5.5% Neuroptera 3.1%	percent volume in diet in Ontario, Nova Scotia, and New York	Belwood and Fenton 1976
Home Range	8.5 km from roost.	Gray bats (*Myotis gresescens & M. sodalis*).	LaVal et al. 1977
Habitat Requirements	day roosts: buildings, trees, occasionally in caves.		Fenton and Barclay 1980
	night roosts: similar to day roosts but more confined space		
	hibernation sites: caves, abandoned mines		
	foraging habitat: forest and edge	Missouri	LaVal et al. 1977
	Forest, field, and over streams and ponds	Ontario	Fenton and Bell 1979

Table F5.2 (continued)

Parameter	Value[b]	Comments	Reference
Population Density	no data, however populations may be limited by availability of roost sites not by food		Fenton and Barclay 1980
Behavior	nocturnal; bimodal activity pattern: ~2200–2400 and ~0330–0500		Anthony and Kunz 1977
	hibernation September–May (north) November–March (south)		Fenton and Barclay 1980
Other	long-lived; may live up to 30 yrs mean life expectancy: ♂ = 4.9 yrs ♀ = 2.9 yrs		Keen and Hitchcock, 1980

[a] The little brown bat is considered a surrogate species for the federally endangered gray bat. Since the gray bat is appoximately the same size as the little brown bat, the exposure parameters for the two species are similar.
[b] Suggested values for use in exposure assessment are in bold.
[c] Allometric equation for estimation of water consumption for bats is:

$$WIR = 0.099(BW)^{0.90}$$

where: WIR= water ingestion rate (L water/individual/day).

Table F5.3. Contaminant concentrations found in mayflies used for Monte Carlo simulations

Analyte	Subreach	Detects	Mininum (mg/kg)	Maximum (mg/kg)	PLE[a] Mean
Arsenic	3.03	3	0.0265	0.0490	0.0344
	4.04	3	0.0260	0.0453	0.0331
	18	3	0.0288	0.0440	0.0349
Lead	3.03	3	0.0697	0.2020	0.1206
	4.04	2	0.0398	0.1350	0.0717
	18	2	0.0400	0.0540	0.0499
Mercury	3.03	3	0.0251	0.0290	0.0276
	4.04	3	0.0188	0.0259	0.0231
	18	3	0.0189	0.0249	0.0212
Aroclor 1254	3.03	3	0.0850	0.1000	0.0940
	4.04	3	0.1200	0.1400	0.1300
	18	3	0.1300	0.1600	0.1400
Zinc	3.03	3	58.124	73.200	63.408
	4.04	3	66.700	89.200	77.800
	18	3	77.100	80.500	78.833

[a] PLE = Product limit estimate.

Table F5.4. Sediment to mayfly uptake factors for the Clinch River

Analyte	Subreach	Sediment PLE mean[a] (mg/kg)	Mayfly PLE mean (mg/kg)	Uptake factor	Mean	Standard error
Arsenic	3.03	19.646	0.034	0.002	0.003946	0.001389
	4.04	9.271	0.033	0.004		
	18	5.355	0.035	0.007		
Lead	3.03	22.23	0.121	0.005	0.00325	0.0011
	4.04	29.216	0.072	0.003		
	18	26.657	0.050	0.002		
Mercury	3.03	7.169	0.028	0.004		
	4.04	1.636	0.023	0.014		
	18	0.11	0.021	0.193	0.008985[b]	0.005135[b]
Aroclor 1254	3.03	0.142	0.094	0.682	0.354267	0.307705
	4.04	2.792	0.130	0.047		
	18		0.140			
Zinc	3.03	102.093	63.41	0.621	0.621574	0.013144
	4.04	120.7	77.8	0.645		
	18	131.592	78.83	0.599		

[a] PLE = Product limit estimate. Sediment data for subreach 3.03 is from PCM 1.1, 1.3, 1.4, 2.2, 2.5, and 2.7. Sediment data for subreach 18 is from TRM 570.8 only.

[b] Average mercury uptake factor was not calculated using the mayfly uptake factor from subreach 18 in the Tennessee River. The mercury concentrations in mayflies and sediment in subreach 18 showed obvious differences compared to ORR sites. This may be a result of mercury speciation found off-site.

Table F5.5. Average actual and estimated contaminant concentrations in Clinch River mayflies

Analyte	Actual mayfly concentration		Estimated mayfly concentration[a]	
	Mean	Standard error	Mean	Standard error
Arsenic	0.0341	0.000536	0.0451	0.0168
Mercury	0.0240	0.00190	0.0267	0.0193
Lead	0.0807	0.0209	0.0846	0.00662
PCBs	0.121	0.0140	0.346	0.322
Zinc	73.348	4.978	73.426	5.353

[a] Estimated mayfly contaminant concentrations were calculated with the sediment concentrations at the site and the mayfly uptake factor.

Table F5.6. Estimated arsenic exposure and hazard assessment for rough-winged swallows

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	6.875	0.000	0.027	0.008	0.000	0.008	0.000	0.000
0	4.727	0.050	0.019	0.005	0.012	0.017	0.001	0.000
1	25.856	0.001	0.102	0.029	0.000	0.029	0.001	0.001
7.01	97.114	0.005	0.383	0.110	0.001	0.111	0.006	0.002
7.02	15.376	0.001	0.061	0.017	0.000	0.018	0.001	0.000
8	7.900	0.000	0.031	0.009	0.000	0.009	0.000	0.000
2.01	1.800	0.000	0.007	0.002	0.000	0.002	0.000	0.000
22	3.859	0.000	0.015	0.004	0.000	0.004	0.000	0.000
2.02	3.091	0.001	0.012	0.003	0.000	0.004	0.000	0.000
2.03	2.038	0.000	0.008	0.002	0.000	0.002	0.000	0.000
2.04	7.832	0.001	0.031	0.009	0.000	0.009	0.000	0.000
13	4.035	0.004	0.016	0.005	0.001	0.005	0.000	0.000
3.01	10.742	0.000	0.042	0.012	0.000	0.012	0.001	0.000
3.02	8.665	0.001	0.034	0.010	0.000	0.010	0.001	0.000
3.03	6.012	0.001	0.056	0.016	0.000	0.016	0.001	0.000
3.04	42.485	0.001	0.168	0.048	0.000	0.048	0.002	0.001
4.01	4.502	0.001	0.018	0.005	0.000	0.005	0.000	0.000
4.02	7.548	0.001	0.030	0.009	0.000	0.009	0.000	0.000

Table F5.6 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.03	9.819	0.000	0.039	0.011	0.000	0.011	0.001	0.000
4.04	10.920	0.002	0.051	0.015	0.000	0.015	0.001	0.000
18	6.226	0.000	0.048	0.014	0.000	0.014	0.001	0.000
5	11.265	0.000	0.044	0.013	0.000	0.013	0.001	0.000

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.7. Estimated lead exposure and hazard assessment for rough-winged swallows

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	37.979	0.000	0.123	0.035	0.000	0.035	0.005	0.001
0	26.161	0.001	0.085	0.024	0.000	0.025	0.003	0.001
1	72.825	0.002	0.237	0.068	0.000	0.068	0.009	0.003
7.01	16.361	0.002	0.053	0.015	0.000	0.016	0.002	0.001
7.02	24.695	0.002	0.080	0.023	0.000	0.023	0.003	0.001
8	27.700	0.002	0.090	0.026	0.001	0.026	0.003	0.001
2.01	5.400	0.003	0.018	0.005	0.001	0.006	0.001	0.000
22	120.208	0.000	0.391	0.112	0.000	0.112	0.015	0.005
2.02	9.735	0.001	0.032	0.009	0.000	0.009	0.001	0.000
2.03	8.567	0.002	0.028	0.008	0.000	0.008	0.001	0.000
2.04	39.110	0.000	0.127	0.036	0.000	0.036	0.005	0.002
13	17.241	0.002	0.056	0.016	0.000	0.016	0.002	0.001
3.01	44.140	0.002	0.143	0.041	0.000	0.041	0.005	0.002
3.02	33.475	0.001	0.109	0.031	0.000	0.031	0.004	0.001
3.03	29.141	0.002	0.241	0.069	0.000	0.069	0.009	0.003
3.04	25.843	0.002	0.084	0.024	0.000	0.024	0.003	0.001
4.01	22.601	0.002	0.073	0.021	0.000	0.021	0.003	0.001
4.02	25.757	0.003	0.084	0.024	0.001	0.025	0.003	0.001

Table F5.7 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.03	46.629	0.000	0.152	0.043	0.000	0.043	0.006	0.002
4.04	35.445	0.001	0.178	0.051	0.000	0.051	0.007	0.002
18	29.114	0.000	0.057	0.016	0.000	0.016	0.002	0.001
5	48.009	0.000	0.156	0.045	0.000	0.045	0.006	0.002

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.8. Estimated mercury concentrations and hazard assessment for rough-winged swallows

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	0.070	0.000	0.001	0.000	0.000	0.000	0.007	0.001
0	0.063	0.000	0.001	0.000	0.000	0.000	0.007	0.001
1	0.427	0.000	0.004	0.001	0.000	0.001	0.044	0.004
7.01	0.160	0.000	0.001	0.000	0.000	0.000	0.017	0.002
7.02	0.109	0.000	0.001	0.000	0.000	0.000	0.011	0.001
8	0.764	0.000	0.007	0.002	0.000	0.002	0.079	0.008
2.01	0.237	0.000	0.002	0.001	0.000	0.001	0.024	0.002
22	114.073	0.000	1.025	0.293	0.000	0.293	11.737	1.174
2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
2.03	0.026	0.000	0.000	0.000	0.000	0.000	0.003	0.000
2.04	0.286	0.000	0.003	0.001	0.000	0.001	0.030	0.003
13	0.818	0.000	0.007	0.002	0.000	0.002	0.084	0.008
3.01	16.762	0.000	0.151	0.043	0.000	0.043	1.726	0.173
3.02	20.237	0.000	0.182	0.052	0.000	0.052	2.083	0.208
3.03	7.442	0.000	0.031	0.009	0.000	0.009	0.361	0.036
3.04	60.959	0.000	0.548	0.157	0.000	0.157	6.274	0.627
4.01	4.163	0.000	0.037	0.011	0.000	0.011	0.429	0.043

Table F5.8 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.02	1.963	0.000	0.018	0.005	0.000	0.005	0.202	0.020
4.03	2.991	0.000	0.027	0.008	0.000	0.008	0.308	0.031
4.04	1.832	0.000	0.029	0.008	0.000	0.008	0.337	0.034
18	0.132	0.000	0.027	0.008	0.000	0.008	0.306	0.031
5	1.141	0.000	0.010	0.003	0.000	0.003	0.117	0.012

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.9. Estimated PCB exposure and hazard assessment for rough-winged swallows

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	1.594	0.000	0.565	0.162	0.000	0.162	0.229	0.023
2.02	1.167	0.000	0.413	0.118	0.000	0.118	0.168	0.017
2.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.017	0.001	0.006	0.002	0.000	0.002	0.003	0.000
3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.02	0.621	0.000	0.220	0.063	0.000	0.063	0.089	0.009
3.03	0.230	0.000	0.107	0.031	0.000	0.031	0.044	0.004
3.04	0.154	0.000	0.055	0.016	0.000	0.016	0.022	0.002
4.01	0.263	0.000	0.093	0.027	0.000	0.027	0.038	0.004
4.02	0.036	0.000	0.013	0.004	0.000	0.004	0.005	0.001

Table F5.9 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.03	0.069	0.000	0.024	0.007	0.000	0.007	0.010	0.001
4.04	2.792	0.000	0.147	0.042	0.000	0.042	0.060	0.006
18	0.000	0.000	0.169	0.048	0.000	0.048	0.069	0.007
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.10. Estimated zinc exposure and hazard assessment for rough-winged swallows

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	98.765	0.000	61.392	17.574	0.000	17.574	0.249	0.028
0	81.296	0.015	50.534	14.466	0.004	14.470	0.205	0.023
1	232.565	0.018	144.562	41.383	0.004	41.387	0.586	0.067
7.01	97.479	0.023	60.593	17.346	0.005	17.351	0.246	0.028
7.02	91.189	0.014	56.683	16.226	0.003	16.230	0.230	0.026
8	91.700	0.000	57.001	16.317	0.000	16.317	0.231	0.026
2.01	29.900	0.020	18.586	5.320	0.005	5.325	0.075	0.009
22	112.840	0.026	70.141	20.079	0.006	20.085	0.284	0.032
2.02	40.247	0.016	25.018	7.162	0.004	7.165	0.101	0.012
2.03	52.778	0.019	32.807	9.391	0.005	9.396	0.133	0.015
2.04	70.760	0.017	43.984	12.591	0.004	12.595	0.178	0.020
13	88.195	0.013	54.822	15.694	0.003	15.697	0.222	0.025
3.01	192.043	0.017	119.374	34.172	0.004	34.176	0.484	0.055
3.02	156.543	0.012	97.307	27.856	0.003	27.858	0.394	0.045
3.03	125.700	0.014	77.720	22.248	0.003	22.252	0.315	0.036
3.04	101.683	0.019	63.206	18.094	0.004	18.098	0.256	0.029
4.01	54.066	0.042	33.607	9.621	0.010	9.630	0.136	0.016
4.02	68.528	0.008	42.597	12.194	0.002	12.196	0.173	0.020

Table F5.10 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.03	88.214	0.000	54.834	15.697	0.000	15.697	0.222	0.025
4.04	135.919	0.016	96.770	27.702	0.004	27.706	0.392	0.045
18	143.469	0.011	81.700	23.388	0.002	23.390	0.331	0.038
5	265.305	0.000	164.914	47.209	0.000	47.209	0.668	0.076

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.11. Estimated arsenic exposure and hazard assessment for little brown and gray bats

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	6.875	0.000	0.027	0.009	0.000	0.009	0.060	0.005
0	4.727	0.050	0.019	0.006	0.008	0.014	0.094	0.007
1	25.856	0.001	0.102	0.034	0.000	0.034	0.226	0.017
7.01	97.114	0.005	0.383	0.128	0.001	0.129	0.851	0.065
7.02	15.376	0.001	0.061	0.020	0.000	0.020	0.135	0.010
8	7.900	0.000	0.031	0.010	0.000	0.010	0.069	0.005
2.01	1.800	0.000	0.007	0.002	0.000	0.002	0.016	0.001
22	3.859	0.000	0.015	0.005	0.000	0.005	0.034	0.003
2.02	3.091	0.001	0.012	0.004	0.000	0.004	0.028	0.002
2.03	2.038	0.000	0.008	0.003	0.000	0.003	0.018	0.001
2.04	7.832	0.001	0.031	0.010	0.000	0.010	0.069	0.005
13	4.035	0.004	0.016	0.005	0.001	0.006	0.039	0.003
3.01	10.742	0.000	0.042	0.014	0.000	0.014	0.094	0.007
3.02	8.665	0.001	0.034	0.011	0.000	0.012	0.077	0.006
3.03	6.012	0.001	0.056	0.019	0.000	0.019	0.124	0.009
3.04	42.485	0.001	0.168	0.056	0.000	0.056	0.371	0.028
4.01	4.502	0.001	0.018	0.006	0.000	0.006	0.040	0.003
4.02	7.548	0.001	0.030	0.010	0.000	0.010	0.067	0.005

Table F5.11 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.03	9.819	0.000	0.039	0.013	0.000	0.013	0.086	0.006
4.04	10.920	0.002	0.051	0.017	0.000	0.017	0.114	0.009
18	6.226	0.000	0.048	0.016	0.000	0.016	0.107	0.008
5	11.265	0.000	0.044	0.015	0.000	0.015	0.098	0.007

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.12. Estimated lead exposure and hazard assessment for little brown bats and gray bats

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated eayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	37.979	0.000	0.123	0.041	0.000	0.041	0.001	0.000
0	26.161	0.001	0.085	0.028	0.000	0.029	0.001	0.000
1	72.825	0.002	0.237	0.079	0.000	0.079	0.003	0.000
7.01	16.361	0.002	0.053	0.018	0.000	0.018	0.001	0.000
7.02	24.695	0.002	0.080	0.027	0.000	0.027	0.001	0.000
8	27.700	0.002	0.090	0.030	0.000	0.030	0.001	0.000
2.01	5.400	0.003	0.018	0.006	0.001	0.006	0.000	0.000
22	120.208	0.000	0.391	0.130	0.000	0.130	0.005	0.000
2.02	9.735	0.001	0.032	0.011	0.000	0.011	0.000	0.000
2.03	8.567	0.002	0.028	0.009	0.000	0.010	0.000	0.000
2.04	39.110	0.000	0.127	0.042	0.000	0.042	0.001	0.000
13	17.241	0.002	0.056	0.019	0.000	0.019	0.001	0.000
3.01	44.140	0.002	0.143	0.048	0.000	0.048	0.002	0.000
3.02	33.475	0.001	0.109	0.036	0.000	0.036	0.001	0.000
3.03	29.141	0.002	0.241	0.080	0.000	0.081	0.003	0.000
3.04	25.843	0.002	0.084	0.028	0.000	0.028	0.001	0.000
4.01	22.601	0.002	0.073	0.024	0.000	0.025	0.001	0.000
4.02	25.757	0.003	0.084	0.028	0.000	0.028	0.001	0.000

Table F5.12 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated eayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.03	46.629	0.000	0.152	0.051	0.000	0.051	0.002	0.000
4.04	35.445	0.001	0.178	0.059	0.000	0.060	0.002	0.000
18	29.114	0.000	0.057	0.019	0.000	0.019	0.001	0.000
5	48.009	0.000	0.156	0.052	0.000	0.052	0.002	0.000

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.13. Estimated mercury concentrations and hazard assessment in little brown and gray bats

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	0.070	0.000	0.001	0.000	0.000	0.000	0.002	0.000
0	0.063	0.000	0.001	0.000	0.000	0.000	0.002	0.000
1	0.427	0.000	0.004	0.001	0.000	0.001	0.011	0.002
7.01	0.160	0.000	0.001	0.000	0.000	0.000	0.004	0.001
7.02	0.109	0.000	0.001	0.000	0.000	0.000	0.003	0.001
8	0.764	0.000	0.007	0.002	0.000	0.002	0.020	0.004
2.01	0.237	0.000	0.002	0.001	0.000	0.001	0.006	0.001
22	114.073	0.000	1.025	0.342	0.000	0.342	2.997	0.599
2.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.03	0.026	0.000	0.000	0.000	0.000	0.000	0.001	0.000
2.04	0.286	0.000	0.003	0.001	0.000	0.001	0.008	0.002
13	0.818	0.000	0.007	0.002	0.000	0.002	0.022	0.004
3.01	16.762	0.000	0.151	0.050	0.000	0.050	0.441	0.088
3.02	20.237	0.000	0.182	0.061	0.000	0.061	0.532	0.106
3.03	7.442	0.000	0.031	0.010	0.000	0.010	0.092	0.018
3.04	60.959	0.000	0.548	0.183	0.000	0.183	1.602	0.320
4.01	4.163	0.000	0.037	0.012	0.000	0.012	0.109	0.022
4.02	1.963	0.000	0.018	0.006	0.000	0.006	0.052	0.010

Table F5.13 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.03	2.991	0.000	0.027	0.009	0.000	0.009	0.079	0.016
4.04	1.832	0.000	0.029	0.010	0.000	0.010	0.086	0.017
18	0.132	0.000	0.027	0.009	0.000	0.009	0.078	0.016
5	1.141	0.000	0.010	0.003	0.000	0.003	0.030	0.006

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.14. Estimated PCB exposure and hazard assessment for little brown and gray bats

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	1.594	0.000	0.565	0.188	0.000	0.188	1.007	0.101
2.02	1.167	0.000	0.413	0.138	0.000	0.138	0.737	0.074
2.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.017	0.001	0.006	0.002	0.000	0.002	0.012	0.001
3.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.02	0.621	0.000	0.220	0.073	0.000	0.073	0.392	0.039
3.03	0.230	0.000	0.107	0.036	0.000	0.036	0.191	0.019
3.04	0.154	0.000	0.055	0.018	0.000	0.018	0.097	0.010
4.01	0.263	0.000	0.093	0.031	0.000	0.031	0.166	0.017
4.02	0.036	0.000	0.013	0.004	0.000	0.004	0.023	0.002

Table F5.14 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.03	0.069	0.000	0.024	0.008	0.000	0.008	0.044	0.004
4.04	2.792	0.000	0.147	0.049	0.000	0.049	0.262	0.026
18	0.000	0.000	0.169	0.056	0.000	0.056	0.302	0.030
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.15. Estimated zinc exposure and hazard assessment for little brown and gray bats

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
10	98.765	0.000	61.392	20.464	0.000	20.464	0.036	0.018
0	81.296	0.015	50.534	16.845	0.002	16.847	0.030	0.015
1	232.565	0.018	144.562	48.187	0.003	48.190	0.085	0.042
7.01	97.479	0.023	60.593	20.198	0.004	20.201	0.036	0.018
7.02	91.189	0.014	56.683	18.894	0.002	18.897	0.033	0.017
8	91.700	0.000	57.001	19.000	0.000	19.000	0.033	0.017
2.01	29.900	0.020	18.586	6.195	0.003	6.198	0.011	0.005
22	112.840	0.026	70.141	23.380	0.004	23.385	0.041	0.021
2.02	40.247	0.016	25.018	8.339	0.002	8.342	0.015	0.007
2.03	52.778	0.019	32.807	10.936	0.003	10.939	0.019	0.010
2.04	70.760	0.017	43.984	14.661	0.003	14.664	0.026	0.013
13	88.195	0.013	54.822	18.274	0.002	18.276	0.032	0.016
3.01	192.043	0.017	119.374	39.791	0.003	39.794	0.070	0.035
3.02	156.543	0.012	97.307	32.436	0.002	32.438	0.057	0.029
3.03	125.700	0.014	77.720	25.907	0.002	25.909	0.046	0.023
3.04	101.683	0.019	63.206	21.069	0.003	21.072	0.037	0.019
4.01	54.066	0.042	33.607	11.202	0.007	11.209	0.020	0.010
4.02	68.528	0.008	42.597	14.199	0.001	14.200	0.025	0.012

Table F5.15 (continued)

Subreach	Sediment (95% UCL)[a]	Water (95% UCL)[a]	Estimated mayfly (95% UCL)[a]	Food exposure (mg/kg/d)	Water exposure (mg/kg/d)	Total exposure (mg/kg/d)	NOAEL HQ[b]	LOAEL HQ[b]
4.03	88.214	0.000	54.834	18.278	0.000	18.278	0.032	0.016
4.04	135.919	0.016	96.770	32.257	0.003	32.259	0.057	0.028
18	143.469	0.011	81.700	27.233	0.002	27.235	0.048	0.024
5	265.305	0.000	164.914	54.971	0.000	54.971	0.097	0.048

[a] UCL = Upper confidence limit.
[b] NOAEL HQ = No observed adverse effect level hazard quotient; LOAEL HQ = Lowest observed adverse effect level hazard quotient.

Table F5.16. Subreach-contaminant exposure combinations where Monte Carlo simulations were performed

Subreach	Subreach name	Endpoint	
		Rough-winged Swallow	Little Brown or Gray Bats[a]
3.01	Poplar Creek: East Fork Poplar Creek	Hg	Hg
3.02[b]	Poplar Creek: Mitchell Branch	Hg	Hg
3.03[b]	Poplar Creek:	Hg	Hg
3.04	Poplar Creek Mouth	Hg	Hg

[a] The Monte Carlo simulation was performed to determine exposure for little brown/gray bats foraging at multiple subreaches to modify for home range.
[b] Monte Carlo simulation was performed on data from subreaches 3.02 and 3.03 even though hazard quoteints were less than 1. The results were obtained to observe differences in exposure distributions as swallows and bats foraged progressively downstream.

Table F5.17. Measured mercury concentrations in sediment and estimated concentrations in mayflies from Poplar Creek used in the Monte Carlo simulation

Subreach	Lognormal sediment concentration (mg/kg)		Estimated mayfly concentration (mg/kg)	
	Mean	Standard deviation	Mean	Standard error
3.01	-0.9797	2.5071	0.9749	0.2243
3.02	1.9344	0.4206	0.1414	0.0055
3.03	1.5822	0.1844	0.0271[a]	0[a]
3.04	2.2773	0.5394	0.2938	0.0139

[a] Actual mercury concentration found in mayflies at subreach 3.03.

Table F5.18. Contaminant concentrations in surface water used in the Monte Carlo simulations

Analyte	Subreach	Mean	Standard error
Mercury	3.01	0.00016	0.000016
	3.02	0.00015	0.000016
	3.03	0.00014	0.000015
	3.04	0.00022	0.000041

Table F5.19. Estimated NOAELs[a] and LOAELs[a] for rough-winged swallows

Contaminant	Experimental information						Estimated NOAEL (mg/kg/d)	Estimated LOAEL (mg/kg/d)
	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation		
Arsenic	arsenite	mallard duck	5.14 128d	12.84 128d	mortality	USFWS 1964	20.141	50.36
Lead	metal	American kestrel	3.85 7 mo		reproduction	Pattee 1984	7.7	
Lead	acetate	Japanese quail		11.26 12 wk	reproduction	Edens et al. 1976		23.61
Mercury	methyl	mallard duck	0.0064[b] 3 gen.	0.064 3 gen.	reproduction	Heinz 1979	0.025	0.25
Zinc	zinc sulfate	chicken	14.5 44 wk	130.9 44 wk	reproduction	Stahl et al. 1990	70.66	619.42
PCBs	Aroclor 1254	Ring-necked Pheasant	0.18[b] 17 wk	0.18 17 wk	reproduction	Dahlgren et al. 1972	0.706	7.06

[a] NOAEL = No observed adverse effect level; LOAEL = Lowest observed adverse effect level.
[b] Estimated NOAEL: LOAEL to NOAEL factor applied.

Table F5.20. Estimated NOAELs[a] and LOAELs[a] for little brown bats and gray bats

Contaminant	Experimental information						Estimated NOAEL (mg/kg/d)	Estimated LOAEL (mg/kg/d)
	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation		
Arsenic	As+3	mouse	0.126[b] 3 gen.	1.26 3 gen.	reproduction	Schroeder and Mitchner 1971	0.199	1.99
Lead	acetate	rat	8 3 gen	80 3 gen	reproduction	Azar et al. 1973	28.43	284.35
Mercury	methyl	rat	0.032 3 gen.	0.16 3 gen.	reproduction	Verschuuren et al. 1976	0.114	0.57
Zinc	oxide	rat	160 gestation	320 gestation	reproduction	Schlicker and Cox 1968	568	904
PCBs	Aroclor 1254	white-footed mouse	0.135[b] 18 mo.	1.35 18 mo.	reproduction	Linzey 1987	0.187	1.87

[a] NOAEL = No observed adverse effect level; LOAEL = Lowest observed adverse effect level.
[b] Estimated NOAEL: LOAEL to NOAEL factor applied.

Appendix F6

DREDGE SPOIL ECOLOGICAL RISKS

Table F6.1. Life history parameters for the eastern cottontail (*Sylvilagus floridanus*)

Parameter	Value[a]	Comments	Reference
Body Weight	1.134 kg (♂) 1.244 kg (♀) **1.2** kg (mean♂+♀)		Chapman et al. 1980
Food Consumption Rate	**0.237** kg/d		Dalke and Sime 1941
Water Consumption Rate	**0.116** L/d	estimated using Equation 12; assuming 1.2 kg bw	
Soil Consumption Rate	**0.015** kg/d	assumed comparable to that for black-tailed jackrabbit (6.3% of diet) assuming diet of 0.237 kg/d and a 6.3% soil consumption rate	Arthur and Gates 1988
Diet Composition	exclusively herbivorous bark, twigs, buds, dried herbs (fall, winter) herbaceous plants (spring, summer)		Dalke and Sime 1941
Home Range	3.2 ha (♂); 2.1 ha (♀) 7.2 ha (♂); 2.8 ha (♀) 7.8 ha (♂); 2.4 ha (♀) 3.1 ha (♂); 1.5 ha (♀)	winter - Pennsylvania spring summer fall	Althoff and Storm 1989
Habitat Requirements	wide variety of habitats used; old fields preferred		Chapman et al. 1980
Population Density	0.41–2.10 /ha (mean = 1.1/ ha)	Michigan	Eberhardt et al. 1963
Behavior	activity is greatest at dusk and dawn (crepuscular) active year round - does not hibernate		Chapman et al. 1980 EPA 1993a

[a] Suggested values for use in exposure assessment are in bold.

Table F6.2. Chemical concentrations found in deep water sediment (future spoil material) within each subreach

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
1	4,4'-DDD	1	0.256	0.129	1.07	0.127	0.385	0.127
1	4,4'-DDT	1	0.259	0.125	1.052	0.134	0.385	0.134
1	Arsenic	2	8.02	3.014	27.05	5.006	11.034	8.02
1	Benzo(a)anthracene	1	0.653	0.137	1.515	0.516	0.789	0.789
1	Benzo(k)fluoranthene	1	0.653	0.137	1.521	0.516	0.791	0.791
1	Beryllium	2	0.701	0.107	1.377	0.594	0.808	0.701
1	Cadmium	2	0.572	0.155	1.549	0.417	0.727	0.572
1	Chromium	2	14.735	4.869	45.478	9.866	19.604	14.735
1	Chrysene	1	0.655	0.14	1.536	0.516	0.795	0.795
1	Copper	2	27.728	1.359	36.307	26.369	29.087	27.728
1	Fluoranthene	1	0.669	0.153	1.632	0.516	0.821	0.821
1	Lead	2	34.674	4.558	63.455	30.116	39.233	34.674
1	Mercury	2	0.092	0.032	0.295	0.059	0.124	0.092
1	Nickel	2	18.447	4.877	49.209	13.575	23.319	18.447
1	Pyrene	1	0.665	0.149	1.608	0.516	0.815	0.815
1	Selenium	2	0.557	0.138	1.426	0.42	0.695	0.557
1	Silver	2	0.267	0.062	0.661	0.205	0.329	0.267
1	Zinc	2	95.855	26.277	261.763	69.577	122.132	95.855
7	2-Methylnaphthalene	2	0.11	0.041	0.37	0.07	0.15	0.11

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
7	4-Nitrophenol	1	0.694	0.125	1.485	0.569	0.82	0.569
7	Aluminum	2	15469.95	938.86	21397.67	14531.1	16408.81	15469.95
7	Antimony	4	0.37	0.055	0.47	0.2	0.68	0.27
7	Arsenic	10	16.67	5.374	26.52	4.25	63.84	16.67
7	Barium	2	142.99	15.922	243.52	127.06	158.91	142.99
7	Benzo(a)anthracene	2	0.21	0.02	0.31	0.19	0.22	0.21
7	Benzo(a)pyrene	2	0.54	0.08	1.07	0.46	0.63	0.54
7	Benzo(b)fluoranthene	2	0.05	0	0.07	0.04	0.05	0.05
7	Benzo(ghi)perylene	2	0.04	0	0.06	0.04	0.05	0.04
7	Beryllium	10	1.09	0.061	1.21	0.75	1.52	1.09
7	Boron	2	5.27	0.492	8.38	4.78	5.76	5.27
7	Cadmium	5	0.46	0.057	0.57	0.26	0.82	0.4
7	Calcium	2	5507.36	956.747	11548.03	4550.62	6464.11	5507.36
7	Chromium	10	29.73	3.935	36.94	19.15	58.61	29.73
7	Chrysene	2	0.03	0	0.05	0.03	0.04	0.03
7	Cobalt	2	13.36	0.113	14.07	13.24	13.47	13.36
7	Copper	10	23.66	2.404	28.06	14.82	37.25	23.66
7	Fluoranthene	1	0.26	0.09	0.83	0.17	0.35	0.17
7	Indeno(1,2,3-cd)pyrene	2	0.04	0	0.05	0.04	0.04	0.04
7	Iron	2	26615.44	2320.46	41266.26	24294.98	28935.9	26615.44

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
7	Lead	10	20.9	1.87	24.32	13.58	30.09	20.9
7	Magnesium	2	2485.09	186.65	3663.54	2298.44	2671.74	2485.09
7	Manganese	2	1295.65	282.74	3080.82	1012.9	1578.39	1295.65
7	Mercury	2	0.13	0.023	0.17	0.05	0.23	0.12
7	Nickel	10	26.14	1.959	29.73	17.71	41.02	26.14
7	Phenanthrene	2	0.04	0.014	0.13	0.03	0.05	0.04
7	Potassium	2	1720.37	296.896	3594.9	1423.48	2017.27	1720.37
7	Pyrene	2	0.06	0.01	0.13	0.05	0.07	0.06
7	Selenium	8	2.03	0.885	3.66	0.27	9.5	2.04
7	Silver	7	0.09	0.025	0.14	0.02	0.26	0.1
7	Sodium	2	50.82	3.464	72.69	47.35	54.28	50.82
7	Thallium	1	0.4	0.03	0.45	0.25	0.57	0.57
7	Uranium	2	0.76	0.022	0.89	0.73	0.78	0.76
7	Vanadium	2	36.75	5.903	74.02	30.84	42.65	36.75
7	Zinc	10	76.86	6.224	88.27	46.29	103.68	76.86
2.04	2-Methylnaphthalene	4	0.15	0.1	0.38	0.03	0.44	0.15
2.04	4-Nitrophenol	1	0.991	0.497	2.161	0.193	2.444	0.193
2.04	Aluminum	3	9225.09	862.83	11744.55	7583	10505.59	9225.09
2.04	Arsenic	4	6.42	1.41	9.74	4.17	10.21	6.42

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
2.04	Barium	3	101.8	19.56	158.91	65.21	132.06	101.8
2.04	Benzo(a)anthracene	1	0.27	0.08	0.47	0.1	0.5	0.1
2.04	Benzo(a)pyrene	3	0.36	0.07	0.53	0.17	0.5	0.31
2.04	Benzo(b)fluoranthene	3	0.187	0.108	0.441	0.019	0.503	0.082
2.04	Benzo(ghi)perylene	3	0.199	0.104	0.444	0.062	0.503	0.097
2.04	Benzo(k)fluoranthene	1	0.257	0.097	0.485	0.031	0.503	0.031
2.04	Beryllium	4	0.66	0.08	0.85	0.44	0.78	0.66
2.04	Bis(2-ethylhexyl)phthalate	3	0.227	0.128	0.527	0.045	0.589	0.183
2.04	Boron	3	3.42	0.23	4.08	3.16	3.87	3.42
2.04	Cadmium	4	0.34	0.06	0.48	0.2	0.48	0.34
2.04	Calcium	3	6516.11	1376.29	10534.86	4470	9133.72	6516.11
2.04	Chromium	4	14.19	1.09	16.77	11.01	16.02	14.19
2.04	Chrysene	3	0.21	0.1	0.445	0.066	0.503	0.112
2.04	Cobalt	3	15.32	3.29	24.92	9.32	20.65	15.32
2.04	Copper	4	10.12	0.83	12.07	8.45	12.32	10.12
2.04	Di-n-butylphthalate	2	0.33	0.05	0.45	0.22	0.44	0.4
2.04	Dibenzofuran	1	0.257	0.097	0.485	0.03	0.503	0.03
2.04	Diethylphthalate	1	0.26	0.1	0.49	0.03	0.5	0.03
2.04	Fluoranthene	4	0.187	0.051	0.306	0.095	0.331	0.187
2.04	Fluorene	1	0.28	0.08	0.47	0.11	0.5	0.11

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
2.04	Indeno(1,2,3-cd)pyrene	3	0.198	0.104	0.444	0.055	0.503	0.097
2.04	Iron	3	16701.42	2463.58	23895.04	11927.27	20143.64	16701.42
2.04	Kjeldahl nitrogen	3	888.14	290.11	1735.25	314.43	1250	888.14
2.04	Magnesium	3	2933.04	608.91	4711.06	2250	4147.73	2933.04
2.04	Manganese	3	2716.64	1067.54	5833.85	795.7	4484.22	2716.64
2.04	Mercury	4	0.12	0.04	0.23	0.07	0.25	0.12
2.04	Naphthalene	4	0.14	0.11	0.4	0.02	0.47	0.14
2.04	Nickel	4	13.72	0.94	15.93	11.31	15.39	13.72
2.04	Pentachlorophenol	1	1.1	0.69	3.11	0.17	2.44	0.17
2.04	Phenanthrene	4	0.14	0.07	0.3	0.02	0.33	0.14
2.04	Potassium	3	952.54	3.78	963.58	947.64	959.97	952.54
2.04	Pyrene	2	0.234	0.069	0.397	0.035	0.356	0.115
2.04	Selenium	1	1.06	0.69	3.07	0.33	2.44	0.33
2.04	Silver	4	0.24	0.11	0.49	0.07	0.55	0.24
2.04	Sodium	3	32.99	2.52	40.34	28	36.08	32.99
2.04	Total combustible organics (TCO)	3	349377.8	39039.13	463371.5	293000	424346.	2349377.8
2.04	Total organic carbon (TOC)	3	9550	2784.76	17681.75	4050	13058.56	9550.29
2.04	Uranium	3	0.6	0.19	1.14	0.35	0.96	0.6
2.04	Vanadium	3	16.32	2.27	22.96	12.2	20.04	16.32
2.04	Zinc	4	60.84	3.34	68.7	52.6	67.55	60.84

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.01	Aluminum	1	6954.67	.	.	6954.67	6954.67	6954.67
3.01	Arsenic	1	1.31	.	.	1.31	1.31	1.31
3.01	Barium	1	59.54	.	.	59.54	59.54	59.54
3.01	Benzo(b)fluoranthene	1	0.162	.	.	0.162	0.162	0.162
3.01	Beryllium	1	0.53	.	.	0.53	0.53	0.53
3.01	Bis(2-ethylhexyl)phthalate	1	0.025	.	.	0.025	0.025	0.025
3.01	Cadmium	1	0.09	.	.	0.09	0.09	0.09
3.01	Calcium	1	496.15	.	.	496.15	496.15	496.15
3.01	Chromium	1	10.26	.	.	10.26	10.26	10.26
3.01	Chrysene	1	0.158	.	.	0.158	0.158	0.158
3.01	Cobalt	1	9.74	.	.	9.74	9.74	9.74
3.01	Copper	1	5.4	.	.	5.4	5.4	5.4
3.01	Di-n-butylphthalate	1	0.02	.	.	0.02	0.02	0.02
3.01	Diethylphthalate	1	0.08	.	.	0.08	0.08	0.08
3.01	Fluoranthene	1	0.161	.	.	0.161	0.161	0.016
3.01	Heptachlor	1	0	.	.	0	0	0
3.01	Iron	1	10908.23	.	.	10908.23	10908.23	10908.23
3.01	Kjeldahl nitrogen	1	76.84	.	.	76.84	76.84	76.84
3.01	Lead	1	8.48	.	.	8.48	8.48	8.48
3.01	Magnesium	1	950.43	.	.	950.43	950.43	950.43

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.01	Manganese	1	319.04	.	.	319.04	319.04	319.04
3.01	Mercury	1	0.04	.	.	0.04	0.04	0.04
3.01	Nickel	1	10.34	.	.	10.34	10.34	10.34
3.01	Pentachlorophenol	1	0.15	.	.	0.15	0.15	0.15
3.01	Phenanthrene	1	0.16	.	.	0.16	0.16	0.16
3.01	Potassium	1	606.14	.	.	606.14	606.14	606.14
3.01	Pyrene	1	0.026	.	.	0.026	0.026	0.026
3.01	Silver	1	0.03	.	.	0.03	0.03	0.03
3.01	Sodium	1	22.62	.	.	22.62	22.62	22.62
3.01	Total combustible organics (TCO)	1	33449.94	.	.	33449.94	33449.9	433449.94
3.01	Total organic carbon (TOC)	1	6287.04	.	.	6287.04	6287.04	6287.04
3.01	Uranium	1	0.61	.	.	0.61	0.61	0.61
3.01	Vanadium	1	10.55	.	.	10.55	10.55	10.55
3.01	Zinc	1	28.21	.	.	28.21	28.21	28.21
3.02	2-Methylnaphthalene	3	0.2	0.08	0.38	0.06	0.41	0.13
3.02	3-Nitroaniline	3	652.94	234.97	1339.05	369.06	1119.21	652.94
3.02	Acenaphthene	2	0.25	0.05	0.38	0.17	0.41	0.19
3.02	Acenaphthylene	1	0.251	0.061	0.395	0.119	0.414	0.119
3.02	Aluminum	3	12227.09	2036.55	18173.79	9444.22	16194.25	12227.09

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.02	Anthracene	2	0.258	0.053	0.382	0.183	0.414	0.196
3.02	Antimony	1	0.46	0.08	0.7	0.3	0.59	0.3
3.02	Arsenic	5	3.36	0.79	5.05	1.45	6.26	3.36
3.02	Barium	3	107.76	3	116.51	101.85	111.61	107.76
3.02	Benzo(a)anthracene	2	0.413	0.193	0.867	0.062	0.95	0.284
3.02	Benzo(a)pyrene	3	0.35	0.088	0.556	0.194	0.568	0.299
3.02	Benzo(b)fluoranthene	3	0.397	0.208	0.887	0.056	0.978	0.318
3.02	Benzo(ghi)perylene	1	0.284	0.044	0.387	0.224	0.414	0.25
3.02	Benzo(k)fluoranthene	3	0.311	0.053	0.436	0.213	0.408	0.308
3.02	Beryllium	5	0.55	0.1	0.77	0.3	0.81	0.55
3.02	Bis(2-ethylhexyl)phthalate	3	0.265	0.076	0.443	0.125	0.401	0.22
3.02	Boron	3	5.04	2.17	11.36	2.57	9.36	5.04
3.02	Butylbenzylphthalate	1	0.23	0.08	0.41	0.03	0.41	0.03
3.02	Cadmium	5	0.51	0.19	0.91	0.23	1.24	0.51
3.02	Calcium	3	2226.89	562.48	3869.32	1309.63	3249.54	2226.89
3.02	Carbazole	2	0.18	0.03	0.27	0.12	0.22	0.16
3.02	Chromium	5	17.79	3.07	24.32	9.28	28.16	17.79
3.02	Chrysene	2	0.35	0.143	0.686	0.047	0.715	0.214
3.02	Cobalt	3	17.23	1.87	22.69	13.83	20.28	17.23
3.02	Copper	5	18.28	5.21	29.39	9.26	37.95	18.28

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.02	Dibenz(a,h)anthracene	1	0.237	0.072	0.406	0.064	0.414	0.064
3.02	Dibenzofuran	2	0.241	0.063	0.389	0.113	0.414	0.164
3.02	Fluoranthene	3	0.527	0.292	1.214	0.084	1.378	0.492
3.02	Fluorene	2	0.26	0.05	0.38	0.2	0.41	0.2
3.02	Indeno(1,2,3-cd)pyrene	2	0.294	0.047	0.404	0.214	0.414	0.25
3.02	Iron	3	19420.86	911.48	22082.35	17598.69	20378.28	19420.86
3.02	Magnesium	3	1761.5	280.02	2579.14	1209.94	2121.32	1761.5
3.02	Manganese	3	855.85	144.22	1276.96	575.99	1056.22	855.85
3.02	Mercury	5	1.68	1.12	4.07	0.03	6.1	1.68
3.02	Naphthalene	2	0.21	0.08	0.39	0.04	0.41	0.1
3.02	Nickel	5	29.58	10.7	52.39	7.78	70.58	29.58
3.02	PCB-1248	1	0.154	0.091	0.368	0.009	0.388	0.208
3.02	PCB-1254	3	0.32	0.181	0.745	0.01	0.73	0.32
3.02	PCB-1260	1	0.27	0.183	0.704	0.01	0.79	0.28
3.02	Phenanthrene	3	0.52	0.3	1.23	0.04	1.4	0.47
3.02	Phenol	1	0.28	0.467	0.385	0.22	0.41	0.22
3.02	Potassium	3	1262.24	229.87	1933.45	921.29	1699.79	1262.24
3.02	Pyrene	3	0.501	0.272	1.141	0.076	1.29	0.464
3.02	Selenium	2	0.73	0.28	1.39	0.25	1.4	0.28
3.02	Silver	5	0.3	0.22	0.76	0.02	1.17	0.3

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.02	Sodium	3	49.96	0.14	50.36	49.69	50.15	49.96
3.02	Uranium	3	6.96	4.8	20.99	1.17	16.49	6.96
3.02	Vanadium	3	18.63	1.94	24.29	15.41	22.12	18.63
3.02	Zinc	5	76.88	18.74	116.83	49.74	149.85	76.88
3.03	Acenaphthene	1	0.03	.	.	0.03	0.03	0.03
3.03	Acenaphthylene	1	0.121	.	.	0.121	0.121	0.121
3.03	Aluminum	1	14985.24	.	.	14985.24	14985.24	14985.24
3.03	Anthracene	1	0.042	.	.	0.042	0.042	0.042
3.03	Arsenic	1	5.28	.	.	5.28	5.28	5.28
3.03	Barium	1	120.6	.	.	120.6	120.6	120.6
3.03	Benzo(a)anthracene	1	0.231	.	.	0.231	0.231	0.231
3.03	Benzo(a)pyrene	1	0.159	.	.	0.159	0.159	0.159
3.03	Benzo(b)fluoranthene	1	0.285	.	.	0.285	0.285	0.285
3.03	Benzo(ghi)perylene	1	0.175	.	.	0.175	0.175	0.175
3.03	Benzo(k)fluoranthene	1	0.067	.	.	0.067	0.067	0.067
3.03	Beryllium	1	0.92	.	.	0.92	0.92	0.92
3.03	Boron	1	12	.	.	12	12	12
3.03	Cadmium	1	3.31	.	.	3.31	3.31	3.31
3.03	Calcium	1	2594.28	.	.	2594.28	2594.28	2594.28

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.03	Carbazole	1	0.05	.	.	0.05	0.05	0.05
3.03	Chromium	1	44.36	.	.	44.36	44.36	44.36
3.03	Chrysene	1	0.238	.	.	0.238	0.238	0.238
3.03	Cobalt	1	20.12	.	.	20.12	20.12	20.12
3.03	Copper	1	36.3	.	.	36.3	36.3	36.3
3.03	Dibenz(a,h)anthracene	1	0.036	.	.	0.036	0.036	0.036
3.03	Dibenzofuran	1	0.105	.	.	0.105	0.105	0.105
3.03	Fluoranthene	1	0.479	.	.	0.479	0.479	0.479
3.03	Fluorene	1	0.05	.	.	0.05	0.05	0.05
3.03	Indeno(1,2,3-cd)pyrene	1	0.162	.	.	0.162	0.162	0.162
3.03	Iron	1	24873.89	.	.	24873.89	24873.89	24873.89
3.03	Kjeldahl nitrogen	1	608.8	.	.	608.8	608.8	608.8
3.03	Lead	1	37.73	.	.	37.73	37.73	37.73
3.03	Magnesium	1	2238.63	.	.	2238.63	2238.63	2238.63
3.03	Manganese	1	692.45	.	.	692.45	692.45	692.45
3.03	Mercury	1	6.67	.	.	6.67	6.67	6.67
3.03	Naphthalene	1	0.21	.	.	0.21	0.21	0.21
3.03	Nickel	1	62.44	.	.	62.44	62.44	62.44
3.03	Phenanthrene	1	0.38	.	.	0.38	0.38	0.38
3.03	Phenol	1	0.21	.	.	0.21	0.21	0.21

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.03	Potassium	1	1719.32	.	.	1719.32	1719.32	1719.32
3.03	Pyrene	1	0.296	.	.	0.296	0.296	0.296
3.03	Silver	1	3.32	.	.	3.32	3.32	3.32
3.03	Sodium	1	74.33	.	.	74.33	74.33	74.33
3.03	Total combustible organics (TCO)	1	89231.29	.	.	89231.29	89231.2	989231.29
3.03	Total organic carbon (TOC)	1	16964.8	.	.	16964.8	16964.8	16964.8
3.03	Uranium	1	8.7	.	.	8.7	8.7	8.7
3.03	Vanadium	1	21.52	.	.	21.52	21.52	21.52
3.03	Zinc	1	160.94	.	.	160.94	160.94	160.94
3.04	1,4-Dichlorobenzene	1	0.25	0.016	0.298	0.23	0.28	0.23
3.04	2-Methylnaphthalene	3	0.12	0.07	0.32	0.04	0.26	0.12
3.04	4-Chloro-3-methylphenol	1	0.241	0.027	0.319	0.19	0.281	0.19
3.04	4-Methylphenol	1	0.26	0.011	0.294	0.25	0.28	0.28
3.04	Acenaphthene	3	0.17	0.01	0.2	0.15	0.19	0.17
3.04	Acenaphthylene	2	0.211	0.036	0.315	0.165	0.281	0.176
3.04	Aluminum	3	16118.21	2700.13	24002.55	11183.31	20484.92	16118.21
3.04	Anthracene	1	0.216	0.034	0.315	0.149	0.253	0.149
3.04	Arsenic	3	40.96	26.96	119.69	5.32	93.83	40.96
3.04	Barium	3	195.4	53.77	352.41	104.12	290.28	195.4

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.04	Benzo(a)anthracene	3	0.123	0.023	0.19	0.09	0.167	0.123
3.04	Benzo(a)pyrene	3	0.13	0.045	0.263	0.084	0.221	0.13
3.04	Benzo(b)fluoranthene	3	0.169	0.035	0.272	0.115	0.235	0.169
3.04	Benzo(ghi)perylene	2	0.17	0.044	0.298	0.096	0.247	0.132
3.04	Benzo(k)fluoranthene	1	0.179	0.071	0.386	0.037	0.253	0.037
3.04	Beryllium	3	1.23	0.27	2.02	0.75	1.69	1.23
3.04	Bis(2-ethylhexyl)phthalate	2	0.45	0.258	1.203	0.1	0.95	0.39
3.04	Boron	3	24.25	9.8	52.85	14.2	43.84	24.25
3.04	Butylbenzylphthalate	2	0.22	0.02	0.29	0.17	0.25	0.2
3.04	Cadmium	3	2.39	1.6	7.07	0.79	5.6	2.39
3.04	Calcium	3	4196	1204.27	7712.45	2196	6358.23	4196
3.04	Carbazole	1	0.19	0.06	0.37	0.06	0.25	0.06
3.04	Chromium	3	33.71	4.98	48.26	23.76	39.19	33.71
3.04	Chrysene	3	0.121	0.015	0.163	0.093	0.143	0.121
3.04	Cobalt	3	16.71	0.97	19.55	14.87	18.18	16.71
3.04	Copper	3	52.36	14.02	93.31	24.37	68.03	52.36
3.04	Dibenz(a,h)anthracene	1	0.173	0.077	0.397	0.02	0.253	0.02
3.04	Dibenzofuran	2	0.182	0.057	0.347	0.069	0.247	0.149
3.04	Diethylphthalate	2	0.21	0.06	0.37	0.1	0.28	0.17
3.04	Fluoranthene	3	0.165	0.041	0.284	0.09	0.231	0.165

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.04	Fluorene	2	0.17	0.07	0.37	0.03	0.25	0.13
3.04	Indeno(1,2,3-cd)pyrene	2	0.163	0.049	0.307	0.076	0.247	0.12
3.04	Iron	3	27969.13	4470.86	41023.98	21234.41	36430.46	27969.13
3.04	Kjeldahl nitrogen	3	286.87	77.86	514.23	179.77	438.33	286.87
3.04	Lead	3	25.08	2.02	30.97	21.07	27.43	25.08
3.04	Magnesium	3	1914.53	94.58	2190.71	1732.66	2050.53	1914.53
3.04	Manganese	3	660.01	41.21	780.34	593.54	735.44	660.01
3.04	Mercury	3	12.45	6.66	31.9	4.54	25.69	12.45
3.04	Naphthalene	3	0.16	0.02	0.22	0.13	0.2	0.16
3.04	Nickel	3	44.05	4.94	58.48	34.37	50.61	44.05
3.04	PCB-1248	2	0.032	0.017	0.081	0.011	0.065	0.034
3.04	PCB-1254	3	0.08	0.052	0.23	0.01	0.18	0.08
3.04	PCB-1260	3	0.07	0.03	0.153	0.03	0.13	0.07
3.04	Phenanthrene	3	0.14	0.05	0.28	0.07	0.24	0.14
3.04	Phenol	1	0.19	0.061	0.366	0.07	0.25	0.07
3.04	Potassium	3	1809.08	348.47	2826.6	1218.89	2425.19	1809.08
3.04	Pyrene	3	0.163	0.032	0.258	0.104	0.215	0.163
3.04	Selenium	2	1.03	0.27	1.82	0.74	1.57	1.05
3.04	Silver	3	0.98	0.23	1.64	0.64	1.41	0.98
3.04	Sodium	3	181.92	66.71	376.72	74.69	304.29	181.92

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
3.04	Thallium	2	0.41	0.16	0.87	0.21	0.72	0.38
3.04	Total combustible organics (TCO)	3	56402.65	9807.72	85041.04	41013.54	74630.74	56402.65
3.04	Total organic carbon (TOC)	1	13474.22	.	.	13474.22	13474.22	13474.22
3.04	Uranium	3	8.52	3.86	19.79	3.44	16.1	8.52
3.04	Vanadium	3	37.79	11.83	72.34	18.27	59.14	37.79
3.04	Zinc	3	103.49	6.66	122.95	92.56	115.56	103.49
4.01	2-Methylnaphthalene	2	0.25	0.13	0.62	0.08	0.5	0.13
4.01	Acenaphthene	1	0.28	0.11	0.61	0.12	0.5	0.12
4.01	Aluminum	2	9432.43	2521.42	25352.03	6911.01	11953.85	9432.43
4.01	Anthracene	1	0.282	0.112	0.609	0.124	0.499	0.124
4.01	Arsenic	3	5.38	2.34	12.21	2.27	9.96	5.38
4.01	Barium	2	70.33	8.7	125.28	61.63	79.04	70.33
4.01	Benzo(a)anthracene	1	0.271	0.12	0.621	0.092	0.499	0.092
4.01	Benzo(a)pyrene	1	0.263	0.1257	0.63048	0.0692	0.499	0.069
4.01	Benzo(b)fluoranthene	1	0.279	0.114	0.612	0.116	0.499	0.116
4.01	Benzo(ghi)perylene	1	0.261	0.128	0.634	0.062	0.499	0.062
4.01	Benzo(k)fluoranthene	1	0.294	0.103	0.595	0.172	0.499	0.172
4.01	Beryllium	3	0.64	0.08	0.88	0.5	0.77	0.64
4.01	Bis(2-ethylhexyl)phthalate	3	0.336	0.316	1.259	0.02	0.968	0.336

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
4.01	Boron	2	6.29	1.17	13.71	5.12	7.47	6.29
4.01	Cadmium	3	0.36	0.15	0.78	0.17	0.65	0.36
4.01	Calcium	2	2201.81	151.08	3155.72	2050.72	2352.89	2201.81
4.01	Carbazole	1	0.17	0.05	0.49	0.12	0.22	0.12
4.01	Chromium	3	16.89	0.9	19.5	15.23	18.31	16.89
4.01	Chrysene	2	0.251	0.127	0.621	0.082	0.499	0.126
4.01	Cobalt	2	7.83	0.8	12.88	7.02	8.63	7.83
4.01	Copper	3	11.6	4.91	25.94	6.24	21.41	11.6
4.01	Dibenz(a,h)anthracene	1	0.281	0.112	0.61	0.123	0.499	0.123
4.01	Dibenzofuran	1	0.259	0.129	0.636	0.055	0.499	0.055
4.01	Fluoranthene	3	0.28	0.105	0.586	0.174	0.489	0.28
4.01	Fluorene	1	0.29	0.11	0.6	0.15	0.5	0.15
4.01	Heptachlor	2	0.03	0.03	0.13	0	0.1	0
4.01	Iron	2	13266.98	1638.76	23613.69	11628.22	14905.74	13266.98
4.01	Kjeldahl nitrogen	2	341.97	72.11	797.25	269.86	414.08	341.97
4.01	Lead	3	13.84	1.35	17.77	11.74	16.35	13.84
4.01	Magnesium	2	1819.82	239.15	3329.77	1580.67	2058.98	1819.82
4.01	Manganese	2	566.15	275.33	2304.52	290.82	841.48	566.15
4.01	Mercury	3	4.56	3.81	15.68	0.33	12.16	4.56
4.01	N-Nitroso-di-n-propylamine	1	0.31	0.094	0.586	0.21	0.499	0.499

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
4.01	Naphthalene	2	0.19	0.16	0.64	0.02	0.5	0.03
4.01	Nickel	3	16.11	2.25	22.68	11.88	19.54	16.11
4.01	PCB-1254	3	0.15	0.13	0.52	0.01	0.4	0.15
4.01	PCB-1260	1	0.7	0.68	2.69	0.01	2.06	0.01
4.01	Pentachlorophenol	1	1.13	0.64	3.01	0.44	2.42	0.44
4.01	Phenanthrene	3	0.27	0.12	0.61	0.13	0.5	0.27
4.01	Phenol	1	0.3	0.1	0.59	0.18	0.5	0.18
4.01	Potassium	2	1255.17	331.63	3349.02	923.54	1586.8	1255.17
4.01	Pyrene	3	0.274	0.11	0.594	0.156	0.493	0.274
4.01	Selenium	1	0.26	0.06	0.44	0.19	0.38	0.21
4.01	Silver	3	0.64	0.58	2.33	0.05	1.8	0.64
4.01	Sodium	2	36.23	5.21	69.13	31.02	41.44	36.23
4.01	Total combustible organics (TCO)	2	43818.41	2505.17	59635.46	41313.24	46323.59	43818.41
4.01	Total organic carbon (TOC)	2	8983.19	737.75	13641.17	8245.44	9720.94	8983.19
4.01	Uranium	2	0.55	0.16	1.55	0.39	0.71	0.55
4.01	Vanadium	2	13.75	2.13	27.23	11.62	15.89	13.75
4.01	Zinc	3	57.37	5.7	74.02	46.37	65.48	57.37
4.02	2-Methylnaphthalene	1	0.03	.	.	0.03	0.03	0.03
4.02	Aluminum	1	7610	.	.	7610	7610	7610

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
4.02	Arsenic	1	11.2	.	.	11.2	11.2	11.2
4.02	Barium	1	107	.	.	107	107	107
4.02	Benzo(b)fluoranthene	1	0.016	.	.	0.016	0.016	0.016
4.02	Beryllium	1	0.67	.	.	0.67	0.67	0.67
4.02	Bis(2-ethylhexyl)phthalate	1	0.058	.	.	0.058	0.058	0.058
4.02	Boron	1	3.5	.	.	3.5	3.5	3.5
4.02	Cadmium	1	0.19	.	.	0.19	0.19	0.19
4.02	Calcium	1	1500	.	.	1500	1500	1500
4.02	Chromium	1	14.3	.	.	14.3	14.3	14.3
4.02	Cobalt	1	8	.	.	8	8	8
4.02	Copper	1	6.3	.	.	6.3	6.3	6.3
4.02	Iron	1	13300	.	.	13300	13300	13300
4.02	Kjeldahl nitrogen	1	394	.	.	394	394	394
4.02	Lead	1	9.7	.	.	9.7	9.7	9.7
4.02	Magnesium	1	1180	.	.	1180	1180	1180
4.02	Manganese	1	665	.	.	665	665	665
4.02	Mercury	1	0.34	.	.	0.34	0.34	0.34
4.02	Naphthalene	1	0.02	.	.	0.02	0.02	0.02
4.02	Nickel	1	13.3	.	.	13.3	13.3	13.3
4.02	Phenanthrene	1	0.02	.	.	0.02	0.02	0.02

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
4.02	Potassium	1	849	.	.	849	849	849
4.02	Pyrene	1	0.017	.	.	0.017	0.017	0.017
4.02	Silver	1	0.04	.	.	0.04	0.04	0.04
4.02	Sodium	1	21.1	.	.	21.1	21.1	21.1
4.02	Uranium	1	0.31	.	.	0.31	0.31	0.31
4.02	Vanadium	1	12.2	.	.	12.2	12.2	12.2
4.02	Zinc	1	46.8	.	.	46.8	46.8	46.8
4.03	2-Methylnaphthalene	2	0.16	0.07	0.58	0.09	0.23	0.16
4.03	Acenaphthene	1	0.19	0.08	0.68	0.11	0.27	0.11
4.03	Aluminum	2	13152.81	1448.24	22296.65	11704.57	14601.05	13152.81
4.03	Anthracene	1	0.189	0.078	0.681	0.111	0.267	0.111
4.03	Arsenic	2	6.56	1.28	14.63	5.29	7.84	6.56
4.03	Barium	2	116.63	13.01	198.77	103.62	129.64	116.63
4.03	Benzo(a)anthracene	2	0.089	0.023	0.231	0.066	0.111	0.089
4.03	Benzo(a)pyrene	2	0.262	0.221	1.655	0.041	0.482	0.262
4.03	Benzo(b)fluoranthene	2	0.126	0.05	0.445	0.076	0.177	0.126
4.03	Benzo(ghi)perylene	2	0.063	0.026	0.225	0.038	0.089	0.063
4.03	Benzo(k)fluoranthene	2	0.032	0.01	0.094	0.022	0.042	0.032
4.03	Beryllium	2	0.93	0.16	1.92	0.77	1.08	0.93

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
4.03	Bis(2-ethylhexyl)phthalate	2	0.176	0.108	0.86	0.067	0.284	0.176
4.03	Boron	2	3.75	0.2	5	3.55	3.95	3.75
4.03	Cadmium	2	0.58	0.02	0.71	0.55	0.6	0.58
4.03	Calcium	2	3729.12	629.85	7705.84	3099.27	4358.97	3729.12
4.03	Chromium	2	34.13	2.78	51.67	31.35	36.91	34.13
4.03	Chrysene	2	0.102	0.032	0.302	0.07	0.133	0.102
4.03	Cobalt	2	19.61	5.38	53.59	14.23	24.99	19.61
4.03	Copper	2	29.26	6.63	71.15	22.63	35.9	29.26
4.03	Dibenz(a,h)anthracene	1	0.145	0.122	0.913	0.023	0.267	0.023
4.03	Dibenzofuran	2	0.04	0.017	0.149	0.023	0.057	0.04
4.03	Fluoranthene	2	0.133	0.028	0.307	0.105	0.16	0.133
4.03	Fluorene	1	0.15	0.12	0.9	0.03	0.27	0.03
4.03	Indeno(1,2,3-cd)pyrene	2	0.065	0.024	0.219	0.041	0.089	0.065
4.03	Iron	2	23180.05	2543.58	39239.56	20636.47	25723.62	23180.05
4.03	Kjeldahl nitrogen	2	1216.87	288.86	3040.65	928.01	1505.72	1216.87
4.03	Lead	2	34.38	4.37	61.96	30.01	38.75	34.38
4.03	Magnesium	2	2561.2	162.28	3585.8	2398.92	2723.48	2561.2
4.03	Manganese	2	1451.33	116.68	2188.01	1334.65	1568.01	1451.33
4.03	Mercury	2	3.36	0.16	4.37	3.2	3.52	3.36
4.03	Naphthalene	2	0.08	0.03	0.27	0.06	0.11	0.08

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
4.03	Nickel	2	35.8	4.38	63.44	31.43	40.18	35.8
4.03	PCB-1254	2	0.05	0.017	0.154	0.03	0.06	0.05
4.03	PCB-1260	2	0.03	0.003	0.051	0.03	0.03	0.03
4.03	Phenanthrene	2	0.15	0.06	0.5	0.09	0.2	0.15
4.03	Potassium	2	1235.07	124.41	2020.57	1110.66	1359.48	1235.07
4.03	Pyrene	2	0.136	0.034	0.349	0.103	0.17	0.136
4.03	Selenium	1	0.65	0.29	2.5	0.35	0.94	0.35
4.03	Silver	2	0.4	0.01	0.48	0.39	0.41	0.4
4.03	Sodium	2	46.19	0.43	48.88	45.77	46.62	46.19
4.03	Uranium	2	1.95	0.23	3.38	1.73	2.18	1.95
4.03	Vanadium	2	24.31	2.85	42.31	21.46	27.16	24.31
4.03	Zinc	2	102.31	12.09	178.63	90.22	114.4	102.31
4.04	2-Methylnaphthalene	11	0.5	0.284	1.01	0.07	3.54	0.22
4.04	Aluminum	11	14502.77	1228.59	16729.55	7370	20260.22	14502.77
4.04	Antimony	1	0.6	0.055	0.7	0.27	0.78	0.41
4.04	Arsenic	12	9.36	0.536	10.33	6.02	12.16	9.36
4.04	Barium	11	123.32	8.219	138.22	76.4	154.28	123.32
4.04	Benzo(a)anthracene	10	0.54	0.29	1.06	0.07	3.54	0.17
4.04	Benzo(a)pyrene	8	1.12	0.25	1.56	0.06	3.54	0.77

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
4.04	Benzo(b)fluoranthene	11	0.421	0.284	0.93	0.085	3.539	0.137
4.04	Benzo(ghi)perylene	6	0.937	0.27	1.422	0.071	3.539	0.345
4.04	Beryllium	12	1.14	0.05	1.23	0.82	1.42	1.14
4.04	Bis(2-ethylhexyl)phthalate	8	0.528	0.188	0.864	0.07	1.868	0.104
4.04	Boron	11	5.46	0.346	6.09	3.67	7.33	5.46
4.04	Cadmium	12	0.58	0.078	0.73	0.45	1.41	0.58
4.04	Calcium	11	2794.18	120.63	3012.82	1815.76	3313.96	2794.18
4.04	Chromium	12	22.46	2.064	26.17	10.7	33.38	22.46
4.04	Chrysene	8	0.673	0.296	1.206	0.066	3.539	0.113
4.04	Cobalt	11	18.71	1.544	21.5	11.6	26.01	18.71
4.04	Copper	12	37.09	3.173	42.79	18.8	53.42	37.09
4.04	Dibenz(a,h)anthracene	1	1.2	0.22	1.6	0.41	3.54	0.41
4.04	Fluoranthene	11	0.428	0.283	0.936	0.092	3.539	0.145
4.04	Indeno(1,2,3-cd)pyrene	2	1.185	0.223	1.584	0.447	3.539	0.63
4.04	Iron	11	23862.38	1855.06	27224.6	12900	30564.46	23862.38
4.04	Lead	12	30.28	2.32	34.45	14.8	46.38	30.28
4.04	Magnesium	11	2007.91	134.63	2251.92	1270	2697.99	2007.91
4.04	Manganese	11	1408.81	141.42	1665.12	617	2009.59	1408.81
4.04	Mercury	12	2.47	0.33	3.05	1.04	5.56	2.47
4.04	Naphthalene	8	0.73	0.292	1.26	0.05	3.54	0.21

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
4.04	Nickel	12	32.01	1.95	35.51	20.5	40.12	32.01
4.04	PCB-1254	1	0.093	0.08	0.237	0.011	0.975	0.975
4.04	Phenanthrene	11	0.44	0.282	0.94	0.1	3.54	0.15
4.04	Potassium	11	1178.5	118.79	1393.79	478	1744	1178.5
4.04	Pyrene	11	0.442	0.282	0.948	0.099	3.539	0.16
4.04	Selenium	8	0.63	0.114	0.84	0.18	1.24	0.63
4.04	Silver	11	0.39	0.07	0.51	0.2	1	0.39
4.04	Sodium	11	61.57	3.581	68.06	39.72	76.48	61.57
4.04	Uranium	11	1.45	0.128	1.69	0.95	2.21	1.45
4.04	Vanadium	11	25.63	1.706	28.72	15.7	33.4	25.63
4.04	Zinc	12	129.22	6.847	141.51	91.58	156.8	129.22
13	2,4-Dimethylphenol	1	0.232	0.004	0.241	0.22	0.245	0.236
13	Phenol	1	0.248	0.033	0.319	0.174	0.373	0.174
13	PCB-1254	1	0.01	0	0.011	0.009	0.012	0.012
13	Bis(2-ethylhexyl)phthalate	5	0.072	0.008	0.089	0.054	0.094	0.072
13	Anthracene	1	0.246	0.035	0.32	0.163	0.373	0.163
13	Pyrene	4	0.132	0.035	0.207	0.048	0.23	0.107
13	Dibenzofuran	4	0.245	0.063	0.378	0.164	0.491	0.233
13	Benzo(ghi)perylene	4	0.169	0.034	0.241	0.044	0.23	0.154

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
13	Indeno(1,2,3-cd)pyrene	4	0.166	0.034	0.238	0.04	0.23	0.15
13	Benzo(b)fluoranthene	4	0.114	0.037	0.193	0.04	0.245	0.082
13	Fluoranthene	4	0.142	0.041	0.229	0.045	0.236	0.112
13	Benzo(k)fluoranthene	2	0.181	0.067	0.324	0.021	0.373	0.029
13	Acenaphthylene	1	0.245	0.036	0.322	0.149	0.373	0.149
13	Chrysene	4	0.105	0.034	0.176	0.042	0.23	0.073
13	Benzo(a)pyrene	5	0.255	0.087	0.441	0.036	0.441	0.255
13	Dibenz(a,h)anthracene	1	0.246	0.036	0.322	0.152	0.373	0.152
13	Benzo(a)anthracene	3	0.214	0.044	0.308	0.11	0.373	0.155
13	Benzoic acid	2	0.505	0.125	0.772	0.127	0.881	0.249
13	Aluminum	5	11100	675	12500	9620	13400	11100
13	Iron	5	16800	815	18600	14900	19100	16800
13	Lead	5	15.3	0.445	16.2	13.8	16.4	15.3
13	Magnesium	5	1550	56.4	1680	1390	1690	1550
13	Manganese	5	585	122	845	240	905	585
13	Mercury	5	0.941	0.856	2.77	0.037	4.37	0.941
13	Nickel	5	24.2	4.24	33.2	17.5	40	24.2
13	Potassium	5	1260	53.9	1380	1120	1440	1260
13	Silver	5	0.058	0.011	0.082	0.037	0.094	0.058
13	Sodium	5	46.6	4.7	56.6	28.8	55.4	46.6

Table F6.2 (continued)

Reach	Chemical	Detects	Mean	SEM[a]	95% UCL[b]	Min	Max	PLE[c] Mean
13	Arsenic	5	3.23	0.261	3.79	2.56	4.04	3.23
13	Barium	5	97.6	6.67	112	82.8	122	97.6
13	Beryllium	5	0.696	0.04	0.783	0.6	0.834	0.696
13	Boron	5	7.14	1.29	9.89	2.08	9.15	7.14
13	Cadmium	5	0.201	0.055	0.319	0.08	0.376	0.201
13	Chromium	5	16	0.664	17.5	14.1	17.7	16
13	Cobalt	5	14.7	1.21	17.3	11.2	18.3	14.7
13	Copper	5	11	0.923	13	8.89	14.4	11
13	Uranium	5	1.17	0.387	1.99	0.714	2.71	1.17
13	Vanadium	5	17.7	0.754	19.3	16.3	20.1	17.7
13	Zinc	5	61.9	7.48	77.9	45.2	85.3	61.9
13	Calcium	5	1120	47.5	1220	997	1210	1120
13	Selenium	1	0.668	0.433	1.59	0.2	2.4	0.315
13	Acenaphthene	1	0.23	0.004	0.239	0.22	0.245	0.224
13	Di-n-butylphthalate	1	0.27	0.051	0.378	0.114	0.433	0.114
13	Phenanthrene	5	0.189	0.097	0.395	0.039	0.568	0.189
13	Butylbenzylphthalate	4	0.169	0.031	0.236	0.091	0.245	0.15
13	Fluorene	2	0.218	0.017	0.254	0.151	0.245	0.172
13	Carbazole	3	0.203	0.019	0.244	0.151	0.245	0.181
13	Naphthalene	5	0.306	0.236	0.81	0.041	1.25	0.306
13	2-Methylnaphthalene	5	0.423	0.31	1.08	0.052	1.66	0.423

[a] SEM = Standard error of the mean.
[b] UCL = Upper confidence limit.
[c] PLE = Product limit estimate.

Table F6.3. Deep water sediment concentrations within each subreach compared to background concentrations from reach 13 (a reference site)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
1	Arsenic	27.05	11.034	6.46	yes
1	Beryllium	1.377	0.808	1.392	no
1	Cadmium	1.549	0.727	0.402	yes
1	Chromium	45.478	19.604	32	no
1	Copper	36.307	29.087	22	yes
1	Lead	63.455	39.233	30.6	yes
1	Mercury	0.295	0.124	1.882	no
1	Nickel	49.209	23.319	48.4	no
1	Selenium	1.426	0.695	1.336	no
1	Silver	0.661	0.329	0.116	yes
1	Zinc	261.763	122.132	123.8	no
7	Aluminum	21397.67	16408.81	22200	no
7	Antimony	0.47	0.68	NA	yes
7	Arsenic	26.52	63.84	6.46	yes
7	Barium	243.52	158.91	195.2	no
7	Beryllium	1.21	1.52	1.392	yes
7	Boron	8.38	5.76	14.28	no
7	Cadmium	0.57	0.82	0.402	yes

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
7	Calcium	11548.03	6464.11	2240	yes
7	Chromium	36.94	58.61	32	yes
7	Cobalt	14.07	13.47	29.4	no
7	Copper	28.06	37.25	22	yes
7	Iron	41266.26	28935.9	33600	no
7	Lead	24.32	30.09	30.6	no
7	Magnesium	3663.54	2671.74	3100	no
7	Manganese	3080.82	1578.39	1170	yes
7	Mercury	0.17	0.23	1.882	no
7	Nickel	29.73	41.02	48.4	no
7	Potassium	3594.9	2017.27	2520	no
7	Selenium	3.66	9.5	1.336	yes
7	Silver	0.14	0.26	0.116	yes
7	Sodium	72.69	54.28	93.2	no
7	Thallium	0.45	0.57	NA	yes
7	Uranium	0.89	0.78	2.34	no
7	Vanadium	74.02	42.65	35.4	yes
7	Zinc	88.27	103.68	123.8	no

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
2.04	Aluminum	11744.55	10505.59	22200	no
2.04	Arsenic	9.74	10.21	6.46	yes
2.04	Barium	158.91	132.06	195.2	no
2.04	Beryllium	0.85	0.78	1.392	no
2.04	Boron	4.08	3.87	14.28	no
2.04	Cadmium	0.48	0.48	0.402	yes
2.04	Calcium	10534.86	9133.72	2240	yes
2.04	Chromium	16.77	16.02	32	no
2.04	Cobalt	24.92	20.65	29.4	no
2.04	Copper	12.07	12.32	22	no
2.04	Iron	23895.04	20143.64	33600	no
2.04	Magnesium	4711.06	4147.73	3100	yes
2.04	Manganese	5833.85	4484.22	1170	yes
2.04	Mercury	0.23	0.25	1.882	no
2.04	Nickel	15.93	15.39	48.4	no
2.04	Potassium	963.58	959.97	2520	no
2.04	Selenium	3.07	2.44	1.336	yes
2.04	Silver	0.49	0.55	0.116	yes
2.04	Sodium	40.34	36.08	93.2	no

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
2.04	Uranium	1.14	0.96	2.34	no
2.04	Vanadium	22.96	20.04	35.4	no
2.04	Zinc	68.7	67.55	123.8	no
3.01	Aluminum	.	6954.67	22200	no
3.01	Arsenic	.	1.31	6.46	no
3.01	Barium	.	59.54	195.2	no
3.01	Beryllium	.	0.53	1.392	no
3.01	Cadmium	.	0.09	0.402	no
3.01	Calcium	.	496.15	2240	no
3.01	Chromium	.	10.26	32	no
3.01	Cobalt	.	9.74	29.4	no
3.01	Copper	.	5.4	22	no
3.01	Iron	.	10908.23	33600	no
3.01	Lead	.	8.48	30.6	no
3.01	Magnesium	.	950.43	3100	no
3.01	Manganese	.	319.04	1170	no
3.01	Mercury	.	0.04	1.882	no
3.01	Nickel	.	10.34	48.4	no

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
3.01	Potassium	.	606.14	2520	no
3.01	Silver	.	0.03	0.116	no
3.01	Sodium	.	22.62	93.2	no
3.01	Uranium	.	0.61	2.34	no
3.01	Vanadium	.	10.55	35.4	no
3.01	Zinc	.	28.21	123.8	no
3.02	Aluminum	18173.79	16194.25	22200	no
3.02	Antimony	0.7	0.59	NA	yes
3.02	Arsenic	5.05	6.26	6.46	no
3.02	Barium	116.51	111.61	195.2	no
3.02	Beryllium	0.77	0.81	1.392	no
3.02	Boron	11.36	9.36	14.28	no
3.02	Cadmium	0.91	1.24	0.402	yes
3.02	Calcium	3869.32	3249.54	2240	yes
3.02	Chromium	24.32	28.16	32	no
3.02	Cobalt	22.69	20.28	29.4	no
3.02	Copper	29.39	37.95	22	yes
3.02	Iron	22082.35	20378.28	33600	no

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
3.02	Magnesium	2579.14	2121.32	3100	no
3.02	Manganese	1276.96	1056.22	1170	no
3.02	Mercury	4.07	6.1	1.882	yes
3.02	Nickel	52.39	70.58	48.4	yes
3.02	Selenium	1.39	1.4	1.336	yes
3.02	Silver	0.76	1.17	0.116	yes
3.02	Sodium	50.36	50.15	93.2	no
3.02	Uranium	20.99	16.49	2.34	yes
3.02	Vanadium	24.29	22.12	35.4	no
3.02	Zinc	116.83	149.85	123.8	yes
3.03	Aluminum	.	14985.24	22200	no
3.03	Arsenic	.	5.28	6.46	no
3.03	Barium	.	120.6	195.2	no
3.03	Beryllium	.	0.92	1.392	no
3.03	Boron	.	12	14.28	no
3.03	Cadmium	.	3.31	0.402	yes
3.03	Calcium	.	2594.28	2240	yes
3.03	Chromium	.	44.36	32	yes

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
3.03	Cobalt	.	20.12	29.4	no
3.03	Copper	.	36.3	22	yes
3.03	Iron	.	24873.89	33600	no
3.03	Lead	.	37.73	30.6	yes
3.03	Magnesium	.	2238.63	3100	no
3.03	Manganese	.	692.45	1170	no
3.03	Mercury	.	6.67	1.882	yes
3.03	Nickel	.	62.44	48.4	yes
3.03	Potassium	.	1719.32	2520	no
3.03	Silver	.	3.32	0.116	yes
3.03	Sodium	.	74.33	93.2	no
3.03	Uranium	.	8.7	2.34	yes
3.03	Vanadium	.	21.52	35.4	no
3.03	Zinc	.	160.94	123.8	yes
3.04	Aluminum	24002.55	20484.92	22200	no
3.04	Arsenic	119.69	93.83	6.46	yes
3.04	Barium	352.41	290.28	195.2	yes
3.04	Beryllium	2.02	1.69	1.392	yes

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
3.04	Boron	52.85	43.84	14.28	yes
3.04	Cadmium	7.07	5.6	0.402	yes
3.04	Calcium	7712.45	6358.23	2240	yes
3.04	Chromium	48.26	39.19	32	yes
3.04	Cobalt	19.55	18.18	29.4	no
3.04	Copper	93.31	68.03	22	yes
3.04	Iron	41023.98	36430.46	33600	yes
3.04	Lead	30.97	27.43	30.6	no
3.04	Magnesium	2190.71	2050.53	3100	no
3.04	Manganese	780.34	735.44	1170	no
3.04	Mercury	31.9	25.69	1.882	yes
3.04	Nickel	58.48	50.61	48.4	yes
3.04	Potassium	2826.6	2425.19	2520	no
3.04	Selenium	1.82	1.57	1.336	yes
3.04	Silver	1.64	1.41	0.116	yes
3.04	Sodium	376.72	304.29	93.2	yes
3.04	Thallium	0.87	0.72	NA	yes
3.04	Uranium	19.79	16.1	2.34	yes
3.04	Vanadium	72.34	59.14	35.4	yes

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
3.04	Zinc	122.95	115.56	123.8	no
4.01	Aluminum	25352.03	11953.85	22200	no
4.01	Arsenic	12.21	9.96	6.46	yes
4.01	Barium	125.28	79.04	195.2	no
4.01	Beryllium	0.88	0.77	1.392	no
4.01	Boron	13.71	7.47	14.28	no
4.01	Cadmium	0.78	0.65	0.402	yes
4.01	Calcium	3155.72	2352.89	2240	yes
4.01	Chromium	19.5	18.31	32	no
4.01	Cobalt	12.88	8.63	29.4	no
4.01	Copper	25.94	21.41	22	no
4.01	Iron	23613.69	14905.74	33600	no
4.01	Lead	17.77	16.35	30.6	no
4.01	Magnesium	3329.77	2058.98	3100	no
4.01	Manganese	2304.52	841.48	1170	no
4.01	Mercury	15.68	12.16	1.882	yes
4.01	Nickel	22.68	19.54	48.4	no
4.01	Potassium	3349.02	1586.8	2520	no

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
4.01	Selenium	0.44	0.38	1.336	no
4.01	Silver	2.33	1.8	0.116	yes
4.01	Sodium	69.13	41.44	93.2	no
4.01	Uranium	1.55	0.71	2.34	no
4.01	Vanadium	27.23	15.89	35.4	no
4.01	Zinc	74.02	65.48	123.8	no
4.02	Aluminum	.	7610	22200	no
4.02	Arsenic	.	11.2	6.46	yes
4.02	Barium	.	107	195.2	no
4.02	Beryllium	.	0.67	1.392	no
4.02	Boron	.	3.5	14.28	no
4.02	Cadmium	.	0.19	0.402	no
4.02	Calcium	.	1500	2240	no
4.02	Chromium	.	14.3	32	no
4.02	Cobalt	.	8	29.4	no
4.02	Copper	.	6.3	22	no
4.02	Iron	.	13300	33600	no
4.02	Lead	.	9.7	30.6	no

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
4.02	Magnesium	.	1180	3100	no
4.02	Manganese	.	665	1170	no
4.02	Mercury	.	0.34	1.882	no
4.02	Nickel	.	13.3	48.4	no
4.02	Potassium	.	849	2520	no
4.02	Silver	.	0.04	0.116	no
4.02	Sodium	.	21.1	93.2	no
4.02	Uranium	.	0.31	2.34	no
4.02	Vanadium	.	12.2	35.4	no
4.02	Zinc	.	46.8	123.8	no
4.03	Aluminum	22296.65	14601.05	22200	no
4.03	Arsenic	14.63	7.84	6.46	yes
4.03	Barium	198.77	129.64	195.2	no
4.03	Beryllium	1.92	1.08	1.392	no
4.03	Boron	5	3.95	14.28	no
4.03	Cadmium	0.71	0.6	0.402	yes
4.03	Calcium	7705.84	4358.97	2240	yes
4.03	Chromium	51.67	36.91	32	yes

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
4.03	Cobalt	53.59	24.99	29.4	no
4.03	Copper	71.15	35.9	22	yes
4.03	Iron	39239.56	25723.62	33600	no
4.03	Lead	61.96	38.75	30.6	yes
4.03	Magnesium	3585.8	2723.48	3100	no
4.03	Manganese	2188.01	1568.01	1170	yes
4.03	Mercury	4.37	3.52	1.882	yes
4.03	Nickel	63.44	40.18	48.4	no
4.03	Potassium	2020.57	1359.48	2520	no
4.03	Selenium	2.5	0.94	1.336	no
4.03	Silver	0.48	0.41	0.116	yes
4.03	Sodium	48.88	46.62	93.2	no
4.03	Uranium	3.38	2.18	2.34	no
4.03	Vanadium	42.31	27.16	35.4	no
4.03	Zinc	178.63	114.4	123.8	no
4.04	Aluminum	16729.55	20260.22	22200	no
4.04	Antimony	0.7	0.78	NA	yes
4.04	Arsenic	10.33	12.16	6.46	yes

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
4.04	Barium	138.22	154.28	195.2	no
4.04	Beryllium	1.23	1.42	1.392	yes
4.04	Boron	6.09	7.33	14.28	no
4.04	Cadmium	0.73	1.41	0.402	yes
4.04	Calcium	3012.82	3313.96	2240	yes
4.04	Chromium	26.17	33.38	32	yes
4.04	Cobalt	21.5	26.01	29.4	no
4.04	Copper	42.79	53.42	22	yes
4.04	Iron	27224.6	30564.46	33600	no
4.04	Lead	34.45	46.38	30.6	yes
4.04	Magnesium	2251.92	2697.99	3100	no
4.04	Manganese	1665.12	2009.59	1170	yes
4.04	Mercury	3.05	5.56	1.882	yes
4.04	Nickel	35.51	40.12	48.4	no
4.04	Potassium	1393.79	1744	2520	no
4.04	Selenium	0.84	1.24	1.336	no
4.04	Silver	0.51	1	0.116	yes
4.04	Sodium	68.06	76.48	93.2	no
4.04	Uranium	1.69	2.21	2.34	no

Table F6.3 (continued)

Subreach	Chemical	Sediment concentration		Mean background X 2 (mg/kg)	Retained?
		95% UCL[a]	Max		
4.04	Vanadium	28.72	33.4	35.4	no
4.04	Zinc	141.51	156.8	123.8	yes

[a] UCL = Upper confidence limit.

Table F6.4. Total contaminant exposure and hazard quotients (HQs) for cottontail rabbits foraging on future spoils within each subreach

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
1	4,4'-DDD	0.385	0.002	0.0048	0.0004	0.0052	0.53	0.01
1	4,4'-DDT	0.385	0.001	0.0048	0.0002	0.005	0.53	0.01
1	Arsenic	11.034	0.013	0.1379	0.0026	0.1405	0.037	3.8
1	Benzo(a)anthracene	0.789	0.005	0.0099	0.001	0.0109	-	-
1	Benzo(k)fluoranthene	0.791	0.002	0.0099	0.0004	0.0103	-	-
1	Cadmium	0.727	0.007	0.0091	0.0014	0.0105	0.005	2.1
1	Chrysene	0.795	0.005	0.0099	0.001	0.0109	-	-
1	Copper	29.087	11.63	0.3636	2.2969	2.6605	11	0.24
1	Fluoranthene	0.821	0.082	0.0103	0.0162	0.0265	-	-
1	Lead	39.233	1.765	0.4904	0.3486	0.839	5.3	0.16
1	Pyrene	0.815	0.013	0.0102	0.0026	0.0128	-	-
1	Silver	0.329	0.017	0.0041	0.0034	0.0075	-	-
7	2-Methylnaphthalene	0.15		0.0019	0	0.0019	-	-
7	4-Nitrophenol	0.82		0.0103	0	0.0103	-	-
7	Antimony	0.47	0.001	0.0059	0.0002	0.0061	0.037	0.16
7	Arsenic	26.52	0.03	0.3315	0.0059	0.3374	0.037	9.12

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
7	Benzo(a)anthracene	0.22	0.001	0.0028	0.0002	0.0029	-	-
7	Benzo(a)pyrene	0.63	0.002	0.0079	0.0004	0.0083	0.296	0.03
7	Benzo(b)fluoranthene	0.05	0	0.0006	0	0.0006	-	-
7	Benzo(ghi)perylene	0.05		0.0006	0	0.0006	-	-
7	Beryllium	1.21	0.001	0.0151	0.0002	0.0153	0.44	0.03
7	Cadmium	0.57	0.005	0.0071	0.001	0.0081	0.005	1.62
7	Calcium	6464.11		80.8014	0	80.8014	-	-
7	Chromium	36.94	0.12	0.4618	0.0237	0.4855	1822.596	0
7	Chrysene	0.04	0	0.0005	0	0.0005	-	-
7	Copper	28.06	11.224	0.3508	2.2167	2.5675	11	0.23
7	Fluoranthene	0.35	0.005	0.0044	0.001	0.0054	-	-
7	Indeno(1,2,3-cd)pyrene	0.04	0	0.0005	0	0.0005	-	-
7	Manganese	1578.39	160	19.7299	31.6	51.3299	58.6	0.88
7	Phenanthrene	0.05	0.0051	0.0006	0.001	0.0016	-	-
7	Pyrene	0.07	0.001	0.0009	0.0002	0.0011	-	-
7	Selenium	3.66	0.095	0.0458	0.0188	0.0645	0.023	2.8
7	Silver	0.14	0.007	0.0018	0.0014	0.0031	-	-
7	Thallium	0.45		0.0056	0	0.0056	0.005	1.13

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
7	Vanadium	42.65	0.047	0.5331	0.0093	0.5424	0.13	4.17
2.04	2-Methylnaphthalene	0.38		0.0048	0	0.0048	-	-
2.04	4-Nitrophenol	2.161		0.027	0	0.027	-	-
2.04	Arsenic	9.74	0.011	0.1218	0.0022	0.1239	0.028	4.43
2.04	Benzo(a)anthracene	0.47	0.003	0.0059	0.0006	0.0065	-	-
2.04	Benzo(a)pyrene	0.5	0.002	0.0063	0.0004	0.0066	0.296	0.02
2.04	Benzo(b)fluoranthene	0.441	0.001	0.0055	0.0002	0.0057	-	-
2.04	Benzo(ghi)perylene	0.444		0.0056	0	0.0056	-	-
2.04	Benzo(k)fluoranthene	0.485	0.001	0.0061	0.0002	0.0063	-	-
2.04	Bis(2-ethylhexyl)phthalate	0.527	0.008	0.0066	0.0016	0.0082	5.4	0
2.04	Cadmium	0.48	0.005	0.006	0.001	0.007	0.005	1.4
2.04	Calcium	9133.72		114.1715	0	114.1715	-	-
2.04	Chrysene	0.445	0.001	0.0056	0.0002	0.0058	-	-
2.04	Di-n-butylphthalate	0.44	0.007	0.0055	0.0014	0.0069	163	0
2.04	Dibenzofuran	0.485	0.078	0.0061	0.0154	0.0215	-	-
2.04	Diethylphthalate	0.49	0.18	0.0061	0.0356	0.0417	1357	0
2.04	Fluoranthene	0.306	0.0153	0.0038	0.003	0.0068	-	-

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
2.04	Fluorene	0.47	0.015	0.0059	0.003	0.0088	-	-
2.04	Indeno(1,2,3-cd)pyrene	0.444	0	0.0056	0	0.0056	-	-
2.04	Magnesium	4147.73		51.8466	0	51.8466	-	-
2.04	Manganese	4484.22	450	56.0528	88.875	144.9278	58.6	2.47
2.04	Naphthalene	0.4	0.208	0.005	0.0411	0.0461	-	-
2.04	Pentachlorophenol	2.44	0.012	0.0305	0.0024	0.0329	0.16	0.21
2.04	Phenanthrene	0.3	0.031	0.0038	0.0061	0.0099	-	-
2.04	Pyrene	0.356	0.005	0.0045	0.001	0.0054	-	-
2.04	Selenium	2.44	0.063	0.0305	0.0124	0.0429	0.023	1.87
2.04	Silver	0.49	0.025	0.0061	0.0049	0.0111	-	-
3.01	Benzo(b)fluoranthene	0.162	0.001	0.002	0.0002	0.0022	-	-
3.01	Bis(2-ethylhexyl)phthalate	0.025	0	0.0003	0	0.0003	5.4	0
3.01	Chrysene	0.158	0.001	0.002	0.0002	0.0022	-	-
3.01	Di-n-butylphthalate	0.02	0	0.0003	0	0.0003	163	0
3.01	Diethylphthalate	0.08	0.029	0.001	0.0057	0.0067	1357	0
3.01	Fluoranthene	0.161	0.0081	0.002	0.0016	0.0036	-	-
3.01	Heptachlor	0	0	0	0	0	0.09	0

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
3.01	Pentachlorophenol	0.15	0.001	0.0019	0.0002	0.0021	0.16	0.01
3.01	Phenanthrene	0.16	0.016	0.002	0.0032	0.0052	-	-
3.01	Pyrene	0.026	0	0.0003	0	0.0003	-	-
3.02	2-Methylnaphthalene	0.38		0.0048	0	0.0048	-	-
3.02	3-Nitroaniline	1119.21		13.9901	0	13.9901	-	-
3.02	Acenaphthene	0.38	0.007	0.0048	0.0014	0.0061	-	-
3.02	Acenaphthylene	0.395	0.103	0.0049	0.0203	0.0253	-	-
3.02	Anthracene	0.382	0.006	0.0048	0.0012	0.006	-	-
3.02	Antimony	0.59	0.002	0.0074	0.0004	0.0078	0.037	0.21
3.02	Benzo(a)anthracene	0.867	0.006	0.0108	0.0012	0.012	-	-
3.02	Benzo(a)pyrene	0.556	0.002	0.007	0.0004	0.0073	0.296	0.02
3.02	Benzo(b)fluoranthene	0.887	0.003	0.0111	0.0006	0.0117	-	-
3.02	Benzo(ghi)perylene	0.387		0.0048	0	0.0048	-	-
3.02	Benzo(k)fluoranthene	0.408	0.001	0.0051	0.0002	0.0053	-	-
3.02	Bis(2-ethylhexyl)phthalate	0.401	0.006	0.005	0.0012	0.0062	5.4	0
3.02	Butylbenzylphthalate	0.41	0.006	0.0051	0.0012	0.0063	-	-
3.02	Cadmium	0.91	0.009	0.0114	0.0018	0.0132	0.005	2.64

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
3.02	Carbazole	0.22	0.015	0.0028	0.003	0.0057	-	-
3.02	Chrysene	0.686	0.004	0.0086	0.0008	0.0094	-	-
3.02	Copper	29.39	11.756	0.3674	2.3218	2.6892	11	0.24
3.02	Dibenz(a,h)anthracene	0.406	0.001	0.0051	0.0002	0.0053	-	-
3.02	Dibenzofuran	0.389	0.063	0.0049	0.0124	0.0173	-	-
3.02	Fluoranthene	1.214	0.0608	0.0152	0.012	0.0272	-	-
3.02	Fluorene	0.38	0.006	0.0048	0.0012	0.0059	-	-
3.02	Indeno(1,2,3-cd)pyrene	0.404	0.001	0.0051	0.0002	0.0052	-	-
3.02	Mercury	4.07	0.31	0.0509	0.0612	0.1121	0.021	5.34
3.02	Naphthalene	0.39	0.202	0.0049	0.0399	0.0448	-	-
3.02	Nickel	52.39	0.7	0.6549	0.1383	0.7931	26.636	0.03
3.02	PCB-1248	0.368	0.002	0.0046	0.0004	0.005	0.02	0.25
3.02	PCB-1254	0.73	0.003	0.0091	0.0006	0.0097	0.016	0.61
3.02	PCB-1260	0.704	0.001	0.0088	0.0002	0.009	0.016	0.56
3.02	Phenanthrene	1.23	0.126	0.0154	0.0249	0.0403	-	-
3.02	Phenol	0.385	0.58	0.0048	0.1146	0.1194	-	-
3.02	Potassium	1699.79		21.2474	0	21.2474	-	-
3.02	Pyrene	1.141	0.018	0.0143	0.0036	0.0178	-	-

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
3.02	Selenium	1.39	0.009	0.0174	0.0018	0.0192	0.023	0.83
3.02	Silver	0.76	0.039	0.0095	0.0077	0.0172	-	-
3.02	Uranium	16.49	0.1039	0.2061	0.0205	0.2266	0.89	0.25
3.02	Zinc	116.83	12	1.4604	2.37	3.8304	106.546	0.04
3.03	2-Methylnaphthalene	0.35		0.0044	0	0.0044	-	-
3.03	Acenaphthene	0.03	0.001	0.0004	0.0002	0.0006	-	-
3.03	Acenaphthylene	0.121	0.031	0.0015	0.0061	0.0076	-	-
3.03	Anthracene	0.042	0.001	0.0005	0.0002	0.0007	-	-
3.03	Benzo(a)anthracene	0.231	0.001	0.0029	0.0002	0.0031	-	-
3.03	Benzo(a)pyrene	0.159	0.001	0.002	0.0002	0.0022	0.296	0.01
3.03	Benzo(b)fluoranthene	0.285	0.001	0.0036	0.0002	0.0038	-	-
3.03	Benzo(ghi)perylene	0.175		0.0022	0	0.0022	-	-
3.03	Benzo(k)fluoranthene	0.067	0	0.0008	0	0.0008	-	-
3.03	Cadmium	3.31	0.034	0.0414	0.0067	0.0481	0.005	9.62
3.03	Carbazole	0.05	0.003	0.0006	0.0006	0.0012	-	-
3.03	Chromium	44.36	0.14	0.5545	0.0277	0.5822	1822.596	0
3.03	Chrysene	0.238	0.001	0.003	0.0002	0.0032	-	-

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
3.03	Copper	36.3	14.52	0.4538	2.8677	3.3215	11	0.3
3.03	Dibenz(a,h)anthracene	0.036	0	0.0005	0	0.0005	-	-
3.03	Dibenzofuran	0.105	1.69	0.0013	0.3338	0.3351	-	-
3.03	Fluoranthene	0.479	0.024	0.006	0.0047	0.0107	-	-
3.03	Fluorene	0.05	0.001	0.0006	0.0002	0.0008	-	-
3.03	Indeno(1,2,3-cd)pyrene	0.162	0	0.002	0	0.002	-	-
3.03	Lead	37.73	1.698	0.4716	0.3354	0.807	5.3	0.15
3.03	Mercury	6.67	0.5	0.0834	0.0988	0.1821	0.021	8.67
3.03	Naphthalene	0.21	0.109	0.0026	0.0215	0.0242	-	-
3.03	Nickel	62.44	0.83	0.7805	0.1639	0.9444	26.636	0.04
3.03	Phenanthrene	0.38	0.039	0.0048	0.0077	0.0125	-	-
3.03	Phenol	0.21	0.29	0.0026	0.0573	0.0599	-	-
3.03	Pyrene	0.296	0.005	0.0037	0.001	0.0047	-	-
3.03	Silver	3.32		0.0415	0	0.0415	-	-
3.03	Uranium	8.7	0.055	0.1088	0.0109	0.1196	0.89	0.13
3.03	Zinc	160.94	16	2.0118	3.16	5.1718	106.546	0.05
3.04	1,4-Dichlorobenzene	0.28	0.03	0.0035	0.0059	0.0094	-	-

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
3.04	2-Methylnaphthalene	0.26		0.0033	0	0.0033	-	-
3.04	4-Chloro-3-methylphenol	0.281		0.0035	0	0.0035	-	-
3.04	4-Methylphenol	0.28	0.21	0.0035	0.0415	0.045	-	-
3.04	Acenaphthene	0.19	0.006	0.0024	0.0012	0.0036	-	-
3.04	Acenaphthylene	0.281	0.0731	0.0035	0.0144	0.0179	-	-
3.04	Anthracene	0.253	0.007	0.0032	0.0014	0.0045	-	-
3.04	Arsenic	93.83	0.11	1.1729	0.0217	1.1946	-	-
3.04	Barium	290.28	0.95	3.6285	0.1876	3.8161	3.6	1.06
3.04	Benzo(a)anthracene	0.167	0.001	0.0021	0.0002	0.0023	-	-
3.04	Benzo(a)pyrene	0.221	0.001	0.0028	0.0002	0.003	0.296	0.01
3.04	Benzo(b)fluoranthene	0.235	0.001	0.0029	0.0002	0.0031	-	-
3.04	Benzo(ghi)perylene	0.247		0.0031	0	0.0031	-	-
3.04	Benzo(k)fluoranthene	0.253	0	0.0032	0	0.0032	-	-
3.04	Beryllium	1.69	0.002	0.0211	0.0004	0.0215	0.44	0.05
3.04	Bis(2-ethylhexyl)phthalate	0.95	0.015	0.0119	0.003	0.0148	5.4	0
3.04	Boron	43.84	1.3	0.548	0.2568	0.8048	-	-
3.04	Butylbenzylphthalate	0.25	0.004	0.0031	0.0008	0.0039	-	-
3.04	Cadmium	5.6	0.057	0.07	0.0113	0.0813	0.005	16.2

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
3.04	Calcium	6358.23		79.4779	0	79.4779	-	-
3.04	Carbazole	0.25	0.017	0.0031	0.0034	0.0065	-	-
3.04	Chromium	39.19	0.13	0.4899	0.0257	0.5156	1822.596	0
3.04	Chrysene	0.143	0.001	0.0018	0.0002	0.002	-	-
3.04	Copper	68.03	27.212	0.8504	5.3744	6.2247	11	0.57
3.04	Dibenz(a,h)anthracene	0.253	0	0.0032	0	0.0032	-	-
3.04	Dibenzofuran	0.247	0.0397	0.0031	0.0078	0.0109	-	-
3.04	Diethylphthalate	0.28	0.1	0.0035	0.0198	0.0233	1357	0
3.04	Fluoranthene	0.231	0.01158	0.0029	0.0023	0.0052	-	-
3.04	Fluorene	0.25	0.007	0.0031	0.0014	0.0045	-	-
3.04	Indeno(1,2,3-cd)pyrene	0.247	0.001	0.0031	0.0002	0.0033	-	-
3.04	Mercury	25.69	1.9	0.3211	0.3753	0.6964	0.021	33.16
3.04	Naphthalene	0.2	0.1038	0.0025	0.0205	0.023	-	-
3.04	Nickel	50.61	0.67	0.6326	0.1323	0.765	26.636	0.03
3.04	PCB-1248	0.065	0	0.0008	0	0.0008	0.02	0.04
3.04	PCB-1254	0.18	0.001	0.0023	0.0002	0.0024	0.016	0.15
3.04	PCB-1260	0.13	0	0.0016	0	0.0016	0.016	0.1
3.04	Phenanthrene	0.24	0.02457	0.003	0.0049	0.0079	-	-

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
3.04	Phenol	0.25	0.35	0.0031	0.0691	0.0723	-	-
3.04	Pyrene	0.215	0.003	0.0027	0.0006	0.0033	-	-
3.04	Selenium	1.57	0.041	0.0196	0.0081	0.0277	0.023	1.21
3.04	Silver	1.41	0.072	0.0176	0.0142	0.0318	-	-
3.04	Thallium	0.72		0.009	0	0.009	0.005	1.8
3.04	Uranium	16.1	0.101	0.2013	0.0199	0.2212	0.89	0.25
3.04	Vanadium	59.14	0.065	0.7393	0.0128	0.7521	0.13	5.79
4.01	2-Methylnaphthalene	0.5		0.0063	0	0.0063	-	-
4.01	Acenaphthene	0.5	0.016	0.0063	0.0032	0.0094	-	-
4.01	Anthracene	0.499	0.013	0.0062	0.0026	0.0088	-	-
4.01	Arsenic	9.96	0.011	0.1245	0.0022	0.1267	0.028	4.52
4.01	Benzo(a)anthracene	0.499	0.003	0.0062	0.0006	0.0068	-	-
4.01	Benzo(a)pyrene	0.499	0.002	0.0062	0.0004	0.0066	0.296	0.02
4.01	Benzo(b)fluoranthene	0.499	0.002	0.0062	0.0004	0.0066	-	-
4.01	Benzo(ghi)perylene	0.499		0.0062	0	0.0062	-	-
4.01	Benzo(k)fluoranthene	0.499	0.001	0.0062	0.0002	0.0064	-	-
4.01	Bis(2-ethylhexyl)phthalate	0.968	0.015	0.0121	0.003	0.0151	5.4	0

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
4.01	Cadmium	0.65	0.007	0.0081	0.0014	0.0095	0.005	1.9
4.01	Calcium	2352.89		29.4111	0	29.4111	-	-
4.01	Carbazole	0.22	0.015	0.0028	0.003	0.0057	-	-
4.01	Chrysene	0.499	0.002	0.0062	0.0004	0.0066	-	-
4.01	Dibenz(a,h)anthracene	0.499	0.001	0.0062	0.0002	0.0064	-	-
4.01	Dibenzofuran	0.499	0.0803	0.0062	0.0159	0.0221	-	-
4.01	Fluoranthene	0.489	0.0245	0.0061	0.0048	0.011	-	-
4.01	Fluorene	0.5	0.015	0.0063	0.003	0.0092	-	-
4.01	Heptachlor	0.1	0	0.0013	0	0.0013	0.533	0
4.01	Indeno(1,2,3-cd)pyrene	0.499	0.001	0.0062	0.0002	0.0064	-	-
4.01	Mercury	12.16	0.92	0.152	0.1817	0.3337	0.021	15.89
4.01	N-Nitroso-di-n-propylamine	0.499	0.79	0.0062	0.156	0.1623	-	-
4.01	Naphthalene	0.5	0.25956	0.0063	0.0513	0.0575	-	-
4.01	PCB-1254	0.4	0.002	0.005	0.0004	0.0054	0.016	0.34
4.01	PCB-1260	2.06	0.003	0.0258	0.0006	0.0263	0.016	1.65
4.01	Pentachlorophenol	2.42	0.011	0.0303	0.0022	0.0324	-	-
4.01	Phenanthrene	0.5	0.0512	0.0063	0.0101	0.0164	-	-
4.01	Phenol	0.5	0.69	0.0063	0.1363	0.1425	-	-

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
4.01	Pyrene	0.493	0.008	0.0062	0.0016	0.0077	-	-
4.01	Silver	1.8	0.091	0.0225	0.018	0.0405	-	-
4.02	2-Methylnaphthalene	0.03		0.0004	0	0.0004	-	-
4.02	Arsenic	11.2	0.013	0.14	0.0026	0.1426	0.028	5.09
4.02	Benzo(b)fluoranthene	0.016	0	0.0002	0	0.0002	-	-
4.02	Bis(2-ethylhexyl)phthalate	0.058	0.001	0.0007	0.0002	0.0009	5.4	0
4.02	Naphthalene	0.02	0.01	0.0003	0.002	0.0022	-	-
4.02	Phenanthrene	0.02	0.002	0.0003	0.0004	0.0006	-	-
4.02	Pyrene	0.017	0	0.0002	0	0.0002	-	-
4.03	2-Methylnaphthalene	0.23		0.0029	0	0.0029	-	-
4.03	Acenaphthene	0.27	0.008	0.0034	0.0016	0.005	-	-
4.03	Anthracene	0.267	0.007	0.0033	0.0014	0.0047	-	-
4.03	Arsenic	7.84	0.009	0.098	0.0018	0.0998	0.028	3.56
4.03	Benzo(a)anthracene	0.111	0.001	0.0014	0.0002	0.0016	-	-
4.03	Benzo(a)pyrene	0.482	0.002	0.006	0.0004	0.0064	0.296	0.02
4.03	Benzo(b)fluoranthene	0.177	0.001	0.0022	0.0002	0.0024	-	-

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
4.03	Benzo(ghi)perylene	0.089		0.0011	0	0.0011	-	-
4.03	Benzo(k)fluoranthene	0.042	0	0.0005	0	0.0005	-	-
4.03	Bis(2-ethylhexyl)phthalate	0.284	0.004	0.0036	0.0008	0.0043	5.4	0
4.03	Cadmium	0.6	0.006	0.0075	0.0012	0.0087	0.005	1.74
4.03	Calcium	4358.97		54.4871	0	54.4871	-	-
4.03	Chromium	36.91	0.12	0.4614	0.0237	0.4851	1822.596	0
4.03	Chrysene	0.133	0.001	0.0017	0.0002	0.0019	-	-
4.03	Copper	35.9	14.36	0.4488	2.8361	3.2849	11	0.3
4.03	Dibenz(a,h)anthracene	0.267	0	0.0033	0	0.0033	-	-
4.03	Dibenzofuran	0.057	0.0092	0.0007	0.0018	0.0025	-	-
4.03	Fluoranthene	0.16	0.00802	0.002	0.0016	0.0036	-	-
4.03	Fluorene	0.27	0.008	0.0034	0.0016	0.005	-	-
4.03	Indeno(1,2,3-cd)pyrene	0.089	0	0.0011	0	0.0011	-	-
4.03	Lead	38.75	2.788	0.4844	0.5506	1.035	5.3	0.2
4.03	Manganese	1568.01	160	19.6001	31.6	51.2001	58.6	0.87
4.03	Mercury	3.52	0.27	0.044	0.0533	0.0973	0.021	4.63
4.03	Naphthalene	0.11	0.0571	0.0014	0.0113	0.0127	-	-
4.03	PCB-1254	0.06	0	0.0008	0	0.0008	0.016	0.05

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
4.03	PCB-1260	0.03	0	0.0004	0	0.0004	0.016	0.02
4.03	Phenanthrene	0.2	0.0205	0.0025	0.004	0.0065	-	-
4.03	Pyrene	0.17	0.003	0.0021	0.0006	0.0027	-	-
4.03	Silver	0.41	0.021	0.0051	0.0041	0.0093	-	-
4.04	2-Methylnaphthalene	1.01		0.0126	0	0.0126	-	-
4.04	Antimony	0.7	0.003	0.0088	0.0006	0.0093	0.037	0.25
4.04	Arsenic	10.33	0.012	0.1291	0.0024	0.1315	0.028	4.7
4.04	Benzo(a)anthracene	1.06	0.002	0.0133	0.0004	0.0136	-	-
4.04	Benzo(a)pyrene	1.56	0.004	0.0195	0.0008	0.0203	0.296	0.07
4.04	Benzo(b)fluoranthene	0.93	0.001	0.0116	0.0002	0.0118	-	-
4.04	Benzo(ghi)perylene	1.422		0.0178	0	0.0178	-	-
4.04	Beryllium	1.23	0.001	0.0154	0.0002	0.0156	0.44	0.04
4.04	Bis(2-ethylhexyl)phthalate	0.864	0.002	0.0108	0.0004	0.0112	5.4	0
4.04	Cadmium	0.73	0.007	0.0091	0.0014	0.0105	0.005	2.1
4.04	Chromium	26.17	0.085	0.3271	0.0168	0.3439	1822.596	0
4.04	Chrysene	1.206	0.001	0.0151	0.0002	0.0153	-	-
4.04	Copper	42.79	17.116	0.5349	3.3804	3.9153	11	0.36

Table F6.4 (continued)

Subreach	Chemical	Sediment (mg/kg)	Modeled vegetation (mg/kg)	Exposure (mg/kg/d)			NOAEL[a] toxicity benchmark	HQ
				Soil	Vegetation	Total		
4.04	Dibenz(a,h)anthracene	1.6	0.007	0.02	0.0014	0.0214	-	-
4.04	Fluoranthene	0.936	0.002	0.0117	0.0004	0.0121	-	-
4.04	Indeno(1,2,3-cd)pyrene	1.584	0.002	0.0198	0.0004	0.0202	-	-
4.04	Lead	34.45	1.55	0.4306	0.3061	0.7368	5.3	0.14
4.04	Manganese	1665.12	170	20.814	33.575	54.389	58.6	0.93
4.04	Mercury	3.05	0.23	0.0381	0.0454	0.0836	0.021	3.98
4.04	Naphthalene	1.26	0.654	0.0158	0.1292	0.1449	-	-
4.04	PCB-1254	0.237	0.004	0.003	0.0008	0.0038	0.016	0.23
4.04	Phenanthrene	0.94	0.096	0.0118	0.019	0.0307	-	-
4.04	Pyrene	0.948	0.003	0.0119	0.0006	0.0124	-	-
4.04	Silver	0.51	0.026	0.0064	0.0051	0.0115	-	-
4.04	Zinc	141.51	14	1.7689	2.765	4.5339	106.546	0.04

[a] NOAEL = No observed adverse effect level.

Table F6.5. Comparison of contaminant concentrations found in deep sediments (future spoil) in each Clinch River reach to screening benchmarks for toxicity to plants

Subreach	Chemical	Sediment concentration maximum (mg/kg)	Phytotoxicity benchmark (mg/kg)	Hazard Quotient
1	Arsenic	11.034	10	**1.1**
1	Cadmium	0.727	3	0.24
1	Copper	29.087	100	0.29
1	Lead	39.233	50	0.78
1	Silver	0.329	2	0.16
7	Antimony	0.68	5	0.14
7	Arsenic	63.84	10	**6.38**
7	Beryllium	1.52	10	0.15
7	Cadmium	0.82	3	0.27
7	Chromium	58.61	1	**58.61**
7	Copper	37.25	100	0.37
7	Manganese	1578.39	500	**3.16**
7	Selenium	9.5	1	**9.5**
7	Silver	0.26	2	0.13
7	Thallium	0.57	1	0.57
7	Vanadium	42.65	2	**21.33**
2.04	Arsenic	10.21	10	**1.02**
2.04	Cadmium	0.48	3	0.16
2.04	Di-n-butylphthalate	0.44	200	0
2.04	Manganese	4484.22	500	**8.97**
2.04	Selenium	2.44	1	**2.44**
2.04	Silver	0.55	2	0.28
3.01	Di-n-butylphthalate	0.02	200	0
3.02	Antimony	0.59	5	0.12
3.02	Cadmium	1.24	3	0.41

Table F6.5 (continued)

Subreach	Chemical	Sediment concentration maximum (mg/kg)	Phytotoxicity benchmark (mg/kg)	Hazard Quotient
3.02	Copper	37.95	100	0.38
3.02	Mercury	6.1	0.3	**20.33**
3.02	Nickel	70.58	30	**2.35**
3.02	PCB-1248	0.388	40	0.01
3.02	PCB-1254	0.73	40	0.02
3.02	PCB-1260	0.79	40	0.02
3.02	Selenium	1.4	1	**1.4**
3.02	Silver	1.17	2	0.59
3.02	Uranium	16.49	5	**3.3**
3.02	Zinc	149.85	50	**3**
3.03	Cadmium	3.31	3	**1.1**
3.03	Chromium	44.36	1	**44.36**
3.03	Copper	36.3	100	0.36
3.03	Lead	37.73	50	0.75
3.03	Mercury	6.67	0.3	**22.23**
3.03	Nickel	62.44	30	**2.08**
3.03	Silver	3.32	2	**1.66**
3.03	Uranium	8.7	5	**1.74**
3.03	Zinc	160.94	50	**3.22**
3.04	Arsenic	93.83	10	**9.38**
3.04	Barium	290.28	500	0.58
3.04	Beryllium	1.69	10	0.17
3.04	Boron	43.84	0.5	**87.68**
3.04	Cadmium	5.6	3	**1.87**
3.04	Chromium	39.19	1	**39.19**
3.04	Copper	68.03	100	0.68
3.04	Mercury	25.69	0.3	**85.63**
3.04	Nickel	50.61	30	**1.69**
3.04	PCB-1248	0.065	40	0

Table F6.5 (continued)

Subreach	Chemical	Sediment concentration maximum (mg/kg)	Phytotoxicity benchmark (mg/kg)	Hazard Quotient
3.04	PCB-1254	0.18	40	0
3.04	PCB-1260	0.13	40	0
3.04	Selenium	1.57	1	**1.57**
3.04	Silver	1.41	2	0.71
3.04	Thallium	0.72	1	0.72
3.04	Uranium	16.1	5	**3.22**
3.04	Vanadium	59.14	2	**29.57**
4.01	Arsenic	9.96	10	**1**
4.01	Cadmium	0.65	3	0.22
4.01	Mercury	12.16	0.3	**40.53**
4.01	PCB-1254	0.4	40	0.01
4.01	PCB-1260	2.06	40	0.05
4.01	Silver	1.8	2	0.9
4.02	Arsenic	11.2	10	**1.12**
4.03	Arsenic	7.84	10	0.78
4.03	Cadmium	0.6	3	0.2
4.03	Chromium	36.91	1	**36.91**
4.03	Copper	35.9	100	0.36
4.03	Lead	38.75	50	0.78
4.03	Manganese	1568.01	500	**3.14**
4.03	Mercury	3.52	0.3	**11.73**
4.03	PCB-1254	0.06	40	0
4.03	PCB-1260	0.03	40	0
4.03	Silver	0.41	2	0.21
4.04	Antimony	0.78	5	0.16
4.04	Arsenic	12.16	10	**1.22**
4.04	Beryllium	1.42	10	0.14

Table F6.5 (continued)

Subreach	Chemical	Sediment concentration maximum (mg/kg)	Phytotoxicity benchmark (mg/kg)	Hazard Quotient
4.04	Cadmium	1.41	3	0.47
4.04	Chromium	33.38	1	**33.38**
4.04	Copper	53.42	100	0.53
4.04	Lead	46.38	50	0.93
4.04	Manganese	2009.59	500	**4.02**
4.04	Mercury	5.56	0.3	**18.53**
4.04	PCB-1254	0.975	40	0.02
4.04	Silver	1	2	0.5
4.04	Zinc	156.8	50	**3.14**

Table F6.6. Estimated NOAELs[a] and LOAELs[a] for the eastern cottontail

Contaminant	Experimental information						Estimated NOAEL (mg/kg/d)	Estimated LOAEL (mg/kg/d)
	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation		
Arsenic	As+3	mouse	0.126[b] 3 gen.	1.26 3 gen.	reproduction	Schroeder and Mitchner 1971	0.037	0.37
Barium	chloride	rat	1.98 16 mo.		growth	Perry et al. 1983	3.6	13.2
	chloride			19.8 10 days	mortality	Borzelleca et al. 1988		
Cadmium	salt	rat	0.008 4 gen.	0.01	reproduction	Wills et al. 1981	0.005	0.007
Manganese	oxide	rat	88 gestation	284	reproduction	Laskey et al. 1992	58.6	189.0
Mercury	methyl	rat	0.032 3 gen.	0.16 3 gen.	reproduction	Verschuuren et al. 1976	0.021	0.110
PCBs	Aroclor 1254	oldfield mouse	0.068[b] 12 mo.	0.68 18 mo.	reproduction	McCoy et al. 1995	0.016	0.16
Selenium	selanate	mouse	0.076[b] 3 gen.	0.76 3 gen.	reproduction	Schroeder and Mitchner 1971	0.023	0.22
Thallium	sulfate	rat	0.0074[b] 60 days	0.074 60 days	reproduction	Formigli et al. 1986	0.005	0.05
Vanadium	sodium metavanadate	rat	0.21[b] 60 days	2.1 60 days	reproduction	Domingo et al. 1986	0.13	1.3

[a] NOAEL = No observed adverse effect level; LOAEL = Lowest observed adverse effect level.
[b] Estimated NOAEL: LOAEL to NOAEL factor applied.

Appendix F7

RADIOLOGICAL RISKS

F7. RADIOLOGICAL RISKS

Estimation of Radiation Doses to Biota

Applicable methodologies for estimating radiation doses to biota have been published by Woodhead (1979), NCRP (1991), Baker and Soldat (1992), and Blaylock et al. (1993). An additional useful reference for general application to external dosimetry was published by Eckerman and Ryman (1992). These references represent the primary source of equations and data used to calculate doses for the exposure scenarios evaluated in this report.

Radiation Dose to Benthic Invertebrates

The highest concentrations of radionuclides in the Clinch River, Poplar Creek, and Watts Bar Reservoir occur in the sediments. The mayfly *Hexagenia bilineata* was chosen as the model organism for evaluating the biological risk to benthic invertebrates. This organism was chosen because it lives almost all of its life cycle in the sediments and is an important part of the natural aquatic food-chain web. Mayfly adults hatch and leave the sediment/water environment after a year of larval development in sediments. An organism which lives imbedded in sediments would be expected to receive a maximized environmental dose. Thus, the mayfly model should represent an upper limit of exposure for the benthic class of invertebrate organisms.

The Blaylock et al. (1993) model for gamma-radiation dose rate to a small organism completely immersed in a mixture of radionuclides in sediments is written:

Immersed in Sediments

$$D_\gamma \text{ (mayfly)} = 18.7 \sum_i E_{\gamma,i} n_i (1 - \Phi) C_{s,I} \text{ mrad/year} \qquad \text{(F.1)}$$

where

$E_{\gamma,i}$ is the photon energy per disintegration during transition from a higher to a lower energy state (Mev/disintegration),

n_i is the proportion of disintegrations producing a gamma ray (dimensionless),

Φ is the fraction of energy $E_{\gamma,i}$ (dimensionless), absorbed by organism (figures appear in Blaylock et al. 1993),

$C_{s,i}$ is the concentration of the radionuclide in sediments (pCi/gm), and

18.7 is a constant for converting $E_{\gamma,i}$ and $C_{s,i}$ to mrad/year.

The total dose from a mixture of gamma-emitters is calculated by solving equation F.1 for each radionuclide and summing over radionuclides.

The comparable equation for beta-radiation dose is similar but substitutes the average beta energy per disintegration, the proportion of the transitions producing a beta particle of that average energy, and an absorbed fraction for the appropriate beta particles. This equation is written :

Immersed in Sediments

$$D_\beta \text{ (mayfly)} = 18.7 \sum_i E_{\beta,i} n_i (1 - \Phi) C_{s,I} \text{ mrad/year} \qquad \text{(F.2)}$$

where

$E_{\beta,i}$ is the average energy per disintegration of the beta-particle (Mev/disintegration),

n_i is the proportion of transitions producing a beta-particle of energy $E_{\beta,i}$,

Φ is the absorbed fraction for the appropriate beta particle (figures appear in Blaylock et al. 1993), and

$C_{s,i}$ is the concentration of the beta-emitting radionuclide in sediments (pCi/gm).

The remaining terms are as defined in equation F.1, and the total beta dose from a mixture of radionuclides is obtained by summation similar to the treatment of gamma emitters.

The dose from internally deposited radionuclides was neglected because mayfly larvae attain an average size of only 25 mm before hatching, and the resulting dose would be a minor fraction of the dose received from immersion in an extensive body of sediments.

Radiation Dose to Epibenthic Fish

The epibenthic fish size is represented by the large fish model in Blaylock et al. (1993). Dimensions of this organism are 1 kg for mass and an ellipsoid geometry of 45 cm x 8.7 cm x 4.9 cm for the major and two minor axes, respectively. Carp (*Cyprinus*), suckers and redhorse (*Moxastoma*), and catfish (*Ictalurus* and *Ameiurus*) are all representative epibenthic fish for Poplar Creek, the Clinch River, and Watts Bar Lake. The exposure scenario assumes that the model fish lies in close proximity to the bottom sediments and is irradiated by radionuclides in the bottom sediments, water, and by ingestion of natural food contaminated with radionuclides. Because self-absorption/shielding of beta particle emissions originating from water and sediment immersion results in a negligible contribution to absorbed dose to the large fish, the beta-emission component of dose was not included in the total dose rate for epibenthic fish. The dose components included are gamma dose rates from water immersion and sediment surface, and beta and gamma dose rates from internally deposited radionuclides.

The equation for estimating the dose received from immersion in water and exposure to sediments is the same as equation F.1, but the appropriate concentration (pCi/gm) of each radionuclide in water is used for the water immersion dose. The absorbed fractions for the large fish model of Blaylock et al. (1993) are used for the gamma-ray energies of the radionuclides under consideration. It is also appropriate to multiply the dose from sediments by 0.5 because the model fish is above an infinite plane of sediments and not immersed. With these considerations noted, the dose rate to a large epibenthic fish from exposure to gamma-emitting radionuclides in sediments is written:

Above Sediments

$$D_\gamma \text{ (fish)} = 9.4 \sum_i E_{\gamma,i}\, n_i\, (1 - \Phi)\, C_{s,i} \text{ mrad/year} \qquad \text{(F.3)}$$

where the terms have been defined above.

Estimation of the immersion dose rate to a large fish is also derived from equation F.1, with the concentration of the gamma-emitting radionuclides in water, $C_{w,i}$ (pCi/gm), used in place of the sediment concentration. The equation is written:

Immersed in Water

$$D_\gamma \text{ (fish)} = 18.7 \sum_i E_{\gamma,i}\, n_i\, (1 - \Phi)\, C_{w,i} \text{ mrad/year} \qquad \text{(F.4)}$$

where the terms have been defined above.

Internal dose from food-chain intake results from both gamma and beta emitters deposited in tissues. This deposition can be determined from direct measurements of radionuclides in fish tissues, or estimated by multiplying a bioaccumulation factor times the concentration of the radionuclide in water under equilibrium conditions. Bioaccumulation factors are listed by Blaylock et al. (1993). The equation for calculating the dose to an epibenthic fish from internal exposure to gamma-emitting radionuclides is written:

Ingestion

$$D_\gamma \text{ (fish)} = 18.7 \sum_i E_{\gamma,i}\, n_i\, \Phi\, C_{f,i} \text{ mrad/year} \qquad \text{(F.5)}$$

where

$C_{f,i}$ is the concentration of radionuclide i in the fish (pCi/gm) and may be calculated from the relationship

$$C_{f,i} = C_{w,i} \times \text{Bioaccumulation Factor for radionuclide i in fish pCi/gm} \qquad \text{(F.6)}$$

The dose rate to an epibenthic fish from beta-emitting radionuclides deposited internally is written

Ingestion

$$D_\beta \text{ (fish)} = 18.7 \sum_i E_{\beta,i}\, n_i\, C_{f,i} \text{ mrad/year} \qquad \text{(F.7)}$$

where the terms have been defined above.

Radiation Dose to Great Blue Heron

The great blue heron is one of the most common large water birds that completes its entire life cycle in the environs of Poplar Creek, the Clinch River, and Watts Bar Reservoir. Adults stand over one meter tall and they spend most of their time wading at the water's edge catching fish for food. The internal dose to a heron from consumption of fish contaminated with radionuclides in their flesh was treated in detail by Baker and Soldat (1992). Their model for internal dose rate to a heron, D (heron), is written:

Ingestion

$$D \text{ (heron)} = \sum_i b_i\, U_h\, f_{l,i}\, E_{h,i}\, (1 - \exp - \lambda_{h,i} T_e) / m_h\, \lambda_{h,i} \text{ rad/day} \qquad \text{(F.8)}$$

where

b_i = body burden concentration of radionuclide i in fish eaten by heron (Ci/kg),
U_h = rate of consumption of fish by heron (0.42 kg/day),
$f_{l,i}$ = uptake fraction of radionuclide i in heron (dimensionless),
m_h = mass of heron (2.39 kg),
$\lambda_{h,i}$ = effective decay constant of radionuclide i in heron (1/days),
T_e = time of exposure (365 days), and
$E_{h,i}$ = 5.12E10+4 $\epsilon_{h,i}$, where $\epsilon_{h,i}$ is the effective absorbed energy (kg - rad/Ci - day).

Simplification of the constants in equation F.8 and conversion of b_i to units of pCi/gm gives the equation for mrad/year which is written:

Ingestion

$$D\ (\text{heron}) = 3.28 \sum_i b_i\, f_{l,i}\, \epsilon_{h,i}\, (1 - \exp - 365\, \lambda_{h,i})/\lambda_{h,i}\ \text{mrad/year} \qquad \text{(F.9)}$$

Baker and Soldat (1992) also discuss the exposure a heron could receive from immersion in contaminated water and direct irradiation from a contaminated shoreline. They recommend an exposure-time reduction factor of 0.3 for both modes of exposure, e. g., the heron receives external exposure from sediments approximately one-third of the time, external exposure from contaminated water one-third of the time, and no external exposure the remaining one-third of the time. This is in contrast to internal exposure which continues uninterrupted after ingestion of contaminated fish. The immersion dose coefficient is also further reduced by 0.5 because the heron's body is above the water, not immersed. They also recommend a dose reduction factor of 0.2 for shoreline roughness and height of the heron above the shoreline. The equations to estimate external dose rates, D (heron), received by the model great blue heron were calculated with the dose coefficients published by Eckerman and Ryman (1992) and are written:

Shoreline

$$D\ (\text{heron}) = 1.87\text{E+}17 \times 0.3 \times 0.2 \sum_i K_i\ C_{s,i}\ \ \text{mrad/year} \qquad \text{(F.10)}$$

where

1.87E+17 = a conversion factor to change Sv/sec per Bq/kg to mrad/year per Ci/kg,

0.3 = dose rate reduction factor to account for the fraction of the time the heron is exposed to shoreline radiation,

0.2 = dose rate reduction factor to account for shoreline roughness, and

Above Water

$$D\ (\text{heron}) = 1.17\text{E+}17 \times 0.3 \times 0.5 \sum_i K_i\ C_{w,I}\ \text{mrad/year} \qquad \text{(F.11)}$$

where

0.3 = dose reduction factor to account for the fraction of the time the heron is exposed above water, and

0.5 = dose reduction factor to account for one-half of an immersion dose.

Radiation Dose to Rabbit

If dredged sediments were deposited on land and allowed to support vegetation through secondary plant succession, or cultivated and planted in forage, the area would attract animal life as a habitat providing food and shelter. This section provides the biological assumptions (USEPA 1993) and dosimetry equations for a model rabbit that might inhabit an hypothetical area of dredged sediments.

Assume that the rabbit is a typical eastern cottontail (*Sylvilagus floridanus*) and lives its entire life cycle on the area covered by sediments. The model rabbit is assumed to weigh 1.2 kg, consume 0.24 kg of fresh vegetation per day, and spend time above and below ground in equal proportion. Equation F.8 from Baker and Soldat (1992) can be modified to compute the dose rate to a rabbit that consumes radioactive vegetation growing on the dredged sediments contaminated with radionuclides. These changes result in redefining b_i and U_h in terms of vegetation consumption by a rabbit, and the mass in

the denominator is changed to 1.2 kg. The internal dose rate, D (rabbit), from ingestion is written:

Ingestion

$$D\,(\text{rabbit}) = \sum_i p_i\, U_r\, f_{1,i}\, E_{r,i}\,(1 - \exp - \lambda_{r,i} T_e)\, m_r\, \lambda_{r,i} \text{ rad/day} \qquad \text{(F.12)}$$

where

p_i = concentration of radionuclide i in vegetation eaten by rabbit (Ci/kg),
U_r = rate of consumption of vegetation by rabbit (0.24 kg/day),
m_r = mass of rabbit (1.2 kg),

and the remainder of the terms are similar to equation F.8, but are defined as pertaining to a rabbit. Simplification of the constants in equation F.12 and conversion of the dose rate units to mrad/year gives

Ingestion

$$D\,(\text{rabbit}) = 3.73 \sum_i p_i\, f_{1,i}\, \epsilon_{r,i}\,(1 - \exp - 365\lambda_{r,i}) / \lambda_{r,I} \text{ mrad/year} \qquad \text{(F.13)}$$

It is also possible for the model rabbit to receive an additional internal dose from inhalation of dust originating from the radioactively contaminated sediments. The expression for estimating intake of radionuclide i by inhalation, $I_{r,i}$, is written:

$$I_{r,i} = C_{s,i} \times A \times B_r \text{ Ci/day} \qquad \text{(F.14)}$$

where

$C_{s,i}$ = concentration of radionuclide i in sediments (Ci/kg),
A = mass of sediment dust per volume of air breathed (1E10-4 kg/m^3), and
B_r = inhalation rate of rabbit (0.63 m^3/day).

The value for mass of respirable dust, A, is an arbitrary choice that is believed to be conservative. After substitution of constants for inhalation rate and mass of sediment dust per volume of air breathed, the final form of the equation for dose rate (mrad/year) due to inhalation is written:

Inhalation

$$D\,(\text{rabbit}) = 0.944 \sum_i C_{s,i}\, f_{1,i}\, \epsilon_{r,i}\,(1 - \exp - 365\lambda_{r,i}) / \lambda_{r,I} \text{ mrad/day} \qquad \text{(F.15)}$$

The total dose rate to the rabbit from internal irradiation is obtained by summation of equations F.13 and F.15.

The external dose rates received by the model rabbit were calculated with the dose coefficients published by Eckerman and Ryman (1992). The equation for calculating the external dose rate, D (rabbit), from residence on a landscape contaminated by radioactive sediments is written:

Above Soil

$$D\,(\text{rabbit}) = 1.87\text{E+}17 \times 0.5 \sum_i K_i\, C_{s,i} \text{ mrad/year} \qquad \text{(F.16)}$$

where

0.5 = dose rate reduction factor to account for the fraction of the total time that is spent above ground.

The equation for calculating external dose rate received by a model rabbit residing in a burrow dug in contaminated soil is written:

Burrow in Soil

$$D\ (\text{rabbit}) = 3.74E{+}17 \times 0.5 \ \sum_i K_i\ C_{s,i}\ \text{mrad/year} \qquad \text{(F.17)}$$

This mode of exposure was treated as immersion in a continuous soil medium and is simply twice the dose rate from exposure above the soil surface. The dose rate reduction factor in this equation accounts for the other one-half of the rabbit's time.

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Appendix F8

ANALYSIS OF FISH AND BENTHIC INVERTEBRATE COMMUNITIES

F8. ANALYSIS OF FISH AND BENTHIC INVERTEBRATE COMMUNITIES

F8.1 FISH COMMUNITIES

F8.1.1 Data Sets

The Vital Signs Monitoring Program was initiated in 1990 and was expanded in 1991 to include 24 reservoirs. Data for 1991 through 1993 were available for this risk assessment. As explained in Brown et al. (1993), three "zones" were sampled within each reservoir: (1) the forebay immediately upstream of the dam, (2) the transition zone, defined as the mid-reservoir region where the water changes from free-flowing to quiescent, and (3) the inflow or headwater region of the reservoir. Sampling occurred in the fall of each year. Within each zone, two types of samples were collected. Ten electrofishing transects were sampled during daylight hours in the shoreline. Habitats were sampled "in proportion to their occurrence in the zone." Where conditions permitted, 12 overnight gill net samples (100-ft nets with five 20-ft panels with mesh sizes ranging from 1 to 3 inches) were collected in each reservoir zone. Because these two gears have greatly different efficiencies at collecting fish of different species and sizes, separate analyses were performed for each gear type.

TVA survey data were obtained in electronic form from TVA's Norris Laboratory. For purposes of our analysis, data for the 13 mainstem reservoirs were aggregated in two different ways. To examine between-year differences, the 13 mainstem reservoirs were grouped (Table F8.1) into seven river systems: French Broad, Tennessee (split into eastern and western portions), Watts Bar, Clinch, Powell, and Holston. Alternatively, the differences among the thirteen reservoirs were examined by combining the three years of data for each gear type.

A similar survey for the Clinch River Remedial Investigation was conducted in 1992 and 1993. This survey included three sites in the Clinch River arm of Watts Bar Reservoir, three sites in Poplar Creek Embayment, and one site each in lower Watts Bar, the Tennessee River arm of Watts Bar, and Norris Reservoir. Sampling techniques were the same as those used in the Vital Signs Monitoring Program, except that only five electrofishing runs and five gill net sets were performed during each sampling period.

F8.1.2 Methods

We used discriminant analysis to explore the differences in fish community composition of river systems and reservoirs. Our objective was to determine whether the samples of fish communities from Watts Bar reservoir are unusual when compared with the communities of ecologically similar reservoirs in the Tennessee Valley. Discriminant analysis answers this question by identifying the equations that best predict the source of a sample based on its species composition. If this discriminant function is unable to predict the source well, then it is safe to say that we do not have enough statistical power to detect differences in community composition between reservoirs.

Because the variables used to discriminate must be interval, we used species abundances as our discriminating variables. When abundances are used as discriminating variables, species or age classes with inherently high spatial or temporal variability can create spurious variation that hides meaningful patterns in the data. Gizzard shad, threadfin shad, and young-of-the-year fish in general are both abundant and highly variable. To address concerns about seasonal and spatial variation in abundances,

Table F8.1. Assignment of fish sampling stations[a] to river systems

	River System						
Reservoir	Clinch	Powell	French Broad	Holston	Tennessee	Watts Bar	West Tennessee
Norris	F, T, T1	T2					
Douglas			I, FB, T				
Cherokee				I, FB, T			
Melton Hill	I, FB, T						
Ft. Loudon					I, FB, T		
Watts Bar						I1, I2, FB, T	
Chicka-mauga					I, FB, T		
Nickajack					I, FB, T		
Pickwick							I, FB, T
Wilson							I, FB
Wheeler							I, FB, T
Gunters-ville							I, FB, T
Kentucky							I, FB, T

[a]Station codes: I = reservoir inflow; T = reservoir transition zone; F = reservoir forebay.

we removed gizzard and threadfin shad and young-of-the-year fish of all species from the analysis. Abundances of all remaining species were log-transformed to improve normality. Finally, we used a stepwise procedure to remove species that failed to contribute to (or reduced) our ability to discriminate between samples from different rivers. In the stepwise analysis, we retained species that contributed an additional 5% to the canonical correlation between species and sections of river.

We used a canonical discriminant method that assumes that the species abundances are drawn from a multivariate normal distribution with a common underlying variance- covariance matrix. This assumption is needed mainly for the hypothesis testing, and not for the development of discriminant functions and classification. Although the assumption can never be definitively tested, more replicates in each river section would have enabled us to compare the variance-covariance matrices of the samples. We used cross-validation to compare the parametric and non-parametric methods of discriminant

analysis provided in SAS's DISCRIM procedure. We found that the ability of the discriminant functions to classify observations was better for the multivariate normal, parametric method.

We chose canonical discriminant analysis for several reasons. First, canonical discriminant functions allowed us to visualize the reservoirs in a reduced-dimensional space. Second, the pooled-within river correlation matrix allowed us to identify species making the largest contributions to differences in fish communities between rivers. Finally, canonical discriminant functions are numerically stable in comparison to other multivariate methods because colinearity between species is less influential.

Klecka (1980) describes these functions as linear combinations of the discriminating variables (species abundances):

$$f_{km} = u_0 + u_1X_{1km} + u_2X_{2km} + \ldots + u_pX_{pkm},$$

where f_{km} is the weight of sample m in group (e.g., reservoir) k on the canonical discriminant function; X_{ikm} is the abundance of species i for sample m in group k. The coefficients u_i of the first canonical discriminant function are calculated such that they maximize the distances among all group means. The coefficients of subsequent functions also maximize distances among group means, but with the added constraint that they are orthogonal to each other. In general, the classification resulting from canonical discriminant analysis with all axes is the same as that from regular discriminant analysis except when colinearity exists among river sections. In that situation, the canonical analysis is more robust (Klecka 1980).

To classify a sample, a posterior probability of group (river) membership is estimated. The probability depends on two factors: the fraction of samples in each group and the Mahalanobis distance from the sample to each group centroid (mean). The sample is assigned to the group with the highest posterior probability. The Mahalanobis distance measure accounts for correlations between species abundances and scales species according the variability in their observed abundances. It turns out that the squared Mahalanobis distance between group means has a chi-square distribution with p-degrees of freedom. This fact allows us to test the significance of distances between reservoirs or groups of reservoirs. The Mahalanobis distance (in species abundance space) between all pairs of river sections can be observed in the results. In general, the river with the lowest cross-validation error rate shows the most unique species composition.

Multivariate methods provide useful graphical summaries and rigorous statistical criteria for determining differences between sites. However, because they incorporate both species composition and relative abundance, they are subject to errors introduced by spatial and temporal variability of species distributions (due to weather or current changes or simple random fluctuations) that can introduce extraneous variability and either mask real differences between sites or introduce spurious differences. Therefore, a second analysis based only on species richness, defined as number of species per sample, was performed.

We evaluated differences in species richness among reservoirs. The data set included all species, but excluded young-of-the-year. The counts were transformed using a square-root transformation to obtain approximately normal distributions of richness. Differences among reservoirs and among locations within the Clinch River/Poplar Creek system were evaluated using SAS statistical software (GLM procedure). Mean transformed fish species richness values were compared using the Waller-Duncan k-ratio t-test. We used a k-ratio of 100. This ratio reflects the ratio of type 1 to type 2 error and roughly corresponds to an alpha level of 0.05. This method minimizes the Bayes risk under additive loss, where the loss function is the difference between means. It assumes that the population means have a

normal prior distribution with unknown variance, the log of which has a uniform prior distribution. For the Vital Signs data, richness values were square-root-transformed prior to analysis. For the Clinch River/Poplar Creek data, no transformation was necessary.

Results: TVA Vital Signs Data

Results of the canonical discriminant analyses of the Vital Signs data are summarized in Figures F8.1 through F8.10. Figures F8.1 through F8.6 display results by year, with the reservoirs grouped into river systems. Figures F8.7 and F8.8 display comparisons among individual reservoirs, with all years combined. Only the first two canonical variables are plotted for each data set. However, plots of the third through sixth variates show similar patterns to those of the first two. The symbols represent individual sample values; the names of the river systems are printed at the location of the mean value for each system. For all three years, and both gear types, all river systems were significantly different from all other systems. A regional pattern is, however, apparent. Regardless of year or gear type, West Tennessee, Tennessee, and Watts Bar cluster together near the center of the plots. The reservoirs comprising all three of these systems are mainstem, run-of-the-river reservoirs. The most extreme reservoirs for each year and gear type are always storage reservoirs located in the upper Tennessee Valley: the Powell (Powell Arm of Norris Lake) in 1991, the Holston (Cherokee Lake) and French Broad (Douglas Lake) in 1992, and the Powell, Clinch, Holston, and French Broad in 1993. Results for the combined-years analysis were similar. For the gill net data (Fig. F8.7), the three storage reservoirs stand out as distinctly different from the run-of-the-river reservoirs. For the electrofishing data (Fig. F8.8), mean canonical variate values for all reservoirs upstream from Watts Bar reservoir are located on the left side of the plot; means for all reservoirs downstream from Watts Bar are located on the right side.

We also looked at "loadings," i.e., the contribution of different fish species to the discriminant functions. Species with high (>0.30) correlations with any of the first four canonical variables for each year and data set are listed in Table F8.2. The most obvious visible pattern in this table is that different sets of species are important for each gear type. For the electrofishing data, more than half of the species with high loadings are centrarchids (largemouth bass, spotted bass, readear/redbreast/longear sunfish, white/black crappie). These species are, for the most part, non migratory. They have relatively small home ranges and are relatively invulnerable to static gear such as gill nets. In contrast, relatively few of the species making major contributions to the discriminant functions for the gill net data sets are centrarchids. Fish with high loadings in the gill net are predominantly mobile species such as quillback, striped bass, and suckers. The only species that is frequently important for both gear types is the walleye, a species that is found predominantly in the upper Tennessee Valley because of temperature and spawning habitat requirements.

Figure 6.8 and 6.9 (Sect. 6, Vol. 1) show results of the species richness analysis for all three years and both gear types. Melton Hill Reservoir is either lowest or next-to-lowest in species richness for every year and gear type. Results of the Waller-Duncan K-ratio test show that Melton Hill falls into the lowest significance group for every data set except the 1993 gill net data. For most data sets, the reservoirs with the highest species richness are located in the lower Tennessee Valley (i.e., below Chattanooga): Kentucky Reservoir in the 1992 and 1993 gill net data and the 1991 and 1992 electrofishing data; Wilson Reservoir in the 1991 gill net data, and Nickajack Reservoir in the 1993 electrofishing data. Among the seven upper-valley reservoirs (Chickamauga, Watts Bar, Ft. Loudon, Melton Hill, Norris, Cherokee, and Douglas), Chickamauga Reservoir had the highest species richness in every data set except the 1991 gill net and 1992 electrofishing data; Watts Bar reservoir ranked first or second among the upper valley reservoirs for every data set except the 1992 gillnet and the 1991 electofishing. The different gear types give substantially different results. For the gill net data, no geographic trends are apparent except that Melton Hill is the lowest. For the electrofishing data, Chickamauga Reservoir is the only upper valley reservoir in the top half of the rankings; the five reservoirs upstream

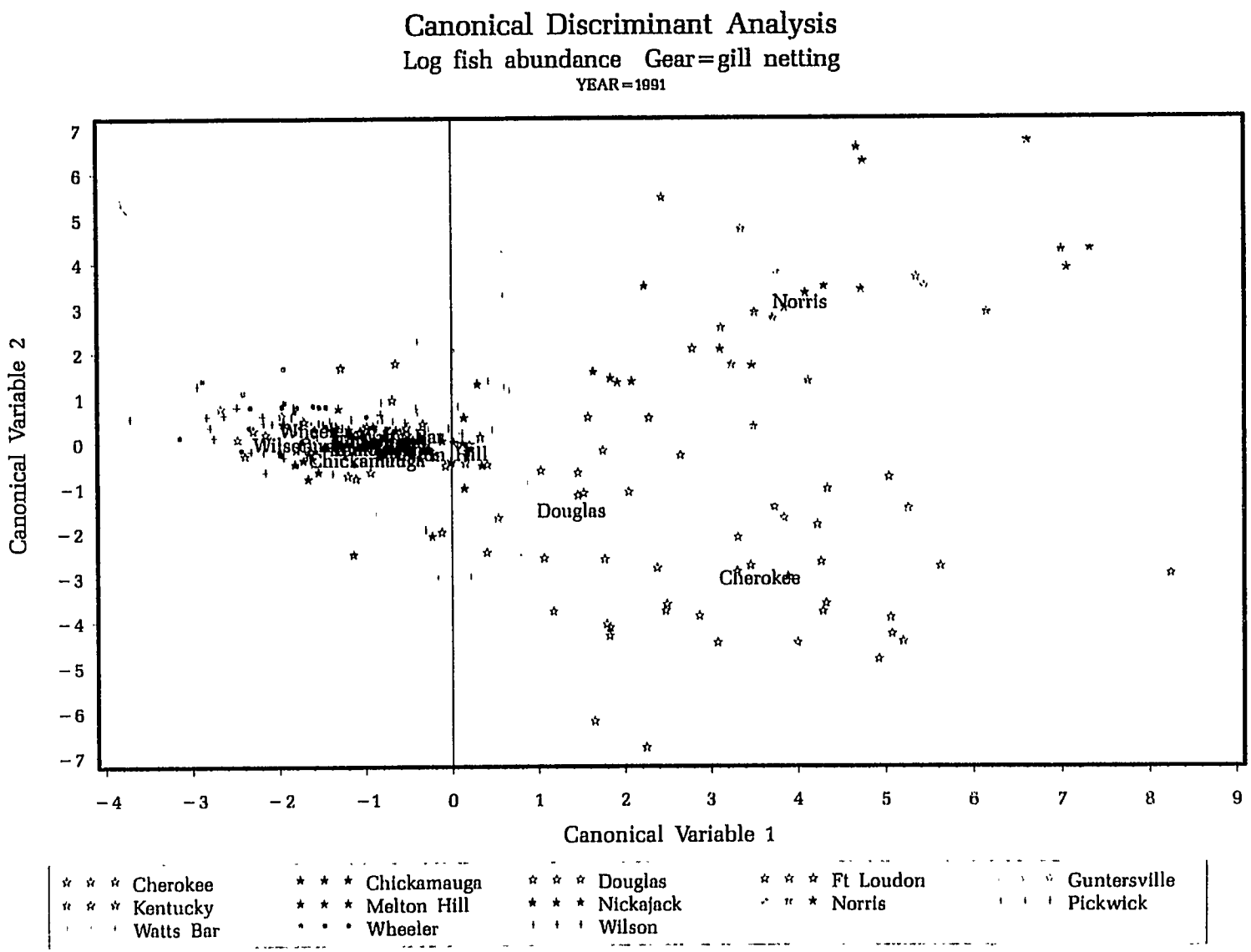

Fig. F8.1. Canonical discriminant analysis of the fish communities sampled by gill netting in Tennessee Valley reservoirs in 1991; grouped by drainage.

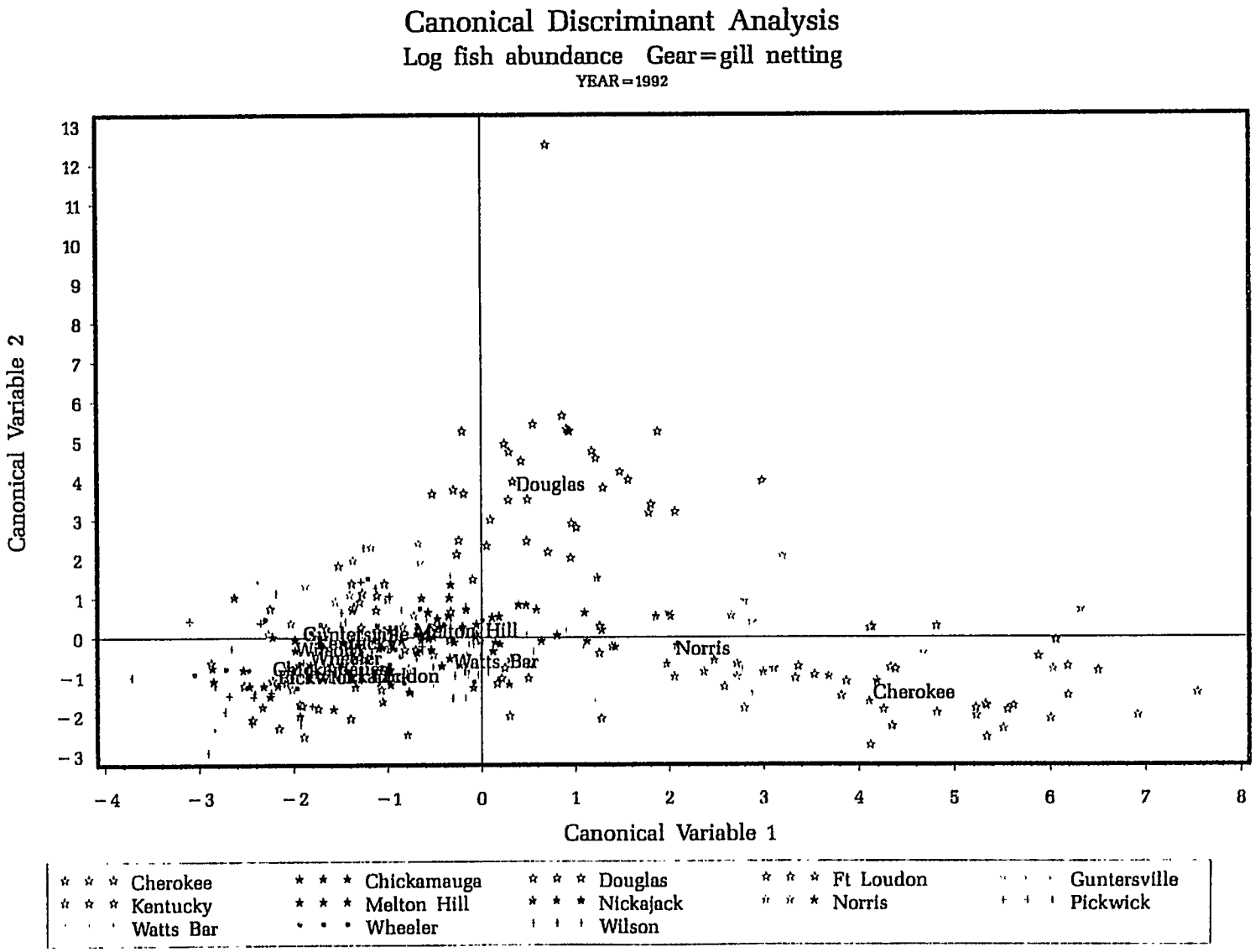

Fig. F8.2. Canonical discriminant analysis of the fish communities sampled by gill netting in Tennessee Valley reservoirs in 1992; grouped by drainage.

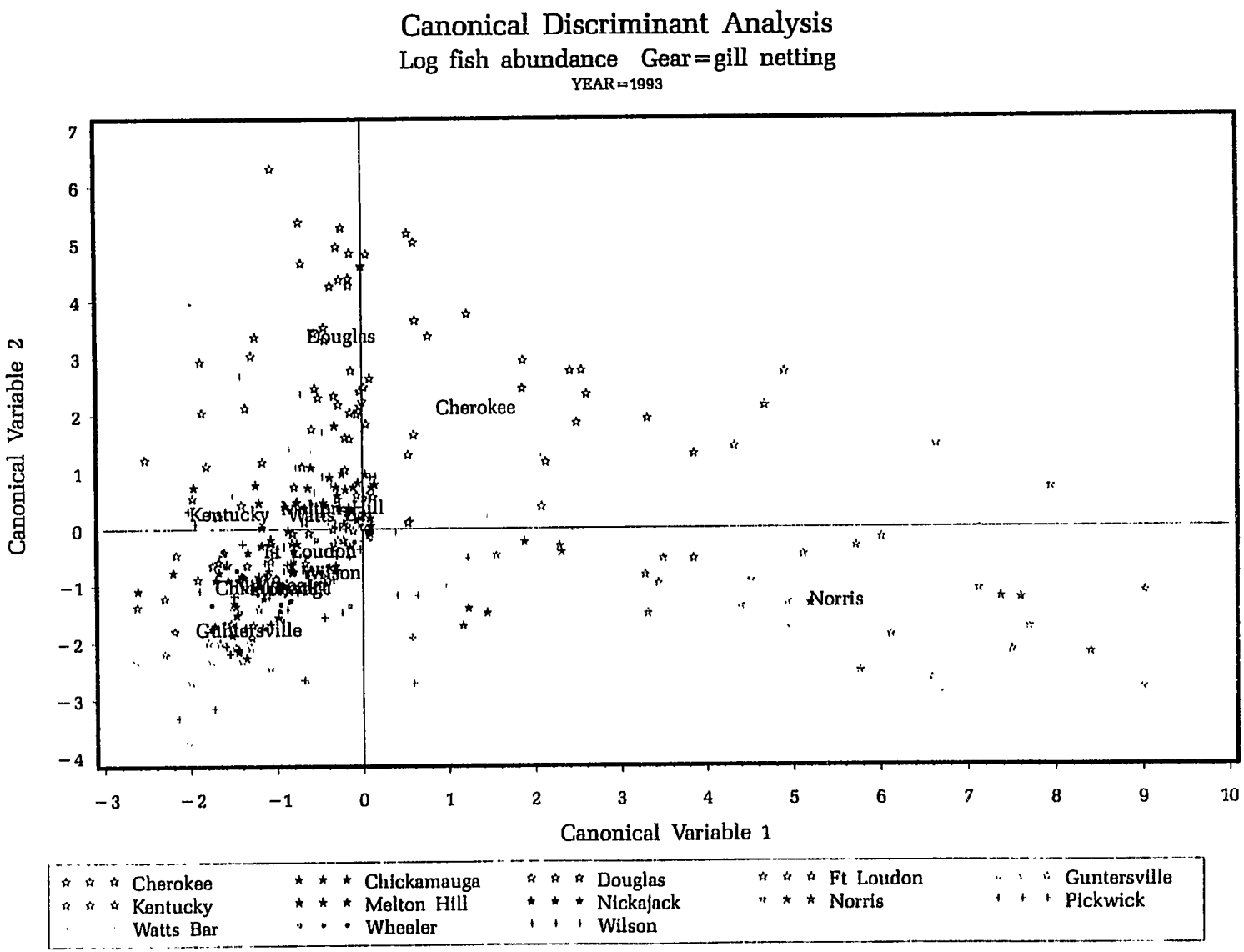

Fig. F8.3. Canonical discriminant analysis of the fish communities sampled by gill netting in Tennessee Valley reservoirs in 1993; grouped by drainage.

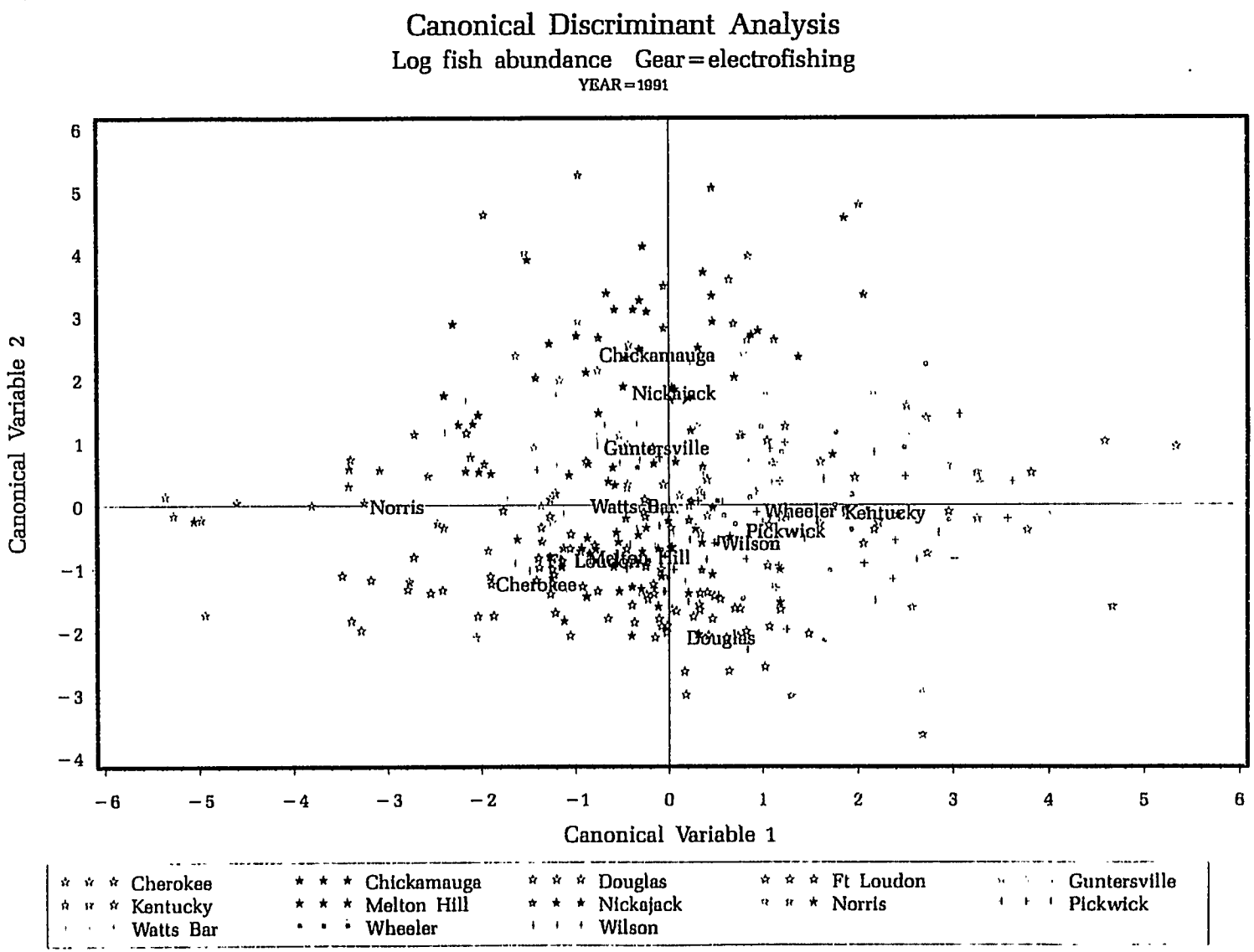

Fig. F8.4. Canonical discriminant analysis of the fish communities sampled by electrofishing in Tennessee Valley reservoirs in 1991; grouped by drainage.

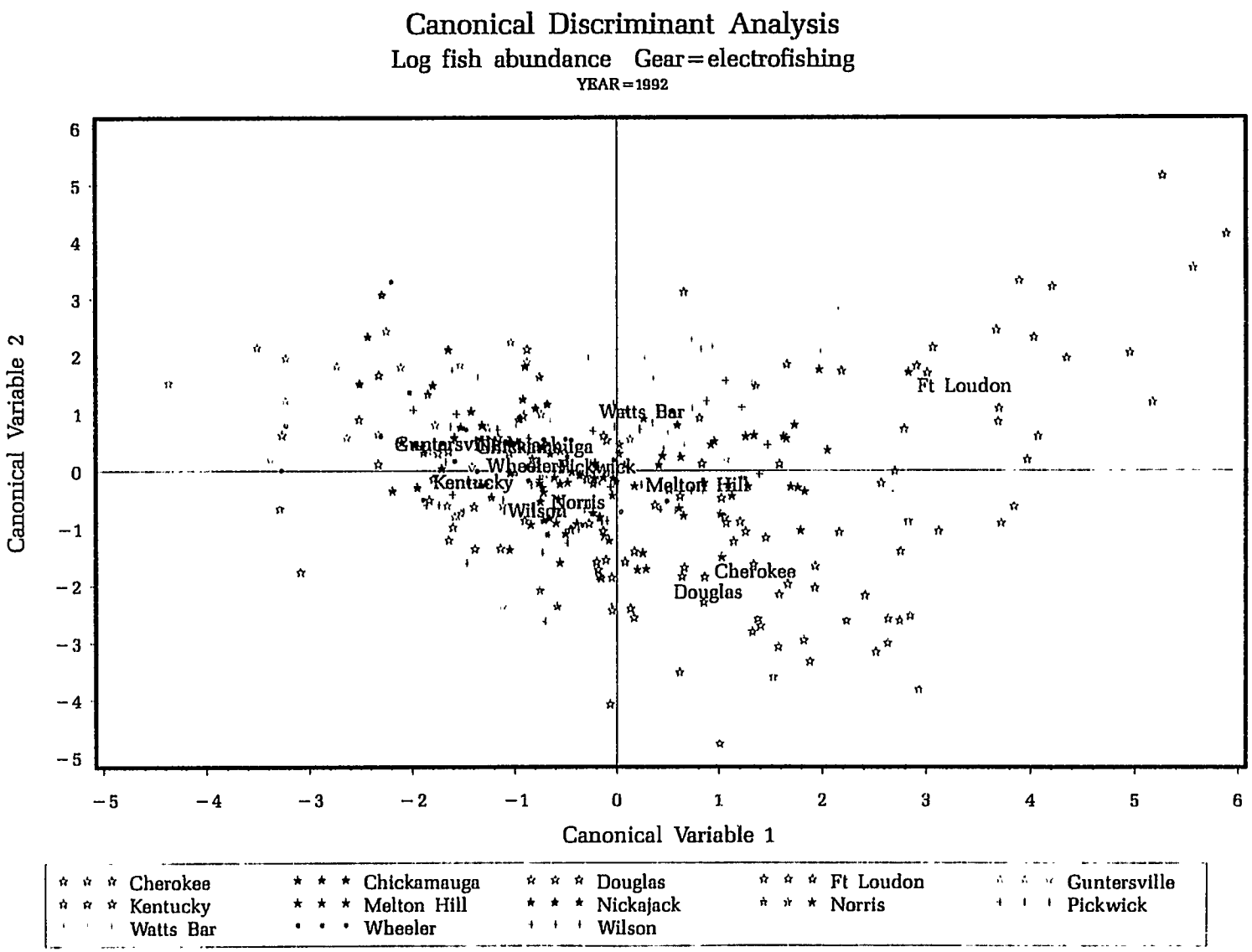

Fig. F8.5. Canonical discriminant analysis of the fish communities sampled by electrofishing in Tennessee Valley reservoirs in 1992; grouped by drainage.

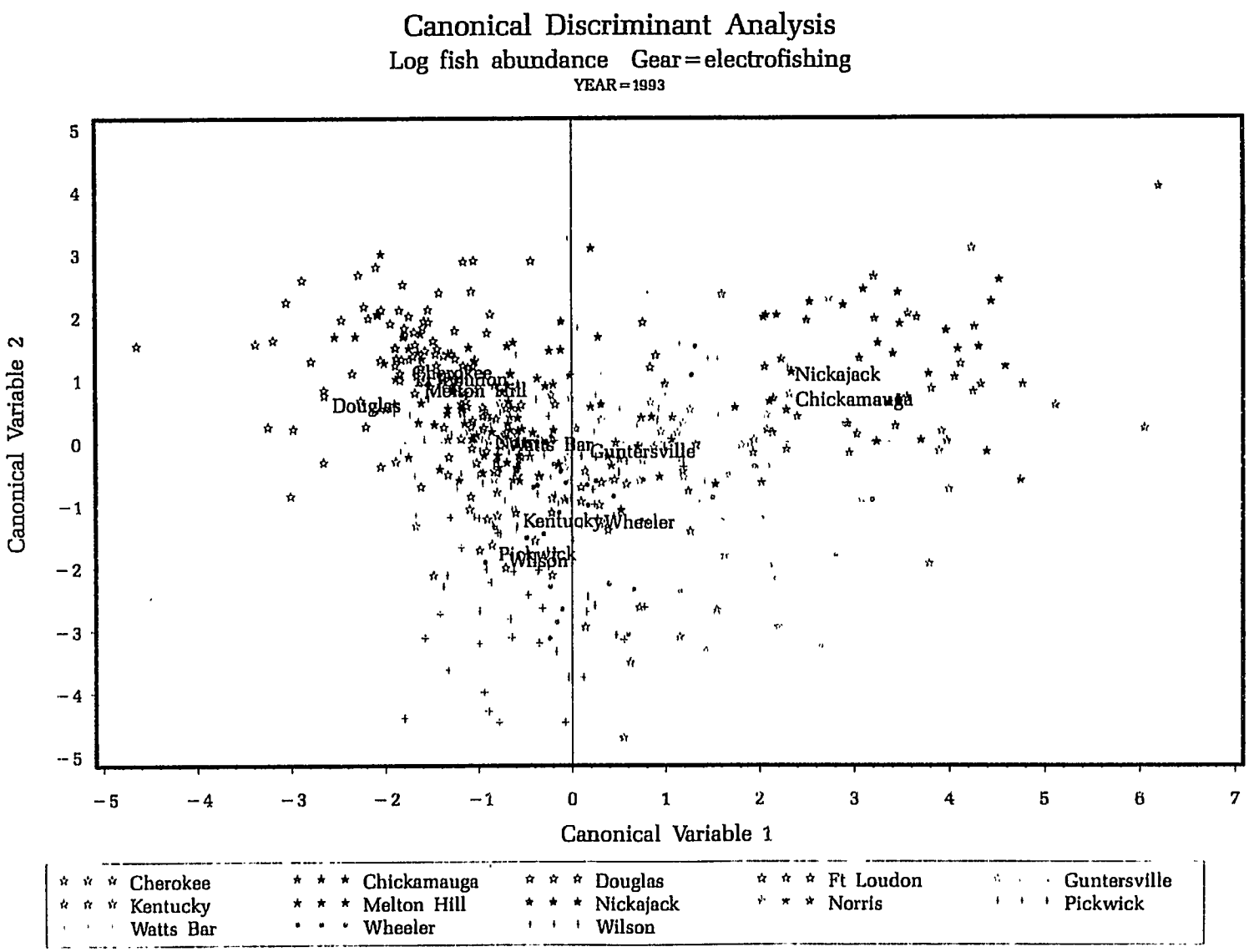

Fig. F8.6. Canonical discriminant analysis of the fish communities sampled by electrofishing in Tennessee Valley reservoirs in 1993; grouped by drainage.

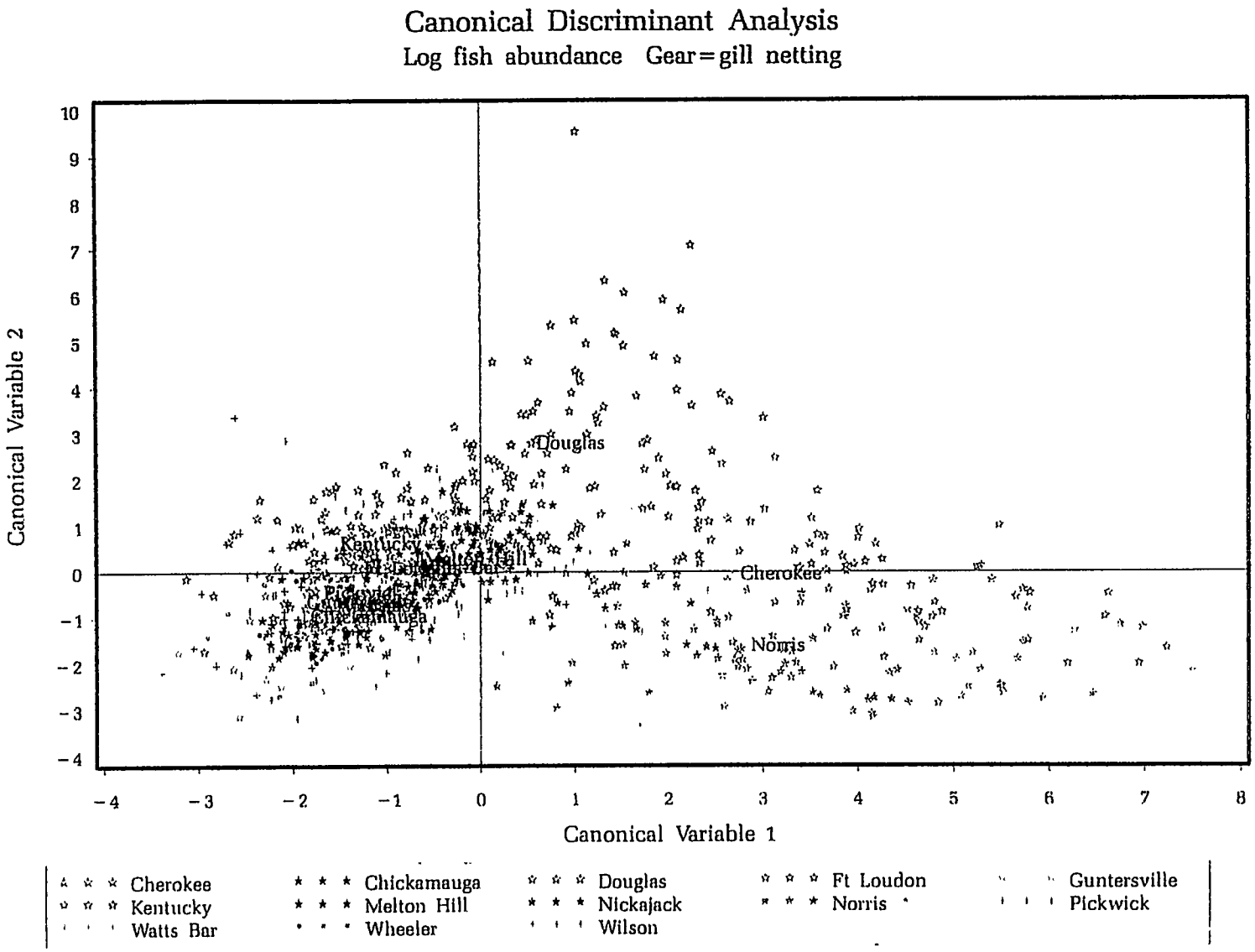

Fig. F8.7. Canonical discriminant analysis of the fish communities sampled by gill netting in individual Tennessee Valley reservoirs.

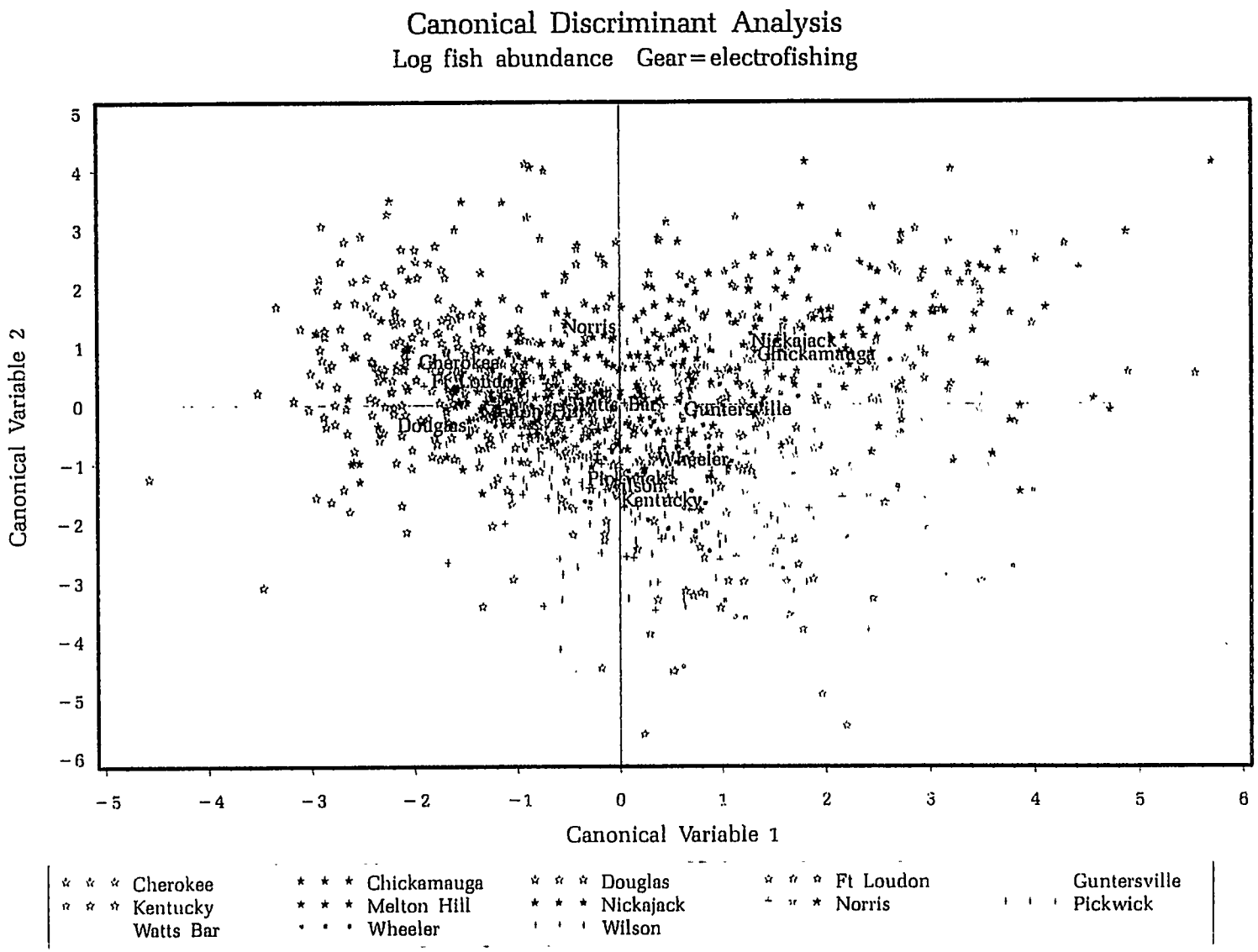

Fig. F8.8. Canonical discriminant analysis of the fish communities sampled by electrofishing in individual Tennessee Valley reservoirs.

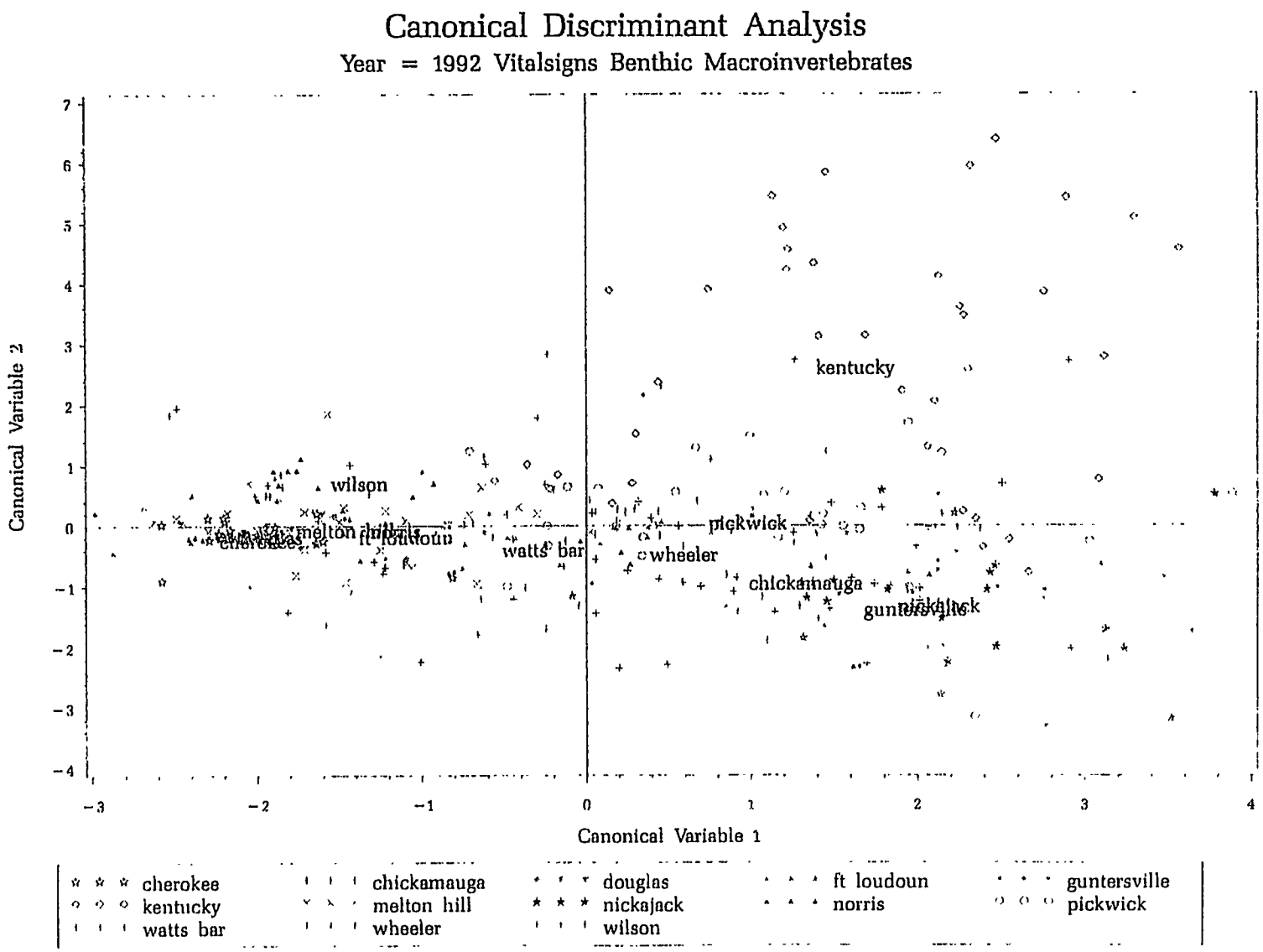

Fig. F8.9. Canonical discriminant analysis of the benthic macroinvertebrate communities sampled for the Vitalsigns Program in individual Tennessee Valley reservoirs in 1992.

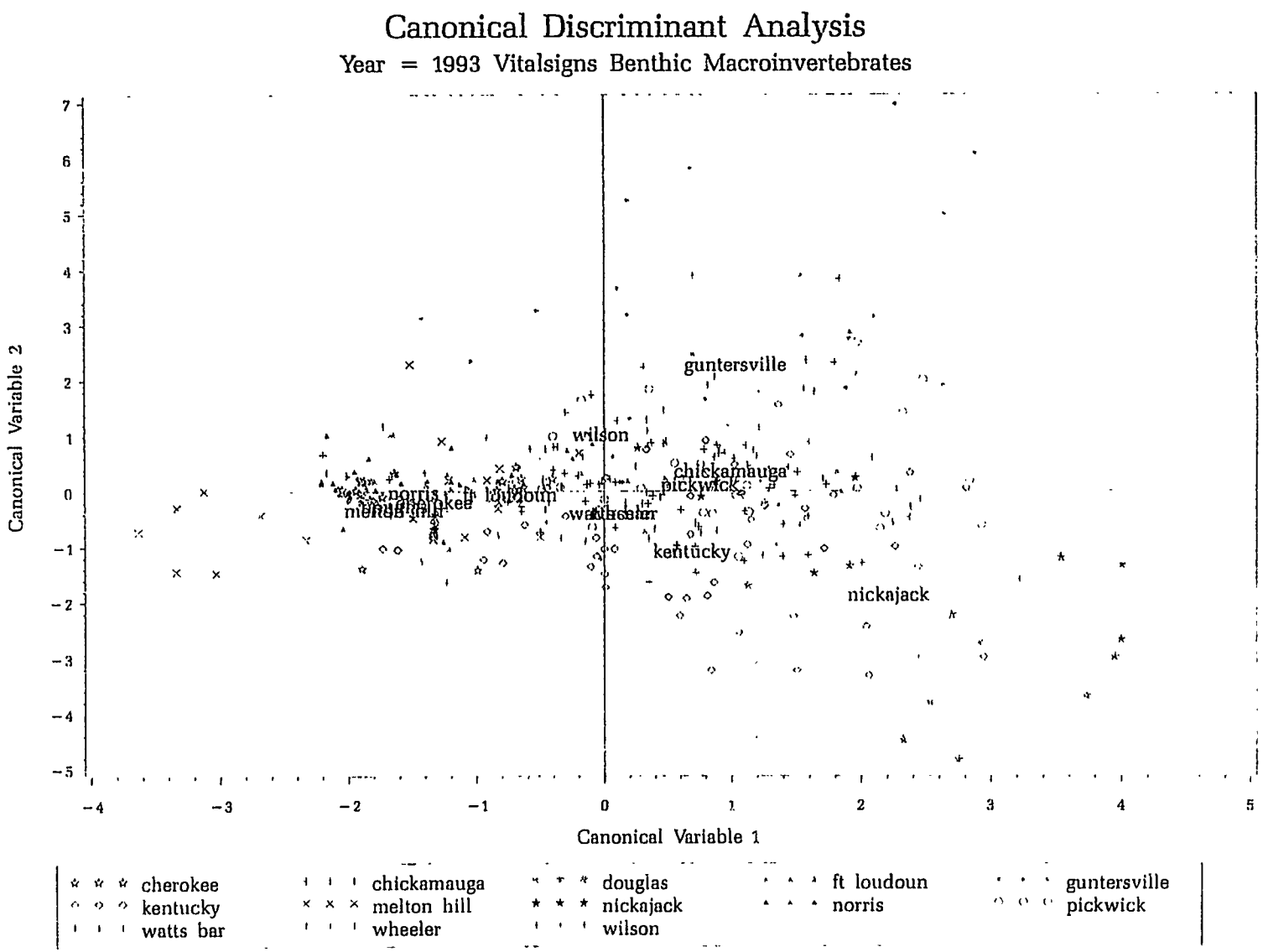

Fig. F8.10. Canonical discriminant analysis of the benthic macroinvertebrate communities sampled for the Vitalsigns Program in individual Tennessee Valley reservoirs in 1993.

Table F8.2. Species having high contributions to canonical variable values

Data set	1st canonical variable	2nd canonical variable	3rd canonical variable	4th canonical variable
1991 electrofish	walleye black redhorse shorthead red-horse	redbreast sunfish white bass redear sunfish largemouth bass spotted bass	redear sunfish spotted sucker	redbreast sunfish
1991 gill net	quillback silver redhorse walleye	quillback silver redhorse	quillback white crappie river carp-sucker	white crappie walleye black crappie
1992 electrofish	largemouth bass redear sunfish warmouth	redbreast sunfish longear sunfish northern hog-sucker	redear sunfish redbreast sun-fish black redhorse	warmouth white bass
1992 gill net	walleye striped bass quillback skipjack herring	sauger striped bass silver redhorse	walleye sauger silver redhorse black redhorse	walleye striped bass blue catfish
1993 electrofish	spotted bass white bass white crappie redear sunfish	largemouth bass spotted bass longear sunfish common carp redbreast sun-fish northern hog-sucker	white bass longear sunfish black redhorse walleye	white crappie walleye redbreast sun-fish redear sunfish, northern hog-sucker
1993 gill net	skipjack herring river carp-sucker walleye striped bass yellow bass quillback	silver redhorse river carp-sucker walleye	silver redhorse golden red-horse white crappie sauger	striped bass

Table F8.2 (continued)

Electrofish - across years	spotted bass common carp redear sunfish emerald shiner	spotted bass longear sunfish redbreast sun-fish	common carp redbreast sun-fish shorthead red-horse	largemouth bass white bass
Gill net - across years	quillback striped bass walleye skipjack herring	walleye white crappie sauger	striped bass sauger	goldeye

from Watts Bar are the five lowest in species richness. Cherokee, Norris, Douglas, and Melton Hill are all significantly lower in richness than every other reservoir in the valley.

Parallel analyses were performed for total fish density (individuals per sample), however, it was found that abundance and richness were highly correlated for every data set. Similar patterns were evident, e.g., Melton hill consistently the lowest in fish density, lower valley reservoirs in general with higher fish density than upper valley reservoirs, and Watts Bar intermediate within the valley as a whole.

In spite of the clear differences in species composition between gear types, the overall pattern in river system similarity is the same for both: storage reservoirs are different from run-of-the-river reservoirs, and upper Tennessee Valley reservoirs are different from lower Tennessee Valley reservoirs. These large-scale geographic patterns must be considered when valley-wide ecological data are used to evaluate the condition of a single reservoir. The implication of this result for the Clinch Arm BERA is that no single reservoir can serve as a comparable reference ecosystem. Although upstream reservoirs such as Norris can be presumed unaffected by DOE-derived contaminants, they are ecologically distinct for a variety of reasons unrelated to contaminants.

F8.2 BENTHIC MACROINVERTEBRATES

Sources of data

The Vital Signs Monitoring Program sampled three zones within each reservoir (Masters 1993): (1) the forebay immediately upstream of the dam, (2) the transition zone, defined as the mid-reservoir region where the water changes from free-flowing to quiescent, and (3) the inflow or headwater region of the reservoir. At each sampling location, ten evenly-spaced samples were collected along the length of a line-of-sight transect across the reservoir. Most samples were taken using a Ponar dredge, however, a Peterson dredge was used where rocky substrates predominated.

Vital Signs data were obtained in electronic form from T. McDonough at the TVA Norris laboratory. Planktonic organisms, fish eggs, and terrestrial species recorded during sample sorting were deleted from the data sets prior to analysis. Counts of individual species were standardized to a per m^2 basis. To check for errors introduced during these procedures, total densities (numbers per m^2) per site were calculated and compared to values in TVA's published tables. In the original data sets, organisms were classified "to the lowest practical taxon" (Masters 1993). This classification scheme produced an

excessively large number of total taxa (142–189). For our analysis TVA's taxa were grouped into families, resulting in a more manageable 37–56 unique taxa. Each dredge haul was treated as a separate sample, yielding a total of ten samples per transect. All data were log-transformed prior to analysis. To maximize the ecological similarity of the sites being compared, only mainstem reservoirs (Kentucky, Pickwick, Wilson, Wheeler, Guntersville, Nickajack, Chickamauga, Watts Bar, Ft. Loudoun, Melton Hill, Norris, Douglas, and Cherokee) were included in the analysis.

ER-program data were obtained through Task 9 of the TVA/DOE Interagency Agreement supporting the Clinch River Remedial Investigation. These data were collected at eight stations in the Clinch River between Melton Hill Dam and Watts Bar Reservoir and at eight stations in Poplar Creek. These data were collected using the same sampling protocol used for the Vital Signs data and were transformed prior to analysis using the procedures described above.

For the Vital Signs data, canonical discriminant analyses were performed for each year to identify general patterns in community structure across reservoirs (Sect. 6.2.2.4). A similar analysis was performed for the ER Program data. However, due to sample size considerations it was necessary to combine the sampling sites into three groups: Clinch River above Poplar Creek (CRM-21, CRM-19, and CRM-14.5), Poplar Creek (PCM-8, PCM-7, PCM-6, PCM-5.1, PCM-4.3, PCM-2.9, PCM 1., and PCM-0.5), and Clinch River below Poplar Creek (CRM-11, CRM-9, CRM-6.7, and CRM-3.7). Station CRM-1.0, which is located in the Clinch arm of Watts Bar Reservoir, was considered ecologically distinct from the other Clinch River sites and deleted from this analysis.

One-way analysis of variance was used to investigate patterns in species richness, defined as number of species per m^2. For the Vital Signs data, richness values were square-root-transformed prior to analysis. For the near-field data, no transformation was necessary. For both analyses the ANOVA was followed by a multiple-comparison test (the Ryan-Einot-Gabriel-Welsch Multiple Range Test from the SAS GLM Procedure) to determine significant differences between reservoirs.

A multiple linear regression analysis was performed to investigate the influence of physical characteristics and contaminant concentrations on benthic community structure in the Clinch River and in Poplar Creek. Physical and Chemical data were obtained from the CRRI database.

Benthic community measures investigated using multiple linear regression analysis included (1) total species richness and dominance, and (2) the abundance of five major invertebrate taxa: Tubificidae, Chironomidae, Diptera, Hexagenia, and Veneroida. Explanatory variables investigated included depth; substrate characteristics (% sand, % silt, % clay, % gravel); total organic carbon (TOC); total PCBs, total PAH, and toxic metals in whole sediment samples; and ammonia nitrogen and aluminum in sediment pore water. The metals investigated included arsenic, cadmium, chromium, lead, mercury, nickel, silver, and zinc. Because all of these were found to be highly intercorrelated in initial exploratory analyses, the concentrations of the individual metals (except for aluminum) were combined into toxic units (TUs) prior to analysis. TUs were calculated by normalizing the concentration of each metal to the ER-L for that metal and then summing the TUs for all metals.

The Clinch River and Poplar Creek data were analyzed separately. First, a step-wise backward elimination procedure was used to develop explanatory models for each of the community measures. In most of these analyses toxic metals were eliminated. PCB and PAH were retained in most of the final models. However, because of the high collinearity of many of the explanatory variables (especially correlations between PAH, PCB, and TOC), it was not possible to identify influences of specific contaminants on benthic macroinvertebrate communities. To provide a more robust analysis (i.e., one less influenced by collinearity among variables), a two-stage analysis of physical vs. chemical effects

was performed. In the first stage, a regression model that included only the physical variables (i.e., depth, % sand % silt, % clay, % gravel, and TOC) was developed. No backward elimination step was performed. In the second stage, a model that included both the physical variables and all of the chemical variables was developed. The significance of the influence of the chemical variables on the benthic community measures was tested by comparing the residual sums of squares for the two models.

Results: Vital Signs Data

Results of the canonical discriminant analyses of the Vital Signs data are summarized in figures F8.9 through F8.11. Only the first two canonical variables are plotted. The symbols represent individual sample values; the names of the reservoirs are printed at the location of the mean value for each reservoir. For all three years, most reservoirs were significantly different from all other reservoirs. Some regional patterns are, however, apparent. Reservoirs in the upper Tennessee Valley (Watts Bar, Ft. Loudoun, Melton Hill, Norris, Douglas, and Cherokee), were more similar to each other than to reservoirs below Watts Bar Dam. Figures F8.9 through F8.11 show that these six reservoirs consistently tend to cluster together. Reservoirs in the lower Tennessee Valley (Wilson, Wheeler, Pickwick, Chicamauga, Guntersville, Nickajack, and Kentucky) are more dispersed and therefore more distinct from each other. Benthic invertebrate families with high (>0.30) correlations with any of the first four canonical variables for each data set are listed in Table F8.3. The Corbiculidae and the Hydropsychidae are the most important families in terms of contributions to the discriminant functions. The Corbiculidae have high correlations with the first canonical variable for all three Vital Signs data sets; the Hydropsychidae contribute to the first canonical variable in two of the three data sets and contribute to one or more of the canonical variables in every data set. Of the 56 benthic macroinvertebrate families represented in the Vital Signs data, only 18 are highly correlated with any canonical variable. Note that, in spite of their high abundance and frequent numerical dominance, Tubificidae and Chironomidae are relatively unimportant contributors to the discriminant analyses for the Vital Signs data. Hence, Tennessee Valley reservoirs in general differ more with respect to rarer taxa than with respect to the abundant and widely-distributed tubificids and chironomids.

Results from the richness analyses were similar. The six upper reservoirs were consistently in the lower half of the data set when ranked by species richness. Melton Hill in 1992 is the only exception to this pattern. Douglas Lake had the lowest species richness in every year and Ft. Loudoun, Cherokee, and Douglas were among the four lowest in two of the three years. Watts Bar Reservoir ranked 8th in richness in 1992, 12th in 1993, and 9th in 1994. Figure F8.12 displays this pattern graphically. A general decline in richness is evident above Nickajack Reservoir in 1992 and 1994 and above Chickamauga Reservoir in 1993.

Figure F8.13 shows that these trends are generally unrelated to benthic invertebrate density (#/m^2), for which the only apparent trend is consistently lower density in Douglas and Cherokee Reservoirs. Figures F8.14 and F8.15, however, show a visible trend in species composition: the per cent of tubificids and, to a lesser extent, chironomids in benthic samples is higher in the upper reservoirs than in the lower reservoirs.

Thus, valley-wide benthic invertebrate communities show a consistent geographic pattern: reservoirs in the lower Tennessee Valley are relatively diverse and distinct from each other; reservoirs in the upper valley are less diverse and more similar to each other.

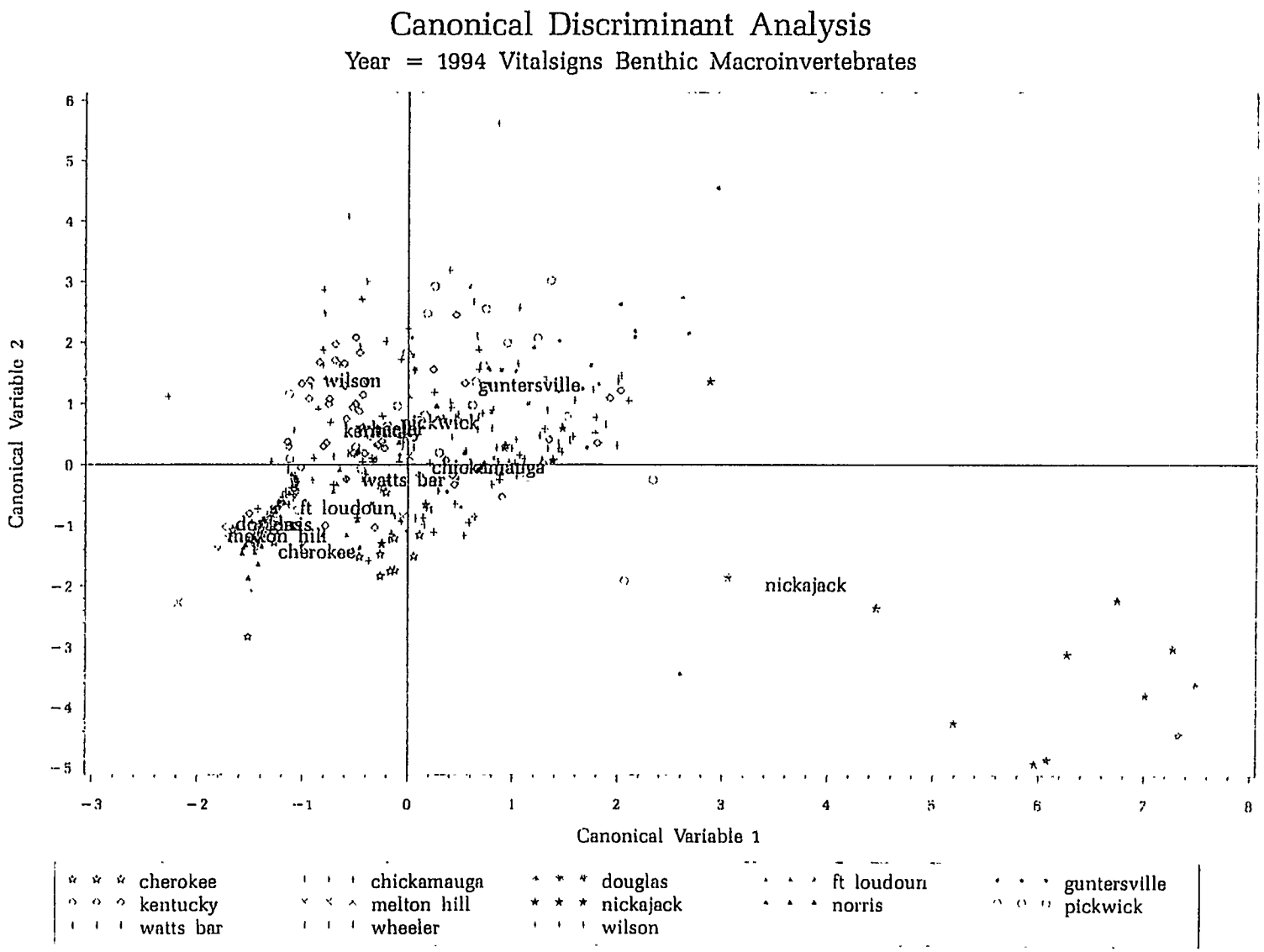

Fig. F8.11 Canonical discriminant analysis of the benthic macroinvertebrate communities sampled for the Vitalsigns Program in individual Tennessee Valley reservoirs in 1994.

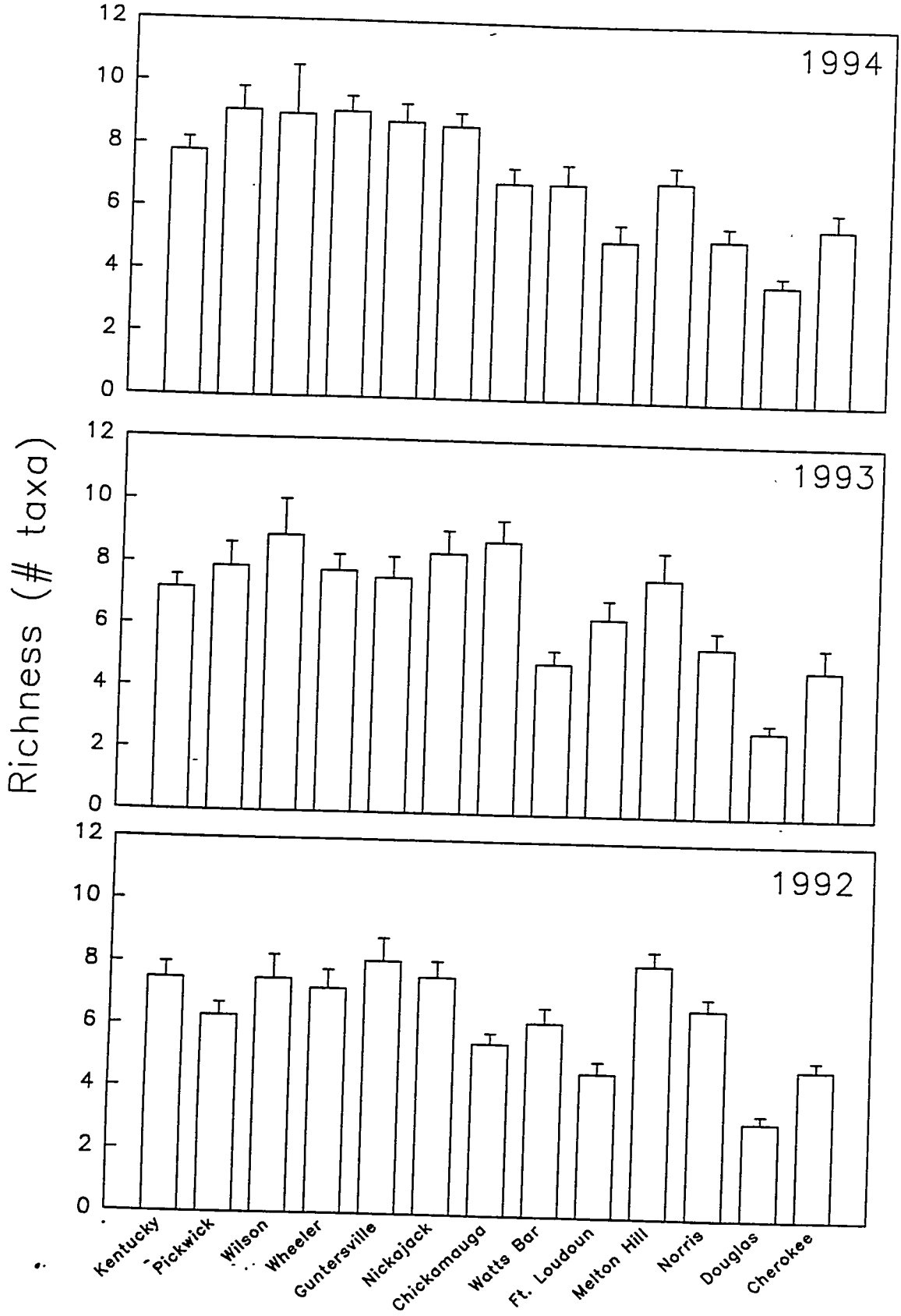

Fig. F8.12. Taxonomic richness (Mean ± SE) of benthic macroinvertebrates sampled for the Vitalsigns Program in individual reservoirs in 1992–1994.

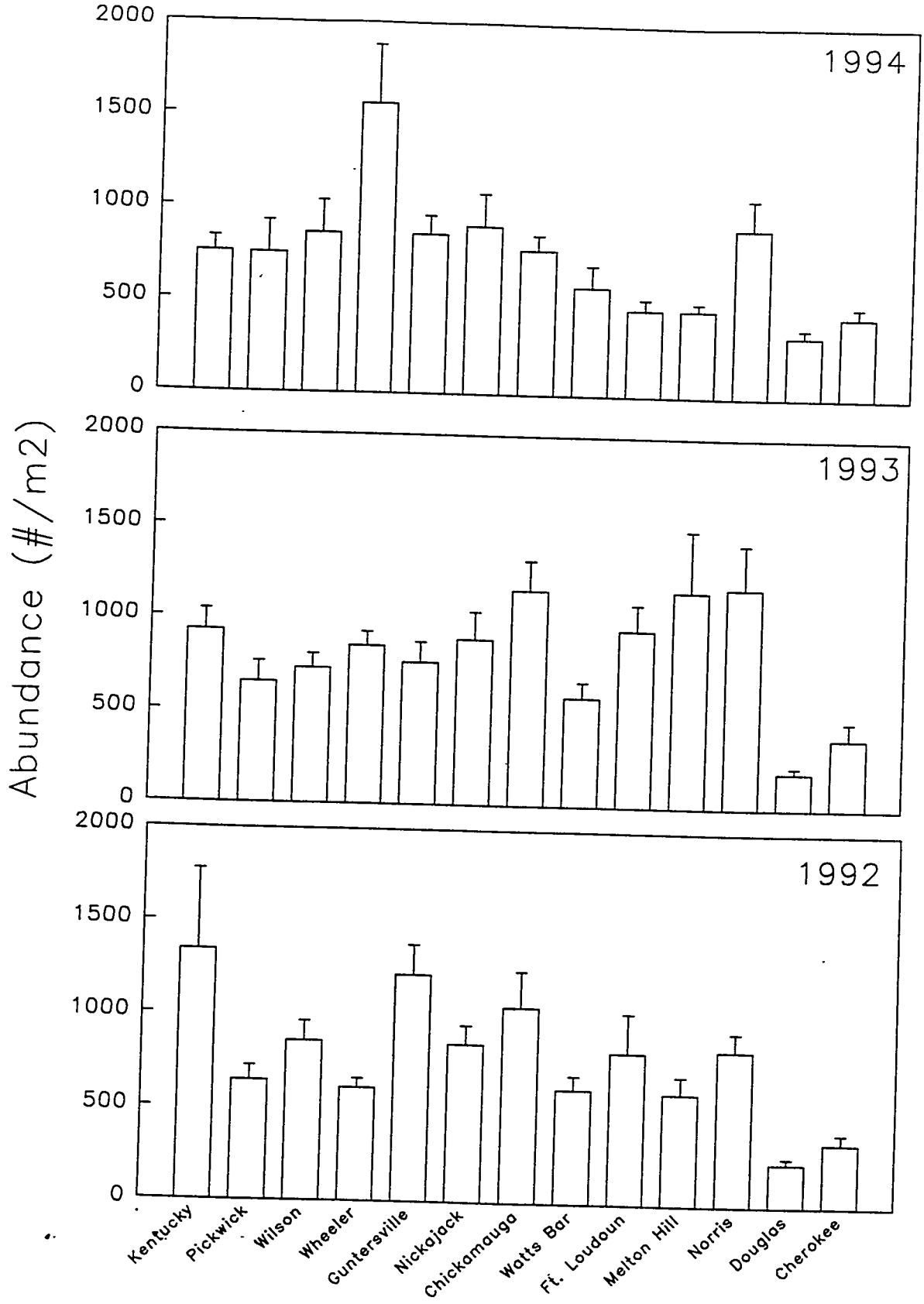

Fig. F8.13. Abundance (Mean ± SE) of benthic macroinvertebrates sampled for the Vitalsigns Program in individual reservoirs in 1992–1994.

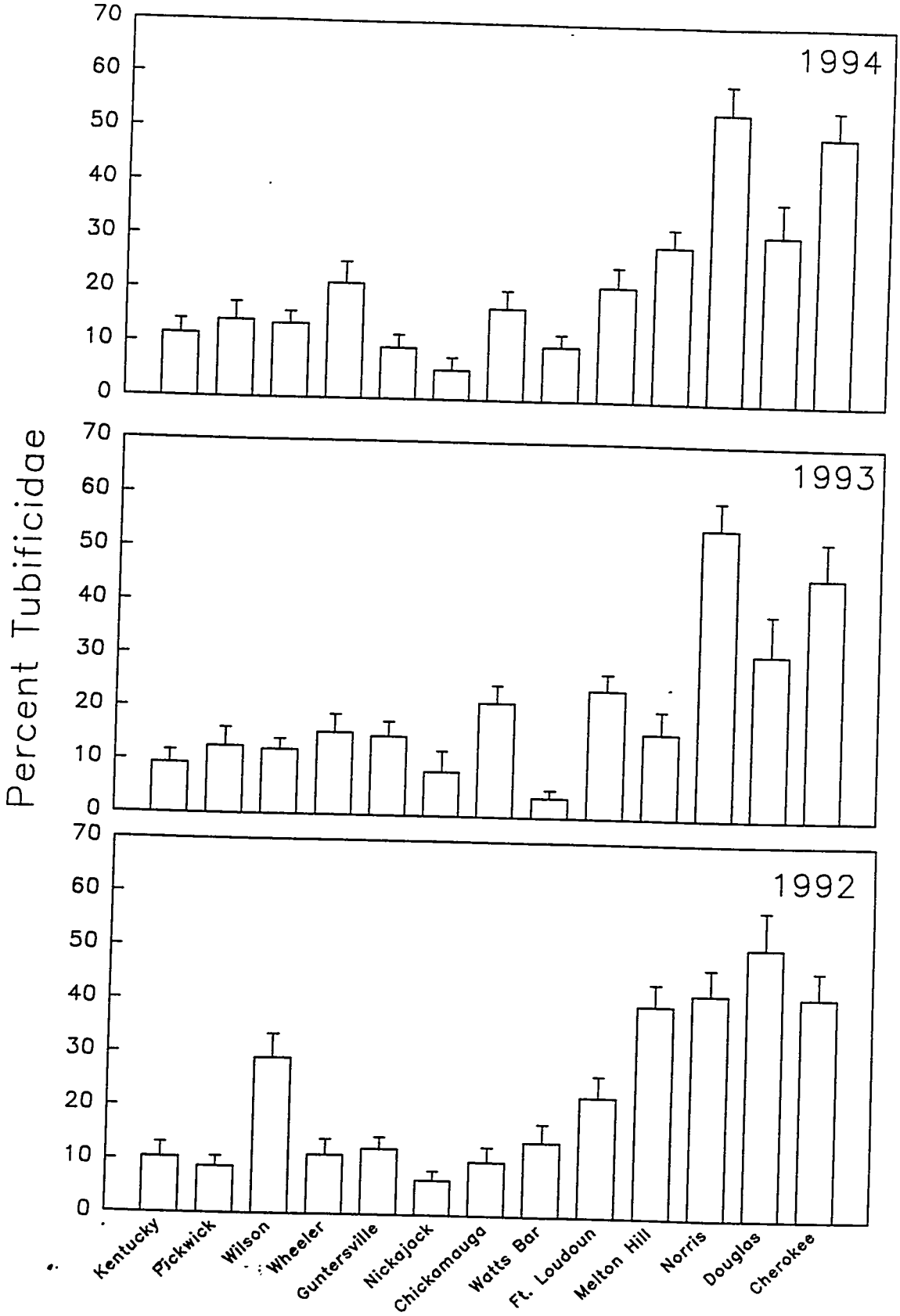

Fig. F8.14. Percentage (Mean ± SE) of benthic macroinvertebrate community represented by *Tubificidae* in individual reservoirs in 1992–1994.

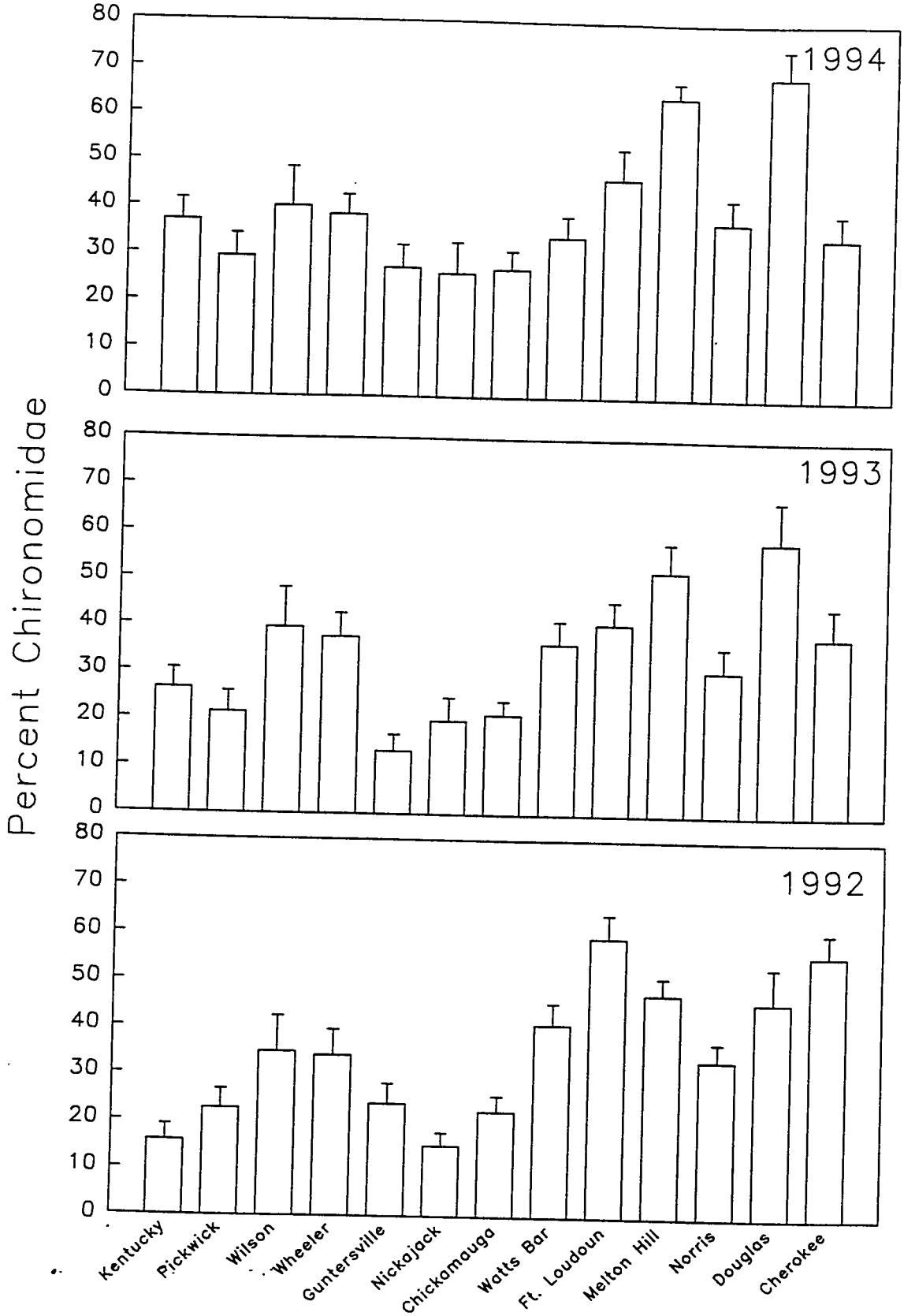

Fig. F8.15. Percentage (Mean ± SE) of benthic macroinvertebrate community represented by *Chironomidae* in individual reservoirs in 1992–1994.

Table F8.3. Invertebrate families having high (>0.3) correlations with canonical variables

Data set	1st canonical variable	2nd canonical variable	3rd canonical variable	4th canonical variable
ER Program	Ephemeridae Ceratopogonidae Chironomidae	Ephemeridae Tubificidae Chironomidae Corbiculidae	N/A	N/A
Vital Signs 1992	Corbiculidae	Gammaridae Unionidae Pleuroceridae Asellidae	Erpobdellidae Sphaeriidae Polycentropodidae	Hydropsychidae
Vital Signs 1993	Corbiculidae Hydropsychidae Ephemeridae	Hydropsychidae Viviparidae Glossiphoniadae	Tubificidae	Naididae Tubificidae Sphaeriidae Asellidae
Vital Signs 1994	Hydropsychidae Corbiculidae Planariidae	Hydropsychidae Corbiculidae Glossiphoniidae Pleuroceridae	Hydropsychidae Ephemeridae Pleuroceridae Hydrobiidae	Glossiphoniidae Crangonyctidae

Results: Near-Field Data

Results of the discriminant analysis of ER Program data are summarized in Figure F8.16. The three groups of sites are roughly equally different from each other, as shown by the positions of the mean canonical variable values. In particular, the two groups of Clinch River sites are roughly as different from each other in terms of benthic community structure as either is from Poplar Creek. The "below" sites and the Poplar Creek sites differ primarily in terms of the first canonical variable (X-axis on Figure F8.16). Table F8.3 shows that the families making important contributions to this variable are the Ephemeridae, Ceratopogonidae, and Chironomidae. Differences in abundance of these three families are therefore the most important in distinguishing Poplar Creek from the Clinch River below Poplar Creek. Similarly, Canonical Variable 2 separates the "above" sites from Poplar creek and the Clinch River below Poplar Creek. Table F8.3 shows that the Ephemeridae, Tubificidae, Chironomidae, and Corbiculidae are the families that distinguish the Clinch River above Poplar Creek from the other two reaches. Because it was necessary to group sites to achieve sufficient replication for an analysis, it was not possible to use the discriminant analysis to check for gradients in community structure along the length of the Clinch River.

Some spatial information is, however, available from the analysis of taxonomic richness. Figure 6.16 (Sect. 6, Vol. 1) shows spatial trends in benthic invertebrate abundance and richness. A clear trend is evident in abundance, with abundance generally increasing with decreasing distance from Watts Bar Reservoir. The analysis of variance showed that benthic invertebrate abundance is significantly higher at the three lower-most stations (CRM-1, CRM-3.7, and CRM-6.7) than at stations CRM-9 and higher. Species richness shows a generally increasing trend, except for the very high richness ar CRM-14.5.

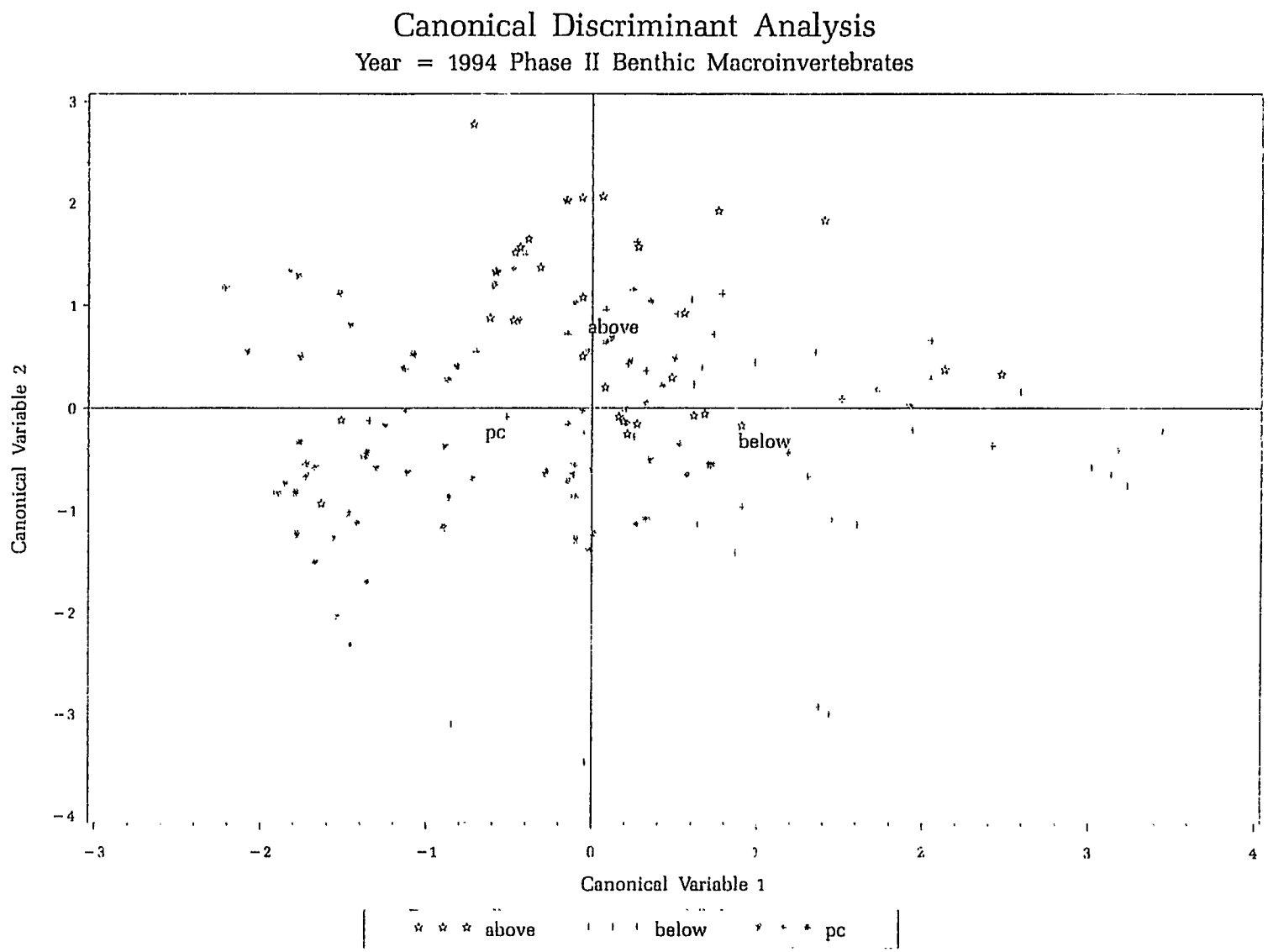

Fig. F8.16. Canonical discriminant analysis of the benthic macroinvertebrate communities sampled for the Environmental Restoration Program in the Clinch River/Poplar Creek system in 1994; grouped by location relative to Poplar Creek.

Figure 6.17 (Sect. 6, Vol. 1) shows trends in % Chironomidae and Tubificidae. Chironomids were relatively more abundant at CRM-1 and CRM-3.7 than at upstream sites, otherwise no trend is evident. Tubificids, in contrast, were relatively less abundant at CRM-1, CRM-3.7, and CRM-6.7 than at upstream sites. None of the above trends show distinct changes in abundance, richness, or composition immediately above or below the mouth of Poplar Creek (CRM-14.5 and CRM-11, respectively).

Few consistent trends are evident for stations within Poplar Creek. The two most-upstream sites, PCM-8 and PCM-7, had lower invertebrate abundance and richness than did other poplar creek sites (Figure 6.18 - Sect. 6, Vol. 1), however, because of high within-transect variability most of the differences are not statistically significant. There is some indication chironomids were relatively more abundant, and tubificids relatively less abundant, at upstream sites (Figure 6.19 - Sect. 6, Vol. 1). Again, because of high variability, these differences are not statistically significant.

Tables 6.9 and 6.10 (Sect. 6, Vol. 1) present results of the two-stage multiple linear regression analysis of the influence of physical characteristics and contaminant concentrations on benthic community structure. Table 6.9 presents (1) the % of the total variance in each community measure explained by the physical model alone, (2) the additional variance explained by inclusion of chemical variables, and (3) results of a significance test for the chemical variables. Table 6.9 shows that, for both the Clinch River and Poplar Creek, physical variables are much more important than chemical variables. Depth and TOC were by far the most important variables. Chemical variables did, however, explain significant additional amounts of variance over that explained by the physical variables alone. An analysis of the signs of coefficients for each of these variables is presented in Table 6.10 Chironimidae and Tubificidae are generally recognized as indicators of poor water quality. Abundance of these families should, therefore, be positively correlated with contaminant concentrations in sediment. Dominance, i.e., the % of total benthic invertebrates belonging to the two most abundant taxa, should also be positively correlated with contaminant concentrations. Species richness and the abundance of all of the other invertebrate taxa is expected to be negatively correlated with sediment contamination. Table 6.10 presents, from the analysis of the full model with physical and chemical variables, (1) the number of times each chemical variable was significantly correlated with a community measure, (2) the consistency of the signs of the correlations with expectation, and (3) the number of correlations that were not significant.

Table 6.10 (Sect. 6, Vol. 1) provides no evidence for an effect of any specific contaminants on benthic invertebrates. Although all of the contaminants other than ammonia nitrogen are significantly correlated with community measures more often than not, the signs of the correlation coefficients are roughly equally divided between "consistent" and "inconsistent" with the hypothesis that contaminants are affecting benthic invertebrates. For Poplar Creek, PAH and aluminum in pore water were significantly correlated with community measures more often than not, and the signs of the correlations were consistent with the "contaminant effects" hypothesis more often than not. Toxic metals, however, were not significantly correlated with community measures more often than not, and none of the signs of the correlations were consistent with the "contaminant effects" hypothesis.

The fact that chemical variables explain a significant additional amount of variance over the physical variables in a variety of community measures for the Clinch River and Poplar Creek provides some (admittedly weak) evidence that contaminants may be adversely affecting the benthic community in some locations. Of the contaminants included in the analysis, PAH would appear to be the most likely to be important, however, the evidence is weak. Also, toxic metals in Poplar Creek would appear to be the least likely to be important.

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Remedial Investigation/Feasibility Study of the Clinch River/Poplar Creek Operable Unit

Volume 4. Appendixes G, H, and I—Information Related to the Feasibility Study and ARARs

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Energy Systems Environmental Restoration Program

Remedial Investigation/Feasibility Study of the Clinch River/Poplar Creek Operable Unit

Volume 4. Appendixes G, H, and I—Information Related to the Feasibility Study and ARARs

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PREFACE

This Remedial Investigation/Feasibility Study Report of the Clinch River/Poplar Creek Operable Unit on the Oak Ridge Reservation (DOE/OR/01-1393/V1–V5&D3) was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act for reporting results of a site characterization for public review. This work was performed under Work Breakdown Structure 1.4.12.3.1.02.41 (Activity Data Sheet 9302, "Clinch River/Poplar Creek Operable Unit"). This document provides the Environmental Restoration Program with information about the Phase 1 and Phase 2 investigations (1988–1995) performed at the operable unit. It includes information on risk assessments that have evaluated impacts to human health and the environment, and it contains information about the development of the feasibility study. Information provided in the document forms the basis for the Record of Decision in the Clinch River/Poplar Creek Operable Unit.

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ABBREVIATIONS

AEA	Atomic Energy Act
AES	Automated Estimating System
ALARA	as low as reasonably achievable
APC	Air Pollution Control
ARARs	applicable or relevant and appropriate requirements
AWQC	ambient water quality criteria
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
CRM	Clinch River mile
CWA	Clean Water Act of 1972
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EFPC	East Fork Poplar Creek
EPA	U.S. Environmental Protection Agency
FDA	Food and Drug Administration
FFA	Federal Facilities Agreement
IAG	Interagency Agreement
LDR	land disposal restrictions
LLW	low-level radioactive waste
MCL	maximum contaminant level
MSD	marginal sediment disturbance
NA	Natural Area
NCP	National Contingency Plan
NERP	National Environmental Research Park
NPDS	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPRM	Notice of Proposed Rulemaking
NRC	Nuclear Regulatory Commission
NSSD	no significant sediment disturbance
NWP	Nationwide Permit
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PCB	polychlorinated biphenyl
PCM	Poplar Creek mile
PMSD	potential major sediment disturbance
RCRA	Resource Conservation and Recovery Act
RGO	remedial goal options
RHA	Rivers and Harbors Act
RHS	radioactive hazardous substances
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
TBC	to be considered
TCA	*Tennessee Code Annotated*

TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
USACE	U.S. Army Corps of Engineers
USC	*United States Code*
WAC	waste acceptance criteria
WBS	Work Breakdown Structure
WM	Waste Management
WQC	water quality criteria/criterion

EXECUTIVE SUMMARY

This report presents the findings of an investigation into contamination of the Clinch River and Poplar Creek near the U.S. Department of Energy's (DOE's) Oak Ridge Reservation (ORR) in eastern Tennessee. For more than 50 years, various hazardous and radioactive substances have been released to the environment as a result of operations and waste management activities at the ORR. In 1989, the ORR was placed on the National Priorities List (NPL), established and maintained under the federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Under CERCLA, NPL sites must be investigated to determine the nature and extent of contamination at the site, assess the risk to human health and the environment posed by the site, and, if necessary, identify feasible remedial alternatives that could be used to clean the site and reduce risk. To facilitate the overall environmental restoration effort at the ORR, CERCLA activities are being implemented individually as distinct operable units (OUs). This document is the combined Remedial Investigation and Feasibility Study Report for the Clinch River/Poplar Creek OU.

This report is organized into five volumes, the first of which presents the main text. Chapter 1 describes the regulatory setting, and Chapter 2 broadly portrays the environmental setting. Chapter 3 depicts the operational and release history of the site and characterizes in detail the nature and extent of contamination. Chapter 4 briefly identifies other regulatory requirements that are applicable or appropriate to the site. Chapters 5 and 6 assess the risk to human health and the environment, respectively. Chapter 7 explains the purpose and organization of the feasibility study. Chapter 8 defines remedial action objectives for the site; identifies pathways and contaminants of concern; and screens general response actions, potential remedial technologies, and process options. Chapter 9 develops remedial alternatives based on the remedial action objectives, the screened technologies, and representative process options. Chapter 10 analyzes, evaluates, and compares the remedial alternatives. Chapter 11 lists the references cited in the main text.

Volumes 2–5 consist of appendices that contain supporting data and information. Volume 2 characterizes the biota on the ORR (Appendix A) and summarizes data related to contaminant concentrations in water (Appendix B), in sediment (Appendix C), and in biota (Appendix D). Volume 3 presents information related to the human health risk assessment (Appendix E) and the ecological risk assessments (Appendix F). Volume 4 focuses on the feasibility study, detailing the selection of remedial process options (Appendix G) and providing the basis for the cost estimates for each remedial alternative (Appendix H). Volume 4 (Appendix I) additionally presents the applicable or relevant and appropriate requirements (ARARs), which help define the extent of the remedial response. Volume 5 is a compilation of data from individual studies that were conducted as part of the overall remedial investigation. As such, the volume addresses the quality assurance objectives for measuring the data (Appendix J) and presents selected historical data (Appendix K), data from several discrete water characterization studies (Appendix L), data supporting the sediment characterization (Appendix M), and data related to several biota characterization studies (Appendix N).

BACKGROUND

The ORR is a 34,600-acre tract of land in Anderson and Roane counties, Tennessee. It is administered by DOE, and it houses three main facilities: the Oak Ridge Y-12 Plant, the K-25 Site (formerly known as the Oak Ridge Gaseous Diffusion Plant), and Oak Ridge National Laboratory (ORNL). Each facility was created in the early 1940s as part of the U.S. government's war effort. The K-25 Site was used for the large-scale production of enriched uranium until its shutdown in 1985. The Y-12 Plant had several missions, but it primarily manufactured nuclear weapons components; production there ended in 1992. ORNL was initially a pilot-scale plant for the production of plutonium, but its post-war mission has centered on nuclear reactor research and the production of radionuclides for use in medicine and science. In addition to these operations, each plant has housed large support operations, including maintenance shops; waste treatment, storage, and disposal areas; steam plants; storm and sewer drains; and infrastructure.

The Clinch River/Poplar Creek OU is located adjacent to the ORR and consists of the Clinch River and several tributary embayments in Melton Hill and Watts Bar reservoirs. Both reservoirs are large multipurpose impoundments created and maintained by the Tennessee Valley Authority. The OU extends from the upstream boundary of the ORR at Clinch River mile (CRM) 49 in Melton Hill Reservoir, downstream to the mouth of the Clinch River in Watts Bar Reservoir at Kingston. It also includes several embayments that extend up tributary streams, including the McCoy Branch embayment of Melton Hill Reservoir and the Poplar Creek embayment [up to Poplar Creek mile (PCM) 5.5] of Watts Bar Reservoir. Originally, the OU included all of Watts Bar Reservoir downstream of the confluence of the Clinch and Tennessee rivers, but this area was segregated into a new OU (the lower Watts Bar Reservoir OU) in 1994, and a CERCLA Record of Decision was reached in 1995. No action-based remedial alternatives were implemented in lower Watts Bar Reservoir. The OU is currently being monitored to ensure that exposure to contaminants remains low.

REMEDIAL INVESTIGATION

The remedial investigation had two primary objectives: (1) to characterize the nature and extent of contamination, and (2) to assess the baseline risk to human health and the environment. Under CERCLA, if site risks are too high, remedial action is generally warranted. This investigation was implemented in a phased approach. First, existing environmental data were used to develop a preliminary site model, which considered the known or suspected contaminant sources, the physical characteristics of the site, and the environmental fate of various contaminants. An initial round (Phase 1) of limited sampling of water, sediment, and fish was then conducted (in 1989) to confirm these historical data and to refine the site model. A much more extensive sampling effort (Phase 2) was conducted in 1994 to more definitively meet the objectives.

Nature and Extent of Contamination

Several contaminant sources were included in the site model. The waters of Poplar Creek were known to receive effluent from the Y-12 Plant (and the City of Oak Ridge) via East Fork Poplar Creek (EFPC), which enters the Poplar Creek at PCM 5.5. Large quantities of elemental mercury were released from the Y-12 Plant in the late 1950s, and small quantities currently continue to escape from contaminated buildings, equipment, and soils. Increased levels of mercury, therefore, were predicted in water, sediment, and biota of Poplar Creek downstream of EFPC. (Contamination at the Y-12 Plant and contamination in the EFPC floodplain have been addressed separately in efforts at

other ORR OUs). Other contaminants known to have been released from the Y-12 Plant include uranium, polychlorinated biphenyls (PCBs), and several metals. Poplar Creek also has historically received a variety of effluents from the K-25 Site, through which the creek flows. Numerous metals, uranium, PCBs, laboratory chemicals, and organic solvents are thought to have been released from the site. In addition, the downstream reaches of Poplar Creek formerly received coal ash from the K-770 steam plant at the K-25 Site, and sediment at this location was expected to contain elevated levels of several metals, particularly arsenic.

The contaminants of potential concern in the Clinch River below Melton Hill Dam are primarily man-made radionuclides, by-products of nuclear fission. Contaminants were released to the Clinch River via White Oak Creek, which enters at CRM 20.8. Studies in the 1960s demonstrated that water-soluble radionuclides were rapidly and greatly diluted upon entering the Clinch River and were quickly transported downstream, with little loss of contaminant mass (i.e., they remained in solution). However, those contaminants that adsorbed to particulate matter became bound to particles of suspended sediment and accumulated in areas of sediment deposition. Earlier studies indicated that the principal radionuclide of potential concern in Clinch River sediment at the beginning of this investigation was ^{137}Cs, which is strongly particle-associated and has a relatively long (30-year) half-life. Because peak releases of ^{137}Cs from ORNL occurred at the same time as peak releases of mercury from the Y-12 Plant, peak concentrations of each were known to co-occur in the lower Clinch River, buried under several inches of cleaner sediment. Although one would have expected sediment in the Clinch River below White Oak Creek to contain the highest levels of ^{137}Cs and other radionuclides, there was actually very little sediment in this portion of the river, most having been scoured and transported downstream by the periodic high-volume releases of water from Melton Hill Dam, located approximately 2 miles upstream.

Current contaminant releases from ORNL are much lower than those of the 1950s and 1960s and are largely due to leaching or runoff from waste disposal areas. Most of these areas are no longer in use and are themselves the focus of environmental restoration efforts at ORNL.

Fly ash from the Y-12 steam plant was formerly disposed of in a settling pond located near the headwaters of McCoy Branch on Chestnut Ridge. As a result, several contaminants associated with coal ash, particularly arsenic, were known to be present at elevated levels in surface water and sediment in the McCoy Branch embayment of Melton Hill Reservoir. Because the embayment is bisected by a road built on fill material, conditions were expected to be worse in the upper embayment, whose water had limited mixing (via a culvert) with waters of the lower embayment and the main reservoir.

In addition to these ORR-specific concerns, it was known that fish collected on and near the reservation contained more PCBs than fish found at most upstream reference areas. PCBs had been used at each of the three facilities. The ORR as a whole has likely been a source of PCBs to the environment. However, PCBs have been widely used in transformers and in industrial operations, and numerous potential sources exist throughout eastern Tennessee. The identification of sources is difficult because PCBs bioaccumulate in fish and other organisms to much greater levels than in water or sediment, where they are largely undetected. The extent to which the ORR had contributed to the problem was unclear.

The knowledge of these site conditions was used to guide the remedial investigation. Much of the sampling focused on Poplar Creek, where the combination of multiple sources and site conditions (e.g., areas of significant sedimentation, less water volume than in the Clinch River) were expected

to result in some of the highest levels of contamination. Sampling in the Clinch River focused on fish and sediment, media in which contaminants tend to accumulate. Sediment sampling was limited in the Clinch River between Melton Hill Dam and Poplar Creek because sediment was scarce there.

The results of the site characterization phase of the remedial investigation were consistent with the site model. The nature and extent of contamination were evaluated by identifying those study reaches in which levels of any contaminant in water, sediment, or biota were elevated in comparison with levels in upstream reference reaches. The nature and extent of contamination are described as follows.

- **Arsenic in surface water and sediment of upper McCoy Branch Embayment.** Average concentrations of arsenic (4.1 μg/L) in surface water exceeded the state of Tennessee's recreation-based Ambient Water Quality Criterion. This criterion is designed to protect persons who regularly consume fish taken from a particular body of water. In sediment, elevated levels of arsenic, vanadium, and boron were found throughout McCoy Branch Embayment, but concentrations were highest in the upper embayment.

- **Radionuclide levels in water, sediment, and biota of the Clinch River downstream of White Oak Creek.** Average gross alpha and gross beta levels and mean activities of ^{90}Sr and ^{3}H in surface water were a factor of ten higher than reference values. These data were extremely variable, probably as a result of the extreme variability in flow below Melton Hill Dam. A conservative evaluation of the radionuclide concentrations indicated that, even immediately below White Oak Creek, the state's Ambient Water Quality Criterion for protection of domestic supplies was not exceeded.

  Levels of ^{137}Cs were elevated in Clinch River sediment below the mouth of White Oak Creek. This radionuclide has a strong affinity for particles, particularly the clay minerals that make up a significant portion of Clinch River sediment. However, the discharge of water from Melton Hill Dam resulted in the scouring of most of the sediment from this portion of the river, creating larger inventories of ^{137}Cs in the lower Clinch River, where sedimentation is greater.

  Bluegill sunfish and largemouth bass collected in 1989 from the Clinch River near the mouth of White Oak Creek contained ^{137}Cs at levels 100 times that of fish from upstream reference areas. Catfish were found to have levels approximately ten times that of reference areas. Although elevated, these levels were not thought to pose a significant risk to persons or wildlife consuming these fish, and thus radionuclide analysis was discontinued after the initial round of sampling. However, the species-specific baseline human health risk assessment has identified ^{137}Cs as a contaminant of concern in largemouth bass. Additional bass and sunfish will be collected to determine whether concentrations have dropped since the Phase 1 data were collected.

- **Mercury in surface water, sediment, and biota of Poplar Creek downstream of East Fork Poplar Creek.** Average mercury concentrations in surface water, sediment, and biota were significantly elevated in Poplar Creek downstream of EFPC in comparison with average values upstream of EFPC. Elevated concentrations (up to 0.19 μg/L) measured in Poplar Creek surface water below EFPC and in the Clinch River downstream of Poplar Creek exceed the state's Criterion Continuous Concentration (CCC) (0.012 μg/L). This criterion is designed to protect aquatic life from chronic exposure to mercury. Although also elevated above reference values, mean mercury levels in fish did not exceed the Federal Drug Administration's action level (1.0 mg/kg) in any species sampled. Several individual largemouth bass, however, had mercury

levels that exceeded this value. Increased body burdens of mercury were also found in benthic organisms living in Poplar Creek, in heron eggs and chicks from a rookery near Poplar Creek, and in laboratory mink fed a diet high in fish from Poplar Creek. A decreasing gradient of biological effects, as measured by a suite of physiological and physical indices, was found to extend from upper Poplar Creek downstream through the Clinch River. This gradient in effects can be roughly correlated with a decreasing gradient in fish body burdens of mercury and PCBs in the downstream direction.

- **Metals and radionuclides in the sediment of Poplar Creek.** In addition to mercury, contaminants in Poplar Creek sediment that were elevated above reference levels were silver, arsenic, boron, cadmium, copper, chromium, nickel, vanadium, ^{238}U, ^{235}U, ^{234}U, ^{99}Tc, ^{137}Cs, and ^{60}Co. PCBs (Aroclor 1254), rarely detected in sediment anywhere in the system, were detected in Poplar Creek. As with mercury, concentrations of copper, cadmium, and chromium increased immediately below EFPC and likely represented releases from the Y-12 Plant. Concentrations of silver, nickel, ^{99}Tc, and the uranium isotopes were elevated below K-25 discharge points, and copper and chromium concentrations in this area were substantially increased above the already elevated levels found below EFPC. Increased levels of arsenic, vanadium, and boron were found in lower Poplar Creek and were associated with an area where the disposal of coal ash from the K-770 steam plant historically took place. The increased levels of ^{137}Cs and ^{60}Co were restricted to the last mile of Poplar Creek and are thought to be caused by backflow from the Clinch River, which regularly takes place as a result of reservoir operations.

- **PCBs in fish of Poplar Creek and the Clinch River.** Mean PCB levels in largemouth bass were highest in Poplar Creek. Although no bass were available from the reference reach of Poplar Creek, concentrations were still greater than at most other study and reference sites.

  Mean concentrations of PCBs in catfish were highest in Phase 1 samples collected from the White Oak Creek Embayment (now part of a separate OU) and in fish from the Clinch River immediately downstream. Levels were significantly increased over those in Melton Hill and Norris Reservoir catfish. Mean concentrations in catfish from Poplar Creek below the confluence with EFPC were greater than those in catfish from above the confluence. Mean total PCB concentrations in largemouth bass did not exceed the FDA action level (2.0 mg/kg) at any location. The mean concentration in catfish did not exceed this action level at any location (except at the White Oak Creek Embayment). However, individual fish from the Clinch River and Poplar Creek had concentrations that exceeded this level.

  The PCBs detected in fish flesh were almost exclusively Aroclor 1254 and Aroclor 1260. An analysis of individual PCB congeners in catfish did not reveal any patterns that could explain additional sources of PCB contamination.

Risk Assessment

The data used to characterize the nature and extent of contamination were also used to meet the second objective of the remedial investigation, risk assessment. The baseline risk assessment contained in this report consists of a human health risk assessment and an ecological risk assessment.

Risk to human health was evaluated for seven exposure scenarios, each of which contained one or more pathways through which exposure actually occurs. The seven scenarios were (1) the use of

surface water as an untreated drinking water source, (2) the consumption of fish, (3) the use of the reservoir shoreline during winter drawdown, (4) swimming, (5) the hunting and consumption of waterfowl that frequent the ORR, (6) the dredging and subsequent land disposal of sediment, and (7) the use of surface water for irrigation. In each scenario, risk from carcinogens was assessed by assuming a 30-year exposure duration, and risk from noncarcinogens was assessed by assuming a 6-year exposure period. Under CERCLA, media whose pathways result in either a cumulative excess cancer risk of 1.0E−04 or a Hazard Quotient of 1.0 (a measure of noncarcinogenic exposure) generally warrant remedial action at the site.

The human health risk assessment evaluated the risk from each contaminant for which sufficient data existed to obtain a representative concentration. Therefore, the human health risk assessment identified certain analytes whose presence did not appear to be the result of the ORR operations. Because these contaminants might have contributed significantly to overall risk, they generally were included in the risk assessment.

Thirty-five potential contaminants of concern were identified in Clinch River and Poplar Creek water, sediment, and fish. The majority of contaminants were found in deep sediment, and the greatest risks were identified through the agricultural pathways. Of the contaminants identified, only 2 in water, 7 in fish, and 19 in sediment were clearly site-related.

Eight contaminants of concern, all noncarcinogens, were identified in surface water in the OU. Five were identified in the drinking water scenario; the non-site-related analyte manganese drove the risk in all reaches except in upper McCoy Branch, where arsenic contributed most of the risk. Seven contaminants of concern were identified in the irrigation scenario, and two were identified in the swimming scenario (Poplar Creek only). The two contaminants identified in the swimming scenario (Di-n-octylphthalate and Aroclor 1254, also identified in the irrigation scenario) were detected infrequently and therefore might not be contaminants of concern. In general, the number of contaminants of concern in each scenario was greatest in Poplar Creek and least in McCoy Branch.

Seven contaminants of concern were identified in the shoreline-use scenario, which was based on contaminant concentrations in near-shore sediment only. Melton Hill Reservoir is managed in such a way that no prolonged drawdown occurs; therefore, assessment of this scenario was not conducted for the area. Noncarcinogenic risk was common throughout near-shore areas along both the Clinch River and Poplar Creek, and it was driven almost exclusively by manganese via inhalation of resuspended sediment. A significant (<1.0E−04) excess cancer risk existed in one subreach of Poplar Creek, primarily because of chromium exposure via the inhalation pathway.

Eleven contaminants of concern were found in fish. Most of the contaminants were organic compounds (PCBs and pesticide residues) and were found in catfish and largemouth bass from both the Clinch River and Poplar Creek. The excess cancer risk from the consumption of catfish exceeded 1.0E−03 in all study reaches, primarily as a result of Aroclor 1260. The excess cancer risk from the ingestion of largemouth bass was generally equal to or less than one half of that from the ingestion of catfish. Arsenic and Aroclor 1260 were the primary contributors to carcinogenic risk from the ingestion of largemouth bass. Several radionuclides were also identified as carcinogenic contaminants of concern, but they generally contributed only a small portion of the total risk. The exception was ^{137}Cs, which contributed a significant portion of the risk associated with the ingestion of largemouth bass from the Clinch River immediately below the mouth of White Oak Creek. Contaminants of concern that were important noncarcinogens included mercury, Aroclor 1254, and chlordane in one or more species in Poplar Creek and the Clinch River.

In the dredging scenario, 31 contaminants of concern were identified in sediment. This scenario assessed the risk from contaminant exposure that would occur if dredge spoil were placed on land where it was accessible to humans. Several direct exposure pathways were evaluated, as were several agricultural scenarios in which contaminant concentrations in produce, milk, and beef were modeled from sediment contaminant concentrations.

Of the direct pathways, external exposure to gamma-emitting radionuclides in spoil from throughout most of the Clinch River (including Melton Hill Reservoir) and at the mouth of Poplar Creek would result in an excess cancer risk greater than 1.0E−04. At all locations downstream of White Oak Creek, the primary contributor to risk via external exposure was ^{137}Cs. In Melton Hill Reservoir, the risk was primarily due to ^{60}Co from a non-DOE source (now closed) on Braden Branch. In all reaches for which data were available, manganese in spoil posed the greatest risk to adults and children via the inhalation of resuspended sediment. Barium similarly posed ubiquitous risk but generally only to children. In addition to this noncarcinogenic risk, the inhalation of resuspended spoil from lower Poplar Creek would result in an excess cancer risk of 2.1E−04, primarily due to arsenic and chromium. Finally, the incidental ingestion of arsenic and mercury in spoil from lower Poplar Creek would be potentially harmful to children.

In the three agricultural pathways evaluated under the dredging scenario, the milk and meat ingestion pathways showed the most carcinogenic potential. Evaluation of the majority of the reaches for which data were available indicated that the ingestion of milk and beef produced with vegetation grown on dredge spoil would result in an excess cancer risk greater than 1.0E−04 and that many reaches had risk values an order of magnitude greater. The contaminants responsible for the majority of this risk were members of a class of ubiquitous contaminants known as polycyclic aromatic hydrocarbons. In particular, benzo(a)pyrene and dibenz(a,h)anthracene drove this risk. In addition, in those reaches where it was detected, Aroclor 1260 contributed significantly to the risk. By contrast, the excess cancer risk in vegetables was generally lower, exceeding the 1.0 E−04 threshold in only two locations; in these locations the risk was driven by different analytes than in the other two pathways. In Poplar Creek adjacent to the K-25 Site, ^{99}Tc was the primary contributor to risk, although nine other analytes at this location were also of concern. At one location in the Clinch River, the organic analyte N-nitroso-di-n-propylamine was identified as a contaminant of concern but was detected in only one of three samples from that reach.

Evaluation of every subreach for which there were data indicated that one or more of the agricultural pathways posed an unacceptable risk under the dredging scenario. Fourteen noncarcinogenic contaminants of concern were identified. Risk in the milk and meat pathways was frequently driven by mercury and Aroclor 1254. Risk in the vegetable ingestion pathway was frequently driven by manganese, except in the Poplar Creek subreaches, where mercury was the concern.

The ecological baseline risk assessment estimated the ecological risk due to contaminants in the Clinch River/Poplar Creek OU. Seven assessment endpoints were evaluated during the assessment: (1) reduced species richness or abundance or the increased frequency of gross pathologies in fish; (2) reduced species richness or abundance of benthic macroinvertebrate communities; (3) reduced abundance or production of piscivorous wildlife populations; (4) reduced abundance or production of flying insectivorous wildlife populations; (5) reduced production in terrestrial plant communities; (6) reduced abundance or production of terrestrial wildlife populations; and (7) reduced viability of any individuals of a threatened or endangered species. For each endpoint, the reduction in the parameter was required to be 20% or more and to be the result of toxicity.

Three lines of evidence were used in the ecological risk assessment. First, the site and media-specific contaminant data used in the site characterization were evaluated against a series of benchmark values (e.g., the no-observed-effects level) to determine whether concentrations were great enough to cause adverse effects. Second, site-specific toxicity data were used to determine whether these levels were actually causing a toxic effect at a particular site. Finally, site-specific biological survey data (species richness and abundance) were used to help assess whether any toxicity was actually having an impact at the population or community level. When all lines of evidence were not available for each of the endpoints, risk assessment was usually based on contaminant data alone. The assessment for the fish endpoint used data on fish pathologies and fecundity as a fourth line of evidence.

The fish community in Poplar Creek was found to be at significant risk from episodically high concentrations of several metals (copper, mercury, nickel, and silver). Toxicity to fish was assessed by using several test protocols and organisms. Poplar Creek water was toxic to Japanese medaka and redbreast sunfish embryos, but not to fathead minnows or *Ceriodaphnia*. The fish community of Poplar Creek exhibited decreased species richness and abundance in comparison with a reference site with similar habitat (Bull Run Creek embayment of Melton Hill Reservoir). The results of the ecological risk assessment for fish indicated that, while individual fish were probably suffering some physiological impacts immediately below WOC, the fish community was not being significantly impacted in the Clinch River. In McCoy Branch, adverse impacts could not be ruled out, but data were unavailable for some of the lines of evidence (data on fish community, pathology, and fecundity).

The benthic macroinvertebrate community of Poplar Creek was identified as being at significant risk from several metals (arsenic, mercury, nickel, and silver) and PCBs in surface sediment. The benthic community contained fewer species and had less abundance of organisms than the communities at other sites. The toxicity data did not reveal consistently toxic effects, but in at least one test from each site a toxic response was observed in test organisms of at least one species. The benthic communities of the Clinch River and the McCoy Branch embayment were found not to be significantly impacted by contaminants.

Risks to piscivorous wildlife were assessed by using two avian species (great blue heron and osprey) and two mammalian species (mink and river otter). Two lines of evidence, biomonitoring data and contaminant data in whole fish, were available for assessing risk to heron and osprey. Partly because of their wide foraging behavior, osprey were found to be not at risk from contaminants even though mercury levels in Poplar Creek fish exceeded benchmark values. Although the data indicated that individual heron feeding exclusively in certain portions of Poplar Creek might be at risk, the local populations of the avian species were not expected to be impacted. This conclusion was supported by surveys of the reproductive success of osprey and great blue heron in Poplar Creek: the surveys found high reproduction and no increase in deformities. Mink were not identified as being at risk from contaminants in either Poplar Creek or the Clinch River. However, individual river otter feeding in Poplar Creek near the mouth of EFPC would be expected to have a significant risk of impaired reproduction. Although river otter do not currently exist within the OU, they have recently been reintroduced into east Tennessee, and the natural expansion of their range is expected to lead to their re-establishment on the ORR. Because the otter is a state threatened species, impacts to individual otter would be considered significant.

The risk to insectivorous wildlife was assessed by using one avian species, the rough-winged swallow, and two mammalian species, the gray and little brown bats. In each case, only one line of

evidence (contaminant concentrations in benthic insects) was available for the assessment. These data indicate that a colony of rough-winged swallows feeding in Poplar Creek near the mouth of EFPC could suffer impaired reproductive potential as a result of mercury exposure, but the magnitude of the effects could not be evaluated. Populations of neither species of bat were found to be at risk. Although mercury concentrations in Poplar Creek were high enough to put individual bats at risk if they were to forage exclusively within this area, the foraging range of bats is great enough that this possibility is unlikely.

The ecological risk assessment for terrestrial wildlife was based on a dredging scenario much like that used in the human health risk assessment. The assessment examined risk both to the plant community that would develop on dredge spoil and to a herbivorous mammal (eastern cottontail) foraging there. A single line of evidence (contaminant concentrations in sediment) was available for use in the assessment. In the sediment of one or more study reaches, 12 metals were found at concentrations that exceeded benchmarks indicative of plant toxicity. The greatest number of metals were found in lower Poplar Creek, which contained arsenic, boron, cadmium, chromium, mercury, nickel, selenium, uranium, and vanadium. Benchmark numbers for plants were not available for a large number (i.e., 37) of the organic compounds; therefore, these analytes could not be evaluated. Populations of cottontails foraging on future spoil from lower Poplar Creek or from the Clinch River immediately downstream of Poplar Creek would be at significant risk of impaired reproduction due to levels of mercury and cadmium. A number of other analytes from these (and most other) reaches might pose a risk to individual cottontails foraging on future spoil; however, population-level effects from these contaminants would not be expected.

Ecological risk from radiation exposure was assessed separately. Risks to many of the same endpoint species were assessed, including a benthic organism (a mayfly), epibenthic (bottom-dwelling) fish, piscivorous wildlife (great blue heron), and a terrestrial herbivore (eastern cottontail). The assessment used the contaminant data for radionuclides to calculate the total radiation dose to these organisms. The DOE limit of 1.0 rad/day was used to assess acceptable exposures for most organisms; the International Atomic Energy Agency's recommended limit of 0.1 rad/day for terrestrial organisms was used to assess exposure for cottontail rabbits. None of the calculated doses approached the appropriate benchmarks above; thus, the radiological contaminants in the various environmental media of the OU did not pose a significant ecological risk.

Based on the findings of the site characterization and risk assessments, a number of pathway and media-specific remedial goal options (RGOs) were developed for individual analytes, which represent concentrations corresponding to an ARAR or to an acceptable human health or ecological risk level. RGOs were developed only for those reaches containing one or more environmental media that exceeded one of the criteria and thus indicated the potential need for remedial action in that reach. In almost every reach studied, RGOs were developed for one or more analytes for each of the three media evaluated.

FEASIBILITY STUDY

On the basis of the remedial investigation, a feasibility study was conducted to identify remedial alternatives that would be effective in reducing contaminant concentrations or reducing or eliminating exposure and that could be feasibly implemented. The overall approach taken in the feasibility study was to focus on remedies for site-related contaminants as identified in the site characterization. Therefore, remedies were not evaluated for those reaches in which risk was

primarily the result of non-site-related contaminants (e.g., manganese-driven risks in surface sediment or in water). In addition, no remedies were evaluated for surface water contaminants. Remediation of surface water is best effected at the source of the contamination, which in each case is primarily in upstream OUs. Moreover, remediation of the large volumes of flowing water is not practical. The use of institutional controls is the only remedy considered for limiting human exposure to fish. Therefore, active remedies evaluated in the feasibility study focus on site-related contaminants of concern in sediment.

Four alternatives are evaluated in the feasibility study. Alternative 1, the no-action alternative, is required by CERCLA to be evaluated. As the name implies, this alternative would be easily implemented at no cost. However, the risk assessments indicate that the no-action alternative would not be protective of human health or the environment.

Alternative 2 consists of the use of institutional controls and advisories to reduce exposure to contaminants in fish and sediment. Although not empowered under CERCLA, the state of Tennessee, the Tennessee Valley Authority, and the U.S. Army Corps of Engineers each have separate regulatory authority to regulate activities that could result in the disturbance of sediment in the Clinch River and Poplar Creek. Each of these agencies is party to an interagency agreement with DOE that requires the multiagency review, on a case-by-case basis, of all permit applications that propose activities with the potential to disturb sediment. The state of Tennessee currently issues fish consumption advisories warning the public to avoid or limit consumption of certain species of fish in which contaminant levels are unacceptably high. The present worth cost of implementing alternative 2 for 30 years, including future monitoring and administrative costs, is estimated to be $3.6M.

Alternative 3 incorporates the institutional controls described in alternative 2 and in addition proposes the combined containment and removal of contaminated sediment from Poplar Creek. The presence of several contaminants in the sediment of Poplar Creek posed a risk to human health or benthic organisms. Seven separate locations in Poplar Creek would be remediated, through the use of a combination of sediment containment technologies in the near-shore areas (bottom elevation >733 ft msl) and sediment removal technologies in deep water areas (bottom elevation <733 ft msl). A total area of 388,800 ft^2 is proposed for containment, and a total of 179,250 yd^3 for removal (the top 3 ft of sediment), at a total present worth cost of $109.6M. Removal of the deep sediment would also address the potential for future risks to human health and the environment in the dredging scenario.

Alternative 4 also incorporates the institutional controls of alternative 2, but in addition it proposes the removal of contaminated sediment from Poplar Creek. Removal of those sediments in Poplar Creek that pose a human health or ecological risk would require the removal and safe disposal of approximately 226,500 yd^3 of sediment, at a total present worth cost of approximately $123.5M. Because benthic habitat extends bank-to-bank, addressing the existing ecological risk by removing sediment would also address both the existing human health risk in the near-shore scenario and the potential for future human health risk and ecological risk in the dredging scenario.

Appendix G

SELECTION OF PROCESS OPTIONS

G1. SELECTION OF REPRESENTATIVE PROCESS OPTIONS

This chapter describes technologies and process options retained from the first screening step, technical applicability, for further evaluation in terms of their implementability, effectiveness, and cost. One (or more) representative process option is selected and carried forward for further evaluation to represent the other process options in the technology group. This limits the number of options used in alternative development, but it allows flexibility to reevaluate other options at the proposed plan, the Record of Decision, or the remedial design stages. Options that are extremely difficult to implement, offer no significantly improved protection, or are very expensive will not be used for remedial alternative development.

Fish consumption and exposures to shallow (upper 15 cm exposed at winter pool) sediments are the main threats to human health identified that could reasonably occur. Exposure to deep (covered year round under water) sediments is an unlikely scenario. Deep sediment action technologies may become necessary if, for example, pathways of concern (linked to deep sediments) emerge that elevate human health or ecological risks to unacceptable levels. For this reason, applicable technologies and process options will be discussed with regard to effectiveness, implementability, and cost when possible with respect to deep sediments and retained as contingent options. However, selection of representative process options will not be determined on the basis of deep sediment criteria at this time.

A summary of the technologies retained from the first screening in Figure 8.1, Section 8.2 for site applicability are presented in Table G.1. Each process option is briefly described as to its site, contaminant, and remedial effectiveness, implementability, and cost. Representative process options for various technologies are indicated by bold type. The remaining process options are shown in shaded boxes. Following Table G.1 is a detailed discussion of technical aspects of site-applicable retained options, including effectiveness, implementability, cost, and selection of representative technologies.

G1.1 NO ACTION

This general response action does not initiate remedial action and assumes that present security measures that limit access are not maintained. Short- or long-term monitoring is also excluded. Although this scenario may not reflect current conditions, the purpose of the no action alternative is to provide a baseline for comparison with other alternatives, as required by the National Contingency Plan.

G1.2 INSTITUTIONAL CONTROLS AND ADVISORIES

Institutional controls include access and use restrictions and maintenance and monitoring. These actions can be used alone or in combination with other technologies to reduce the risk of exposure to contamination to acceptable levels. The objectives of access and use restrictions are (1) prevent prolonged exposure to contaminants, (2) control future development and disturbance of the Operable Unit (OU), and (3) ensure continued effectiveness of any engineered remedial actions.

Table G.1. Technology and process option screening summary

General response action	Remedial technology	Process options	Effectiveness	Implementability	Cost
No action	None	**Not applicable**	Will offer no additional protection	None	None
Institutional controls and advisories	Access use and restrictions	**Deed restrictions**	Effective in restricting activities on property owned by DOE which may be released for unrestricted use	Implementable for DOE-owned property	Negligible costs
		Public advisories	Effective in alerting people to fish consumption limits/prohibitions or water contact	Implementable and currently managed by TDEC	Negligible costs
		Permit program	Effective at restricting sediment-disturbing activities such as dredging	Implementable, in place, and currently administered jointly by COE, TDEC, and TVA	Negligible costs
		Land purchase/ condemnation	Effective in placing contaminated property under DOE control	Not currently necessary; no private properties identified with unacceptable contaminant levels	If necessary, costs could be high
		Physical barriers	Effective in limiting access to affected areas	Not difficult to implement	Medium capital; low O&M
	Maintenance and monitoring	**Monitoring**	Effective in detecting contaminant input changes to the system, human availability, or bioavailability	Not difficult to implement	Low capital; low O&M
		Surveillance and maintenance	Effective in ensuring other implemented options continue to perform as needed	Not difficult to implement	Low capital; medium O&M
Source containment	Capping (horizontal barriers)	Armorform	Effective initially for shallow sediment capping, but has an uncertain long-term reliability; not effective for deep sediments	Difficult to implement; will require large amounts of construction equipment, site preparation, and erosion/fugitive dust management during site preparation and cap construction phases	High capital; medium O&M

Table G.1 (continued)

General response action	Remedial technology	Process options	Effectiveness	Implementability	Cost
		Geomembrane cap	Effective for shallow sediment capping with good life expectancy, durability, and reliability; not effective for deep sediments	Difficult to implement; will require large amounts of construction equipment, site preparation, and erosion/fugitive dust management during site preparation and cap construction phases	High capital; low O&M
		Clean sediment	Effective for deep sediment capping, but may be subject to same erosion that removed original sediments and biotic intrusion	Difficult to implement; will potentially require periodic replacement of eroded sediments and is also susceptible to biotic intrusion	Medium capital; low O&M
Removal	Excavation	**Mechanical**	Effectively removes source material from shallow sediment areas; low effectiveness in submerged conditions	Difficult to implement; will require critical timing to execute removal during window of opportunity at winter pool	High capital; low O&M
	Dredging	Mechanical dredges	Effective in removal of source material under submerged conditions; removes material at high densities	Difficult to implement due to potentially increased levels of turbidity	High capital; medium O&M
		Hydraulic dredges	Effective in removal of source material under submerged conditions; removes material at relatively low densities	Difficult to implement; considerable amounts of water will require separation and potentially need treatment before disposal	High capital; medium O&M
		Pneumatic dredges	Effective in removal of source material under submerged conditions; removes material at high densities	Impractical for shallow areas	High capital; medium O&M

Table G.1 (continued)

General response action	Remedial technology	Process options	Effectiveness	Implementability	Cost
Turbidity minimization	Water turbidity minimization	Silt curtains	Effectively contains fugitive sediment; effectiveness may diminish as curtains may respond to fluctuations of moving water	Difficult to install, particularly over large areas; impermeable material reacts to changes in water levels and may break; may require frequent inspections for breaks	Low capital; low O&M
		Silt screens	Effectively contains fugitive sediment; effectiveness depends on filter mesh size and degree of turbidity	Difficult to implement, particularly over large areas; mesh material allows water to pass, but excessive turbidity can clog the material and cause breakage; may require frequent inspections for breaks	Low capital; low O&M
Ex situ treatment	Physicochemical	Chemical extraction/ soil washing	Effective in separating contaminants associated with fine sediment from coarse sediment	Implementability is poor because site sediments are predominantly fine silts and clays; volume reduction minimal	Medium capital; low to medium O&M
		Solidification/ stabilization	Effective in reducing mobility of certain contaminants to acceptable levels	Implementable for certain contaminants (e.g., arsenic); potentially reduces leachability to WAC levels	Medium capital; low O&M
		Chemical-precipitation/ flocculation	Effectively transforms dissolved ions in solution to a solid form causing changes in electrostatic charge and ion flocculation	Difficult to justify new treatment facilities, unless existing on-site facilities cannot treat waste water effluent from drained sediment	Medium capital; low to medium O&M
		Ion exchange	Effective in capturing contaminant ions in water by exchanging them with "donor" ions	Difficult to justify new treatment facilities, unless existing on-site facilities cannot treat waste water effluent from drained sediment	Medium capital; low to medium O&M

Table G.1 (continued)

General response action	Remedial technology	Process options	Effectiveness	Implementability	Cost
	Thermal	Incineration	Effectively removes volatiles (including mercury) from solids at high temperatures	Difficult; air emissions compliance limits off gas contaminants	High capital; high O&M
		Thermal desorption	Effectively removes volatiles (including mercury) from solids at low temperatures		
		Pyrolysis	Effectively removes volatiles (including mercury) from solids at high temperatures	Difficult; air emissions compliance limits off gas contaminants	Medium capital; low O&M
		Infrared thermal	Effectively removes volatiles (including mercury) from solids at low temperatures	Difficult; air emissions compliance limits off gas contaminants	Medium capital; low O&M
	Dewatering	Belt filter press	Effectively dewaters sediment slurry; may require several operating units to dewater large volumes	Implementable, but gravity drainage in sloping dewatering pad is simpler, more cost-effective means to accomplish same task	High capital; medium O&M
		Settling ponds	Effective in dewatering sediment slurry with high water content; not effective for slurry with high solids content	Minimal amounts of water removed during shallow sediment removal render settling ponds impractical; potentially viable in dredging scenario with large quantities of sediment removed at low solids densities	Medium capital; medium O&M
		Fly ash	Effective in absorbing small amounts of free water	Implementable, but increased volumes of treated material raise disposal costs	Low capital; low O&M
		Low temperature thermal heating	Effectivley drives off moisture from soils	Comparatively easy as low temperatures do not breach air emission limits for off gasses	Medium capital; low O&M

Table G.1 (continued)

General response action	Remedial technology	Process options	Effectiveness	Implementability	Cost
		Sloping dewatering pad	Effectively dewaters excavated sediment or sediment slurry with relatively high solids content	Somewhat difficult during site preparation and construction phase, but very low maintenance using gravity drainage and evaporation to dewater sediments	Medium capital; low O&M
Disposal	On-site sediment/ disposal	**Y-12 Plant Landfill V or VII**	Effective, but may have volume limitations and WAC considerations	Implementable, but would have to comply with WAC and TDEC approval	Low capital; low O&M
		Beneficial reuse	Effective for use as backfill at ORR	Implementable, but activity limits must be met and TDEC approval	Low capital; low O&M
	Off-site sediment/ disposal	**Envirocare**	Effective for disposition of dewatered solid low level or Class A mixed waste	Implementable, but difficult due to transport distance	High capital; medium O&M
	Water disposal	**Y-12 Plant West End Treatment Facility**	Effective for treatment and disposal of contaminated water removed from dewatered sediments	Implementable; consultation with wastewater treatment officials needed to schedule wastewater criteria and delivery timetable; potentially more cost-effective than construction of new facilities	High capital; medium O&M
	Waste transportation	**Trucks**	Effective in transporting material in and around on-site areas, but may require precautionary measures to avoid leakage of wet sediment	Implementable; trucks readily available, but precautions regarding leakage are largest concern to assess	Low capital; low O&M
		Rail	Effective for shipments to the western United States	Implementable for shipments of waste material over very long distances (e.g., Envirocare)	Medium capital; low O&M

COE = U.S. Army Corps of Engineers
DOE = U.S. Department of Energy
LLW = low-level radioactive waste
O&M = operation and maintenance
ORNL = Oak Ridge National Laboratory
TDEC = Tennessee Department of Environment and Conservation
TVA = Tennessee Valley Authority
WAC = waste acceptance criteria

G1.2.1 Access and Use Restrictions

- Deed Restrictions—Deed restrictions are legal covenants and notifications placed on property deeds that notify a potential buyer of the limitations on the use of affected property. They are legally binding limitations that can prevent development or other alterations of the property that could increase the health risk of contaminants. Deed restrictions are useful where contaminants lie on Department of Energy (DOE) property at depth and where release of the property can reasonably be expected in the future. For example, use of contaminated sediment or soil for agriculture, landfilling, or other excavation type activities could be prohibited. Irrigation for agriculture may also be excluded or limited depending on water quality.

- Public Advisories—Published and posted fish consumption, water contact, and/or water consumption advisories provide warnings concerning limitations on fish consumption, dermal contact with surface water, and consumption of surface water. Agricultural uses of surface water may be considered for advisory protection for such uses as limits on recommended livestock watering quantities or irrigation of food crops in certain areas. Some advisories are already in place in several waterways in the region, including Clinch River and Poplar Creek for fish consumption limits and/or water contact.

- Permit Programs—U.S. Army Corps of Engineers (USACE), Tennessee Department of Environment and Conservation, and the Tennessee Valley Authority (TVA) must issue a permit before sediment-disturbing activities in the affected area are allowed, whether for maintenance of minimum navigable channel depths, use as aggregate, or for any other similar activity.

- Land Purchase—Land purchase/condemnation is the acquisition of property that is not owned or within the control of DOE and is affected by unacceptable levels of contaminants released by DOE. This option may be considered to place the property under DOE administrative control. In the event that the affected portion of the property presents an unacceptable health hazard and neither purchase nor any other means of risk reduction can be agreed on by the property owner and DOE, then condemnation of some or all of the affected property may become necessary in order to place the property under DOE control and thereby restrict access to it. Currently, no property outside of DOE property has been identified with contaminants with ECR above 1.0×10^{-4} or HI > 1.0 in shallow sediments. No deep sediment contamination has been identified on private property. Deep sediments lie in main channel areas managed by TVA and USACE and would not be available for purchase.

- Physical Barriers—Physical barriers include, but are not limited to, erected fences or similar barricades around the perimeter of a contaminated area that limits access to a site. To maintain and/or enhance effectiveness of the fence, an active, periodic patrol, warning signs, and an active public information program are recommended. Warning signs in fenced areas may offer site-specific information tailored to the area, which contains information in addition to the routine warnings currently in place regarding fish consumption and water contact.

G1.2.1.1 Effectiveness

All of the access and use restrictions can be effective in long-term management of contaminants if sustained and managed properly.

G1.2.1.2 Implementability

All of the access and use restrictions can be implemented with minimal difficulty, except for land purchase/condemnation which is very difficult.

G1.2.1.3 Cost

All access and use restriction process options are comparatively inexpensive relative to active remedial process options outlined in Sections G.1—G.7, except land purchase/condemnation which would vary according to size and land value.

G1.2.1.4 Selection of representative process option(s)

All access and use restriction process options will be carried forward as representative process options, except land purchase/condemnation. Currently, no private property has been identified as having contaminated shallow sediment with unacceptable risk. Redistribution of contaminants may elevate risk on private property to unacceptable levels, at which time land purchase/condemnation may be reevaluated.

G1.2.2 Maintenance and Monitoring

- Monitoring—Long-term monitoring of contaminant levels in water, sediment, and biota is used primarily to identify changes in conditions, evaluate the effectiveness of the chosen remedial action, determine whether adjustments or additional process options are needed, and determine whether existing or future receptors are threatened. Short-term monitoring with frequent sampling may be used to identify changes that arise due to planned sediment-disturbing activities, such as dredging or during implementation of remedial actions where release of potential contaminants from sediment could occur. More frequent monitoring would allow for timely detection of contaminants and subsequent appropriate measures implemented. Examples of OU monitoring include:

- Surface sediment grab samples used in determining the nature and extent of contaminants in sediment. They can serve both as a measure of existing site conditions as it relates to isolating areas targeted for remedial action and as a means of detection in condition changes, such as redistribution of, or, new sources of contaminants.

- Biological samples taken of aquatic, benthic, and piscivorous organisms used to characterize effects from contaminants, which are useful in documenting and evaluating site conditions.

- Surface water samples taken to monitor the water quality at various points along the OU. Monitoring the water can detect new sources or changes in existing sources, which can verify that controls placed on the OU or remedial actions are performing satisfactorily to keep contaminants immobilized.

- Surveillance and Maintenance—Routine surveillance and maintenance would include physical site surveys and maintenance, as needed, to verify and ensure the integrity of any engineered controls or devices (e.g., caps or fences). These process options are used to ensure or verify that the objectives have been and continue to be met. They are all implementable.

G1.2.2.1 Effectiveness

The maintenance and monitoring process options can be effective in long-term management of wastes if instituted and managed properly.

The effectiveness of this response depends on its continued implementation. Access restrictions are subject to change in political jurisdiction, legal interpretations, and regulatory enforcement, and require maintenance of physical barriers.

G1.2.2.2 Implementability

The maintenance and monitoring process options can be implemented with minimal difficulty.

G1.2.2.3 Cost

Maintenance and monitoring process options are comparatively inexpensive.

Cost of maintenance and monitoring activities depends on their scope, frequency, and duration, which in turn, depends on the remedial action alternative selected.

G1.2.2.4 Selection of representative process option(s)

All monitoring and surveillance and maintenance process options are effective, implementable, and cost little. All are carried forward as representative process options for assembly into remedial alternative actions.

G1.3 SOURCE CONTAINMENT

OU-applicable containment technologies include capping. This technology isolates the source of contamination, which remains in place, from human contact or migration to the environment.

G1.3.1 Capping (horizontal barriers)

Capping technology is intended to (1) minimize release of near-shore contaminants by wind or water erosion, (2) isolate shallow sediments from contact by humans or biota, and (3) potentially cover deep sediments should they be uncovered by scouring or similar means. Capping technologies consist of Armorform, geomembrane, and clean sediment covers.

Construction of a cap or cover near or on shore would involve secondary technologies such as clearing, grubbing, erosion control, waste compaction, and regrading before placement of the cap. In general, capping is performed when an extensive quantity of waste materials at a site precludes excavation, costs to remove the material are prohibitive, and/or more extensive remediation is not warranted based on site risks. The main disadvantages of capping are the need for long-term maintenance and uncertain design life. Caps must be periodically inspected for settlement, erosion, and intrusion by animals and deep-rooted vegetation.

Armorform is a double layer woven fabric engineered exclusively to serve as a form for casting concrete erosion control revetments and linings. Armorform is placed on the bottom of a waterway

and filled with clean mortar. The permeable panels retain solids and allow excess water to escape as the solids harden into a concrete structure.

Geomembrane cap construction places an impermeable layer of synthetic material which is placed over contaminated sediments. It is covered by a filter fabric, which protects the geomembrane from the layer of riprap that is placed on top of the filter fabric. The entire cap is secured by an anchor trench approximately 0.3 m (1 ft) wide by 0.6 m (2 ft) deep. The trench runs parallel to the waterway and may be backfilled with clean sediment, concrete, or riprap. The riprap offers good protection from wind and water erosion, as well as, increase shoreline stability and also decrease availability of contaminants.

Clean sediment can be used to cap contaminated sediments in the deep channel areas. Isolation of contaminated sediments may be necessary where cleaner overlying sediments are thin or nonexistent. Clean sediment can be dumped in large quantities from barges over areas in deep water or placed by equipment such as a backhoe in confined or shallow areas.

G1.3.1.1 Effectiveness

For shoreline capping, the geomembrane cap is more effective in the long-term because reliability and stability are greater than that of Armorform. Armorform reliability is expected to diminish comparatively quickly as the concrete ages and cracks, weakening the overall stability of the cap. The geomembrane riprap cover withstands most stresses and, if necessary, replacement of any riprap cover can be done more easily and quickly than replacement of concrete casts. For deep sediments, neither Armorform nor geomembrane caps are considered effective in submerged conditions and reliability of these options would be uncertain.

Clean sediment placed over contaminated deep sediment would be effective although protection may be short-lived because any area where contaminants are exposed due to erosion will likely continue eroding any added sediment. Replenishment of clean sediment may be necessary for this option to remain effective. Biotic action may also compromise the integrity of this cap in either deep or shallow areas.

G.1.3.1.2 Implementability

Implementability of either an Armorform or a geomembrane cap will be difficult, but feasible for shallow sediments. Both require extensive amounts of construction from site preparation to cap construction to closure. Implementation of these are not be technically feasible in deep sediments.

Implementability of placing clean sediment over deep sediments is feasible, but area, depth, and water speed in which sediment cover is needed governs the level of difficulty. Implementation would probably be best when water is lower and speeds are slowed. This minimizes the amount of clean sediment drift away from the area intended for coverage.

G1.3.1.3 Cost

Costs for Armorform or geomembrane cap installation will be high. Significant amounts of site preparation and cap construction require heavy equipment to clear brush and river debris. Armorform may be somewhat higher in materials costs due to the specialized nature of the forms and may require more frequent inspections and potentially more maintenance costs. Geomembrane cap material is comparatively cheaper, but requires somewhat more labor to place two layers of geotextile,

geomembrane, and carefully placed riprap on top. Inspection frequency would be comparatively less for the geomembrane cap as erosion resistance and stability are considered to be better than Armorform; therefore, inspection costs would be less.

Clean sediment costs are moderately high. Sediment itself is relatively cheap depending on the amount needed. Initial placement costs of the sediment will vary according to the area intended for coverage. Large areas, mainly in the open channel, will be covered comparatively quickly and efficiently from barge dumping as most of the sediment covers the bottom by gravity settling. However, costs will increase due to the amount of sediment being used and the use of multiple barges to carry the material from the clean sediment source to its final destination. Small isolated coverages will require typically less sediment, but generally more labor to place the material. Its use in deep water would be extremely costly and the life expectancy low. Armorform requires a considerable amount of time to install and requires periodic inspections and maintenance to ensure that cap integrity remains intact.

G1.3.1.4 Selection of representative process option(s)

Implementability and cost for Armorform or the geomembrane cap are roughly the same, but uncertain performance of the Armorform makes it less desirable. The geomembrane cap is selected as the representative process option for capping shallow sediments, based on greater reliability and durability at comparable cost.

Placement of clean sediment over deep sediments is not chosen at this time as a representative process option due to uncertain reliability, but is site-applicable and retained as a contingent action mainly for deep sediments.

G1.4 REMOVAL

Removal technologies include mechanical excavation and mechanical, hydraulic, and pneumatic dredging of contaminated sediments. These technologies may be used in combination with a dewatering treatment (Sect. 1.6.4), other ex situ treatments (Sects. 1.6.1–3), and/or disposal technology (Sect. 1.7).

G1.4.1 Excavation

Mechanical excavation as discussed in this document is the physical removal of sediment typically using machinery such as backhoes, trackhoes, front-end loaders, bulldozers, clamshells, and draglines. Some units may be mounted on rubber tires (backhoes) that can be used for fast excavations on stable working surfaces. Other track-mounted units (trackhoes and bulldozers) can be used in areas where slippery traction may hinder mobility of tire-mounted types. A general excavation sequence might be as follows.

1. Construct site access (haul roads, etc.), avoiding any wetlands destruction or threatened or endangered plant or animal species destruction.

2. Prepare the site, including silt fences for run-on diversion and runoff control. Scrape sediment to a predetermined depth using a backhoe, trackhoe, front-end loader, or similar device.

3. Load sediment into lined trucks.

4. Transport material to an appropriate treatment area or disposal facility.

5. Cover open, incomplete excavations with a tarp to inhibit precipitation and potential erosion.

6. Seed and mulch disturbed areas above summer pool is recommended. Replacement of sediment is probably unnecessary.

G1.4.2 Dredging

Dredges remove sediment covered by water by dislodging sediment, lifting the sediment, and either transporting it directly to shore or to a temporary staging point (e.g., a barge) pending transport to shore. Three basic types of dredges are effective at removing contaminated sediments: mechanical, hydraulic, and pneumatic.

Mechanical dredges dislodge the sediment using mechanical equipment and dig the sediment as the means for removal. The principal advantage of this type dredge is that the density of the removed material is at or near the same as its in situ density, which means that less water is carried with the sediment, and that smaller volumes of water potentially require treatment. Types of mechanical dredges include bucket wheel dredges, clamshell dredges, and closed-bucket clamshell dredges.

Hydraulic dredges pump sediment in a slurry formed by suctioning the sediment. Some hydraulic dredges use mechanical agitation to loosen the sediment to a sufficient density so that it can be lifted and pumped. Slurry is typically transported across floating or pontoon-supported pipelines to shore. Examples of hydraulic dredges include plain suction, cutterhead, dustpan, hopper, and mud cat.

Pneumatic dredges operate principally by the motive force supplied by compressed air to dislodge the sediment which then is transported by pump to shore. The pneuma pump and the airlift dredge are types of pneumatic dredges.

G1.4.2.1 Effectiveness

Mechanical excavation is effective at removing shallow sediments during winter pool. Other than at winter pool, mechanical excavation remains effective at removing the sediment, although greater levels of turbidity will be generated and require stricter control over fugitive sediment. Careful handling of the saturated material would be necessary to prevent leaks or spills.

Mechanical and hydraulic dredges are effective in dredging shallow or deep sediments. Each is a proven process option type used at other sites to remove contaminated sediments under various conditions. Pneumatic dredges are not effective in shallow conditions. Efficiency of pneumatic dredges increases with water depth, making pneumatic dredges potentially well-suited for deep sediment removal. Dredging, in general, can be somewhat more advantageous in that sediment can be removed through piping to shore facilities, effectively reducing the amount of potential worker exposure.

G1.4.2.2 Implementability

Implementability of mechanical excavation in shallow sediments during winter pool is good compared to dredging. The added water recovered and the greater level of engineering controls necessary to contain fugitive sediment makes dredging more difficult to implement than excavation.

Some mechanical dredges can recover at or near in situ densities, but a certain amount of water contained in sediment pore space will be recovered along with the contaminated sediment and may be considered a waste stream that requires additional treatment and/or disposal. Hydraulic dredges operate in either shallow or deep sediment, but remove large amounts of water along with the sediment to form the slurry, which only increases the amount of water to potentially treat. Pneumatic dredges do not operate efficiently in shallow conditions and are considered implementable only in deep water where it is reported to remove sediment with a high solids content.

G1.4.2.3 Cost

Costs for removal, in general, will be high for capital expenditure and operations costs for either excavation or dredging. Neither technology has a clear cost advantage.

G1.4.2.4 Selection of representative process option(s)

Mechanical excavation is selected as the representative process option to remove contaminated shallow sediments based on greater ease of implementability and because there is typically less water to potentially recover and treat or dispose than with dredging.

Mechanical, hydraulic, and/or pneumatic dredges are site applicable, but are more difficult to use in removing contaminated shallow sediment. Pneumatic dredges will be retained for deep sediment removal.

G1.5 TURBIDITY MINIMIZATION

During removal or containment, sediments may be resuspended in surface water, transported downstream, and deposited on the sediment surface, where it may be available to biota or humans. Turbidity minimization technologies can mitigate adverse effects of sediment resuspension.

G1.5.1 Water Turbidity Minimization

Turbid water minimization limits the amount of fugitive sediment resulting from other remedial actions. Isolation and capture of this sediment diminishes potential risks that may have otherwise risen due to increases of available contaminants leaving the active work site.

Silt curtains are impervious barriers that extend vertically from the water surface to a specified depth. Flexible nylon-reinforced polyvinyl chloride (or similar) fabric forms the barrier and is maintained in a vertical position by flotation segments at the top and a ballast chain (for weight) along the bottom. Tension cables are built into the curtain just below the flotation segment and repeated at some distance(s) below the flotation segment to reinforce the curtain against currents and other hydrodynamic forces. Anchor lines hold the curtain in place in circular or arc-shaped fashion. Silt curtain effectiveness depends on the degree of suspended silt behind the barrier, curtain configuration, mooring, and especially the hydrodynamics of the system.

Silt screens are synthetic geotextile fabrics that allow water to pass through small openings in the fabric yet retain the silt. Mesh size of the material determines the size of particles that can pass. Typical mesh sizes are 70–100 United States standard sieve. The advantage silt screens have over silt curtains is that they can be extended to the bottom sediment. It is suspended at the top by a line of floats and anchored to the bottom. Excess material is installed and allowed to drape at the bottom.

This will allow the slack to be taken up during water level rises without stressing the fabric. The mesh size selection must be small enough to capture the smallest size target particle, yet not clog and reduce water flow. Clogged screens may not properly respond to fluctuations in flow rate or water level and may break.

G1.5.1.1 Effectiveness

Silt screens and silt curtains are effective in retaining fugitive sediments during operations that disturb sediment (e.g., dredging). These process options are not effective for containment or excavation actions because these are conducted when shallow sediments are subaerially exposed.

G1.5.1.2 Implementability

Silt curtains or screens are moderately difficult to install and inspect and maintain for breaks in the material, which would allow potentially contaminated material to escape.

G1.5.1.3 Cost

Costs for these process options will be relatively high and depend on the area to be effectively isolated, and inspection and repairs.

G1.5.1.4 Selection of representative process option(s)

Since both process options are not effective for other than submerged conditions, dredging was not selected as a representative process option, and mechanical excavation is based on removal of shallow sediments exposed at winter pool water level, these will not be selected as representative process options. Either silt curtains or silt screens or both are considered effective, implementable, and cost-effective when used for dredging or similar submerged sediment-disturbing activities and will be retained on a contingent basis.

G1.6 EX SITU TREATMENT

Treatment is used to reduce volume, mobility, or toxicity of a waste. The treatment technologies remaining after the initial technical applicability screening include physicochemical treatment, thermal treatment, and dewatering.

G1.6.1 Physicochemical

A significant number of technically applicable sediment physicochemical treatment process options exist, including chemical extraction/soil washing, solidification/stabilization, dehalogenation, precipitation/flocculation, and ion exchange.

Chemical extraction/soil washing targets contaminants sorbed onto sediment particles, which tend to associate with fine particles. Soil washing separates these from the coarser particles in an aqueous-based system. The wash water may be augmented with a surfactant, pH adjustment, or chelating agent to help remove organics or heavy metals, including radionuclides. This technology offers potential for leaching out contaminants from coarse-grained sediments. The wash fluids and fine-grained sediments are residuals that may need further treatment and/or disposal. Clean coarse-grained sediments can be returned to the site. Soil washing will not be carried forward because large amounts

of fine-grained sediment in the OU will not significantly reduce the amount of waste material to be either additionally treated or disposed of.

Solidification/stabilization can do one or more of the following: improve the handling and physical nature of the sediments, as in free water sorption; decrease the surface area of the waste mass across which transfer or loss of contaminants can occur; and limit the solubility of any hazardous constituents in the waste. Solidification technology adds a reagent to transform the sediments into a solid. Liquid or semi-solid waste tends to become solidified, thus improving the handling and physical nature of the material. Solidification encapsulates the waste into a structurally stable solid. Solidification is achieved by either decreasing the surface area of the waste or surrounding the waste in an impervious capsule. The contaminated sediment is mixed with water and a binding agent and allowed to cure into a solidified mass. Stabilization reduces the mobility of a contaminant by converting COC(s) into less mobile or toxic forms. Wastes that leach heavy metals or other contaminants can be stabilized to immobilize the hazardous contaminants. Although the contaminant is immobilized, the waste may maintain its original physical nature and handling characteristics. Stabilization/solidification can be accomplished by use of cement-based materials, pozzulanic-based materials (silicon dioxide), thermoplastic, and organic polymer materials.

Chemical precipitation/flocculation is a process in which dissolved chemical species such as toxic metals are transformed into a solid phase for removal. This process is primarily used to remove of metals. It decreases solubility of the contaminants either by pH adjustment or by adding chemicals which effectively reduce the electrostatic repulsion inherent in ions, thus causing them to come together due to their net attractive surface charges. The Oak Ridge Reservation (ORR) facilities have the system for treating contaminated water.

Ion exchange is an ex situ volume and toxicity reduction process to remove ionic species, principally inorganics, from aqueous waste streams. Ion exchange is based on use of specifically formulated resins and natural inorganic materials that have an exchangeable ion bound to the resin with a weak ionic bond. If the electrochemical potential of the ion to be recovered (contaminant) is greater than that of the exchangeable ion, the exchange ion goes into solution and the contaminant ion binds to the resin.

G1.6.1.1 Effectiveness

Chemical extraction/soil washing is effective if there is a high amount of coarse-grained material. Large amounts of coarse material will be removed and render a small amount of fine silt and clay with most or all of the contamination.

Solidification/stabilization will effectively reduce the mobility of inorganic contaminants and improve disposal options.

Water may be treated with ion exchange or chemical precipitation/flocculation effectively. Inorganics are the main contaminants in sediment that elevate risk to unacceptable levels. Any leachable portion of these that emanate from dewatering sediment may alter the water quality sufficiently to preclude discharge to the reservoir. Treatment with an ion exchanger for these contaminants may be necessary before other potential treatment steps (for water-borne contaminants that may have been acceptable in sediment, but not in water) or discharge to the reservoir.

No specific consideration was given for effectiveness in physicochemical treatment options applied to deep sediment contaminants, although those described previously (among others) may apply.

G1.6.1.2 Implementability

Chemical extraction/soil washing would be difficult to implement. It is anticipated that much of the site sediment will have a mixture of sands, silts, and clays, of which this process can treat. However, unless there is a significantly high proportion of sand in the OU, treatment with this process will yield little in the way of volume reduction.

Stabilization/solidification is moderately difficult to implement. Only those contaminants that cannot be treated to reduce concentrations by other options and would cause WAC failure for potential disposal sites can be segregated and stabilized to reduce leachability and thus be more acceptable to landfill WACs. The difficulty lies mainly in the amount of handling the sediment may require to segregate the material suitable for this option.

Chemical precipitation/flocculation and ion exchange can be implemented by constructing a dedicated on-site facility to treat the water specifically from site sediments. However, the possibility for this seems unlikely, in light of already constructed operating facilities at all three plants. Nevertheless, volumes or specific contaminants not within the capabilities of any of these treatment facilities may prompt construction of a dedicated facility or upgrade of existing facilities to treat this water.

No specific consideration was given for implementability in physicochemical treatment options applied to deep sediment contaminants, although those described previously (among others) may apply.

G1.6.1.3 Cost

Costs for all of the physicochemical treatments described previously will be high. All have high capital costs and high operating cost. Chemical precipitation/flocculation and ion exchange treatment facilities constructed specifically for the water from sediment is probably not cost effective considering the treatment facilities already in place.

G1.6.1.4 Selection of representative process option(s)

Stabilization/solidification is selected as a representative process option for its implementability and its effectiveness in reducing inorganic contaminant mobility. This option will reduce leachability for metals in sediment, particularly arsenic in McCoy Branch Embayment without overwhelmingly increasing waste volume for the entire waste stream. Volume increases will occur for the sediment to which the process is applied, but proper analysis and sediment waste stream segregation will reduce the amount of material requiring stabilization treatment. Also, some moisture in the sediment will not cause the option to become ineffective. Cement slurry will be added to the sediment and solidify the mass anyway.

Chemical extraction/soil washing was not selected as a representative process option because the reduction in volume is not significant enough to be cost effective. Potentially, little volume reduction would occur and the residual material, whatever its volume, would possibly require additional treatment such as stabilization/solidification before disposal.

Chemical precipitation/flocculation and ion exchange are not selected as representative process options. Both are site applicable and will be retained on a contingent basis, but existing facilities (see Sect. 1.7.2, water disposal) are more appropriate means of wastewater treatment at this time.

G1.6.2 Thermal Treatment

Thermal treatment uses elevated temperatures to destroy, detoxify, or physically stabilize hazardous wastes. The most site applicable thermal treatment is low-temperature thermal desorption (thermal desorption). Other thermal treatments were considered initially, but thermal desorption is the mitigating action chosen because mercury is present in portions of Poplar Creek at concentrations that may present unacceptable risk, and, when removed may fail Toxicity Characteristic Leaching Procedure (TCLP) analysis. Failure of TCLP can limit the number of disposal options as discussed later in Section 1.7.1.

Incineration is the incinerating of incomplete combustion, volatile, or off-gases in a device commonly referred to as an afterburner. Several of alternative incineration processes are available including fluidized bed, circulating bed combuster, and high-temperature slagging and rotary kiln. Fluidized bed and rotary kiln are the more widely available processes and have been used to treat hazardous materials.

Thermal desorption is a low-temperature means of removing volatile mercury (and many organic compounds, if present) from sediments. The system consists of a furnace in which the volatile mercury is desorbed from the waste feed. Desorbed organics and mercury are removed from the furnace by a purge gas and collected by a physical/chemical treatment or are destroyed in an afterburner.

Pyrolysis is the destruction of organic material in the absence of oxygen at a high temperature to reduce toxic organic constituents to elemental gas and water. The absence of oxygen allows separation of the waste into an organic fraction (gas) and an inorganic fraction (salts, metals, particulates) as char material.

Infrared thermal is a commercially available destruction process option that thermally ruptures the chemical bonds of molecules in the absence of oxygen and at high temperatures to reduce toxic organics to elemental gas and water.

G1.6.2.1 Effectiveness

Incinerators have a high destruction efficiency and are effective in treating mixed solid residues. Thermal desorption is very effective at removal of mercury contaminants from solid media (soils and sediments). Pyrolysis is also effective in the destruction of PCBs. Infrared thermal is also an effective treatment for other wastes containing halogenated and nonhalogenated organics, including PCBs. All the thermal processes are more effective than other physicochemical process options for destroying organic contaminants.

G1.6.2.2 Implementability

Implementability of thermal desorption is moderately difficult. Construction of a facility to process the material requires a high level of effort to install the primary equipment and support equipment needed to treat the sediment. However, the option operates at low temperature, thus air emissions permits would not normally be necessary because no off-gas contaminants would occur. Implementability is very good compared to other thermal treatments that operate at high temperatures and would likely require more strict operation controls to meet emissions standards.

G1.6.2.3 Cost

Cost for any of the identified thermal treatments is high, principally from initial capital costs. O&M cost is comparable to other ex situ treatments.

G1.6.2.4 Selection of representative process option(s)

Thermal desorption is selected as a representative process option for its effectiveness at reducing mercury concentrations. It is more cost efficient than most ex situ treatment options requiring specialized equipment to process contaminated sediment and has the advantage over other thermal treatments in that meeting air emissions requirements for this option are less difficult due to low-temperature operation. This process option is more than 99 percent efficient in removing volatile organic compounds from soil.

G1.6.3 Dewatering

The primary purpose of this process is to reduce the moisture content of slurries or sludges to expedite the handling and to prepare the material for further treatment or disposal. The water generated during dewatering may contain contaminants and suspended solids, and wastewater treatment may be necessary.

A belt filter press processes sediment slurry into sediment cakes by squeezing the water from the slurry as it passes across a rolling belt. Sediment is then more easily managed for any further treatment and/or disposal. Anticipated sediment volumes may require multiple units to process large volumes of sediment.

Settling ponds are constructed areas intended for impoundment of sediment/water slurry. Slurry is allowed to collect and by gravity, solids settle out of the water column. Collection of the water and separated sediment make each medium transportable and treatable. Settling ponds are useful when solids content of slurry is low.

Fly ash can be added to absorb free water in sediment slurry. Fly ash combines with the water to make the material easier to handle, transport, and dispose. Disposal (and most other treatment) criteria will necessitate the absence of free water in the material before waste acceptance. Fly ash does not reduce contaminant leachability.

A sloping dewatering pad is constructed sufficiently large enough to handle the volumes of sediment anticipated during implementation of sediment removal by excavation and/or dredging. It would be constructed such that drainage flow is directed toward the collection trench. A perimeter berm would be constructed around the facility to prevent wastewater leaving or run-on entering the facility. Water draining from the sediment will be collected in the trench and then pumped to temporary holding tanks. The net effect is two waste streams, each of which is easier to characterize and handle than previously as a mixture.

G1.6.3.1 Effectiveness

Belt filter presses are effective at actively removing free water from supersaturated sediments. Depending on the volume of sediment to dewater, the process can require several units running in parallel to continually process the sediment. The higher the water content the less efficient the process becomes, including longer process times.

Settling ponds are effective for sediment slurry separation where there is a high water content requiring separation from the solids. Effectiveness for the minimal amounts of water removed during excavation makes this option unsuitable.

Addition of fly ash is effective in absorbing small amounts of free water. Supersaturated sediment is probably not effectively treated by solely adding fly ash. Volume increases are such that the amount of fly ash needed to absorb large amounts of water will prohibitively raise the volume of total material to be disposed.

Sloping dewatering pads are effective at allowing natural processes to dewater sediment. Gravity drainage and evaporation would remove most or all the free water. Proper construction can effectively restrain contamination migration from the pad.

G1.6.3.2 Implementability

A belt filter press is commercially available, but several units may be required to dewater the sediment in a reasonable period of time.

Settling ponds are site applicable, but anticipated volumes of water/sediment slurry are probably not large enough (when excavated) to necessitate implementation of settling ponds which are perhaps most suitable for slurries with generally low solids content.

Fly ash is easily implemented, especially for the anticipated amounts of water brought in by excavating sediment; implementation for high water content sediment would be considerably more difficult.

Sloping dewatering pads would have a somewhat high initial difficulty in construction of the pad, but long-term operation difficulty would be very small because the dewatering process is basically passive.

G1.6.3.3 Cost

Capital cost and O&M cost for belt filter presses are high.

Land acquisition and construction of settling ponds cause this option to be costly. Actual costs depend largely on the expected solids content of the sediment slurry being recovered, the time for a slurry to separate adequately, and the area needed to stage the slurry while it separates.

Fly ash increases the volume of the material to be treated or disposed, raising the costs for both. Contaminated material that meets WAC of potential disposal sites without treatment(s) to reduce contaminant concentrations, mobility, etc. may be treated with only fly ash and sent directly to the disposal facility with modest increases of volume. Material that requires some form of treatment other than free water removal costs significantly more to treat the additional volume and may be considered cost prohibitive.

Cost for a sloping dewatering pad will largely be initial capital cost. Operation cost for only the pad will be minor for maintenance of the pad. Treatment cost is very low because sunlight, air, and gravity dewater the sediment naturally.

G1.6.3.4 Selection of representative process option(s)

Sloping dewatering pad is the selected dewatering treatment option. Operation of the pad is simple and cost effective. Belt filter presses cost more to operate and maintain. Expected water from excavation of shallow sediment is low, which precludes settling ponds. Fly ash is effective at binding with the small amounts of expected free water, but it does not reduce contaminant leachability, and any further treatment(s) or disposal costs will rise because of increased volumes.

G1.7 DISPOSAL

G1.7.1 On-Site Sediment Disposal

This action provides long-term containment and/or isolation of contaminated dredged material, or based on confirmatory sampling, the sediment could be placed on site if it meets applicable regulatory requirements. Characterization of dewatered sediment is imperative to determine the proper handling and disposal method. Radiological surveys and analysis as well as TCLP analysis needs to be performed.

The following discusses the general on-site/off-site disposal options for the sediment. As more specific characterization data become available, some of the disposal options presented will not be available due to potential contaminants and/or inability of the waste to meet disposal facility WAC.

With regard to on-site disposal options, it is very unlikely that a new disposal facility (cell) will be designed, constructed, and operated for Clinch River/Poplar Creek sediments only. Regulatory design criteria, volume, and cost are all factors which make implementation of this option difficult. Cost of developing the cell outweighs the anticipated volume of sediment to be disposed of. Also, regulatory drivers such as land disposal restrictions, waivers, and special waste permits necessitate additional administrative burdens that potentially increase costs, further decreasing feasibility. However, a cell is being constructed at Y-12 LF V to accommodate Lower East Fork Poplar Creek flood plain soils. This cell will have ample capacity to handle the Lower East Fork Poplar Creek floodplain soils and may be potential disposition option for a portion of the dredged Clinch River/Poplar Creek sediments.

G1.7.1.1 Effectiveness

Using an engineered LF would be effective at reducing site risks to humans and ecological receptors. Availability of this option is questionable for disposal of sediments. The effectiveness of this option is high due to an appropriately engineered disposal site with respect to reducing site, human, and ecological risks.

Reclamation of contaminants from sediments and recycling them for economical reuse can be effective at reducing site risks from contaminants.

G1.7.1.2 Implementability

Landfill disposal will be difficult to implement, but no more so than any other potential on-site disposal option. Implementability for this option or any on-site disposal option is probably the most implementable as compared to off-site disposal options, based on transportation requirements and costs, and especially elevated disposal costs.

G1.7.1.3 Cost

Cost for onsite landfill disposal at Y-12 (or any other on-site facility) is high, but likely less than any off-site disposal options.

G1.7.1.4 Selection of representative process option(s)

The Y-12 Landfill is chosen as the representative on-site sediment disposal process option. The other two site applicable process options are not very plausible, mainly based on low degree of implementability and comparatively high cost.

G1.7.2 Off-Site Sediment Disposal

An off-site disposal option that could be very expensive to implement is shipping the sediments to the Envirocare of Utah, Inc. (Envirocare) facility. This site is permitted to accept, store, and dispose of DOE-generated solid low-level Class A mixed waste. Consideration of this facility is restrained by the fact that costs to transport and dispose of untreated solid low-level or mixed waste is very high. Minimal treatment must involve dewatering because Envirocare will not accept waste with free liquids.

G1.7.2.1 Effectiveness

Envirocare is effective in reducing risks from OU contaminants in sediment. Envirocare is located in arid climates, which will reduce potential risks from leachable contaminants after disposal as well.

G1.7.2.2 Implementability

The Envirocare facility option is implementable. An agreement between DOE, USACE and Envirocare establishes facility acceptance of ORR solid LL or mixed wastes, which may eliminate certain treatment steps other than dewatering, reducing potential treatment costs.

G1.7.2.3 Cost

Envirocare is expensive. Generally, off-site disposal is very costly. Off-site mixed waste disposal is even more so. However, a certain amount of cost savings may be attributed to being able to forego treatment of the sediment (other than dewatering, which Envirocare WAC explicitly states no free liquids). Shipping the sediments as low-level versus mixed, based on analytical data, also greatly reduces costs.

Likewise, NTS is expensive. Since it does not accept mixed waste, treatment for certain RCRA metal contaminants may be necessary before acceptance by the facility.

G1.7.2.4 Selection of representative process option(s)

Envirocare is the selected representative off-site sediment disposal process option primarily for its ability to accept solid low-level as well as mixed waste. Risks to the OU are reduced and residual risks at the disposal facility are low due to climate and low potential for leaching.

G1.7.3 Water Disposal

Based on the existing limited data, only one disposal option has been identified for the disposal of the wastewaters obtained from the dewatering of the sediments. The West End Treatment Facility at the Y-12 Plant has been earmarked as the designated location. This is contingent on characterization results of the wastewaters and whether the treatment facility will be able to meet its National Pollutant Discharge Elimination System (NPDES) effluent limits. Consultation with facility officials is necessary to determine wastewater and facility limitations as well as scheduling amounts and delivery times.

G1.7.3.1 Effectiveness

The treatment facility is effective in removing the potential contaminants detected in OU sampling that may occur in drainage from removed sediments. Effectiveness will remain good assuming contaminant types and concentrations remain in the treatability range of the facility.

G1.7.3.2 Implementability

Implementability of treating water at this facility is good, so long as the facility is aware of the anticipated volumes requiring treatment, can meet its NPDES limits, and the contaminant profile remains consistent. Consistency of concentrations of existing contaminants are not anticipated to vary significantly, or, new contaminants to appear that are out of the treatment abilities of the facility. If these situations arise, a pre-treatment for these added contaminants or an alternate treatment facility may be necessary before final disposal.

G1.7.3.3 Cost

Costs for this facility are anticipated to be good. Generally on-site treatments are less expensive than off-site treatment or disposal.

G1.7.3.4 Selection of representative process option(s)

The Y-12 Plant West End Treatment Facility is selected as a representative process option. Effectiveness for OU contaminants currently identified is good. Implementability can be good, but communication with the facility is important in coordinating wastewater delivery and ensuring the facility can meet its NPDES effluent requirements.

G1.7.4 Waste Transportation

Trucks can haul saturated or dewatered sediment. Sediment being sent for dewatering would have the trucks lined to prevent leakage. Sediment not requiring treatment, once dewatered, can also be transported on site by truck.

Water derived from dewatering the sediment that fails to meet criteria for release back to the reservoir can be hauled to the West End Treatment Facility by tanker truck or have smaller polyethylene tanks loaded on flat-bed trucks to haul, depending on volume.

Rail transport of dewatered sediment can send untreated sediment to Envirocare in Utah in B-25 boxes. U.S. Department of Transportation (DOT) requirements for rail transport state that the material be packaged in "strong tight" containers specified in 49 CFR 173.

G1.7.4.1 Effectiveness

Truck transportation is good for hauling material around the ORR site to any of the on-site storage/disposal facilities.

G1.7.4.2 Implementability

Implementability may be difficult for either truck transport or rail transport. Transport of the sediment to the dewatering pad for free water removal is a primary consideration. Leakage from saturated sediments may be a public health hazard and must be avoided. Access road construction to individual areas for trucks to enter and exit will diminish ease of implementability due to the level of construction needed to access some of these areas at the site. Rail transport requires the same access roads to get the sediment out of individual sites, lining of trucks, and dewatering of sediment. Moreover, rail transport necessitates the material be brought to a suitable area with a railroad spur where the material can be packaged and loaded for transport. Water transport is easily implemented, assuming the infrastructure built for trucks to access the dewatering pad is in place.

G1.7.4.3 Cost

Transport cost for on-site transport via trucks is comparatively low. Transport of saturated sediment will likely incur the highest portion of cost due to the necessary precautions added to prevent spills or leakage. On-site transport cost of dewatered sediment is expected to be relatively low. Based on existing contaminant data for shallow sediments, dewatered material should be considered stable because leakage of liquids would no longer pose a threat. Spillage of solids would be avoided, but could be managed with relative ease. Water transport cost is also considered low. Rail transport is relatively high. The distance to be shipped and DOT requirements for shipping mixed waste increase for rail transport cost.

G1.7.4.4 Selection of representative process option(s)

Trucks for sediment and water transport on site, and, rail transport for sediment unsuitable for on-site storage or disposal are selected as representative process options. All are implementable and effective. Depending on the disposal option selected, cost can range from low for on-site trucking to high for rail transport off site.

Appendix H

COST ESTIMATES

H1. ALTERNATIVE 2—INSTITUTIONAL CONTROLS AND ADVISORIES

H1.1 GENERAL ASSUMPTIONS

- The estimate has been prepared in Automated Estimating System (AES) format using the ERNOV95a.val standard value file for labor and escalation rates.
- Costs for public advisories and permit programs have been included in the estimated cost to cover only U.S. Department of Energy (DOE) cost, not other agencies.
- A project contingency of 25 percent has been applied to this estimate because of the level of design at the feasibility study stage.
- Supporting activities and participants required for project management, planning, and engineering have been included based on historical data and best engineering judgement.
- Monitoring costs are included at $150,000 per year. This estimated cost is based on the monitoring plan for Lower Watts Bar.

H1.2 WORK BREAKDOWN STRUCTURE

Below is the Work Breakdown Structure (WBS) to the 4th level with associated participants.

WBS	Title	Participant	Title
2.0	Alternative 2		
2.1	Capital Cost		
2.1.1	Direct Cost		
2.1.1.1	Deed Restriction	Z001	Special
2.1.1.2	Public Advisories	Z001	Special
2.1.1.3	Permit Programs	Z001	Special
2.1.2	Indirect Cost		
2.1.2.1	RA Integration	C087	Environmental Restoration
2.1.2.2	Remedial Action Work Plan	TS01	Tech. Support Contractor
2.2.1	Monitoring and Maintenance		
2.2.1.1	Monitoring	C004	Analytical Services

H1.3 PROJECT SCHEDULE

Below is the assumed project schedule used to prepare the estimate.

Activity	Start		End
Remedial Action Work Plan	12/01/96		02/01/97
Remedial Action	02/01/97		10/01/97
Monitoring and Maintenance	02/01/97	30 years	02/01/27

H1.4 REPORTS

The following AES reports are available from Jacobs Engineering Group Inc.:

- Summary Report per WBS/attribute/participant
- Detail Report
- Life-Cycle Cost Analysis (present value)

H2. ALTERNATIVE 3A—SOURCE CONTAINMENT

H2.1 GENERAL ASSUMPTIONS

- The estimate has been prepared in AES format using the ERNOV95a.val standard value file for labor and escalation rates.
- Cost for deed restrictions, public advisories, and permit programs have been included in the estimated cost to cover only DOE cost, not other agencies.
- A project contingency of 25 percent has been applied to this estimate because of the level of design at the feasibility study stage.
- Supporting activities and participants required for project management, planning, and engineering have been included based on historical data and best engineering judgement.
- Monitoring costs are included at $150,000 per year. This estimated cost is based on the monitoring plan for Lower Watts Bar.

H2.2 WORK BREAKDOWN STRUCTURE

Below is the WBS to the 4th level with associated participants.

WBS	Title	Participant	Title
3.0	Alternative 3A		
3.1	Capital Cost		
3.1.1	Direct Cost		
3.1.1.1	Deed Restriction	Z001	Special
3.1.1.2	Public Advisories	Z001	Special
3.1.1.3	Permit Programs	Z001	Special
3.1.1.4	Source Containment	MK51	MK-F FP Subcontractor
		MK66	MK-F Indirect on FP
		MK67	MK-F Directs on FP
3.1.2	Indirect Cost		
3.1.2.1	RA Integration	AE01	RD A/E
		C069	Central Engineering
		C087	Environmental Restoration
		SC01	Off-site Subcontractor
		TS01	Tech. Support Contractor

WBS	Title	Participant	Title
3.1.2.2	Remedial Design Work Plan	AE01	RD A/E
		C069	Central Engineering
		MK67	MK-F Directs on FP
		TS01	Tech. Support Contractor
3.1.2.3	Remedial Design Report	AE01	RD A/E
		C069	Central Engineering
		MK67	MK-F Directs on FP
		TS01	Tech. Support Contractor
		X035	OFC Env Compliance & Doc
3.1.2.4	Remedial Action Work Plan	AE01	RD A/E
		C069	Central Engineering
		MK67	MK-F Directs on FP
		TS01	Tech. Support Contractor
3.2.1	Monitoring and Maintenance		
3.2.1.1	Monitoring	C004	Analytical Services

H2.3 PROJECT SCHEDULE

Below is the assumed project schedule used to prepare the estimate.

Activity	Start		End
Remedial Design Work Plan	06/01/96		07/15/96
Remedial Design Report	07/01/96		10/15/96
Remedial Action Work Plan	10/15/96		01/01/97
Remedial Action	01/01/97		01/01/98
Monitoring and Maintenance	01/01/98	30 years	01/01/28

H2.4 REPORTS

The following AES reports are available from Jacobs Engineering Group Inc.:

- Summary Report per WBS/attribute/participant
- Detail Report
- Life-Cycle Cost Analysis (present value)

H3. ALTERNATIVE 3B—CONTAINMENT/REMOVAL

Alternative deleted.

H4. ALTERNATIVE 4A—REMOVAL—EXCAVATION ONLY

Alternative deleted.

H5. ALTERNATIVE 4B—REMOVAL—EXCAVATION/DREDGING

H5.1 GENERAL ASSUMPTIONS

- The estimate has been prepared in AES format using the ERNOV95a.val standard value file for labor and escalation rates.
- A project contingency of 25 percent has been applied to this estimate because of the level of design at the feasibility study stage.
- Supporting activities and participants required for project management, planning, and engineering have been included based on historical data and best engineering judgement.

H5.2 WORK BREAKDOWN STRUCTURE

Below is the WBS to the 4th level with associated participants.

WBS	Title	Participant	Title
3.0	Alternative 4		
3.1	Capital Cost		
3.1.1	Direct Cost		
3.1.1.1	Removal (Dredging/Excavation)	MK51	MK-F FP Subcontractor
		MK66	MK-F Indirect on FP
		MK67	MK-F Directs on FP
3.1.2	Indirect Cost		
3.1.2.1	RA Integration	AE01	RD A/E
		C069	Central Engineering
		C087	Environmental Restoration
		SC01	Off-site Subcontractor
		TS01	Tech. Support Contractor
3.1.2.2	Remedial Design Work Plan	AE01	RD A/E
		C069	Central Engineering
		MK67	MK-F Directs on FP
		TS01	Tech. Support Contractor
3.1.2.3	Remedial Design Report	AE01	RD A/E
		C069	Central Engineering
		MK67	MK-F Directs on FP
		TS01	Tech. Support Contractor
		X035	OFC Env Compliance & Doc
3.1.2.4	Remedial Action Work Plan	AE01	RD A/E
		C069	Central Engineering
		MK67	MK-F Directs on FP
		TS01	Tech. Support Contractor

H5.3 PROJECT SCHEDULE

Below is the assumed project schedule used to prepare the estimate.

Activity	Start	End
Remedial Design Work Plan	06/01/96	09/01/96
Remedial Design Report	09/01/96	03/01/97
Remedial Action Work Plan	03/01/97	06/01/97
Remedial Action	06/01/97	06/01/2000

H5.4 REPORTS

The following AES reports are available from Jacobs Engineering Group Inc.:

- Summary Report per WBS-3/WBS-4/participant
- Detail Report
- Life-Cycle Cost Analysis (present value)

Appendix I

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS— FURTHER DISCUSSION

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS— FURTHER DISCUSSION

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) was passed by Congress and signed into law on December 11, 1980 (Public Law 96-510). This act was intended to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste disposal sites." The Superfund Amendments and Reauthorization Act (SARA), adopted on October 17, 1986 (Public Law 99-499), did not substantially alter the original structure of CERCLA but provided extensive amendments to it.

In particular, § 121(d) of CERCLA specifies that remedial actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate to the hazardous substances or particular circumstances at a site. Inherent in the interpretation of applicable or relevant and appropriate requirements (ARARs) is the assumption that protection of human health and the environment is ensured.

The purpose of this report is to supply a preliminary list of available federal and state chemical-, location-, and action-specific ARARs for the remediation of the Clinch River/Poplar Creek operable unit (OU). CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA § 121(e) and Federal Facilities Agreement (FFA) § XXII]. CERCLA defines "on-site" to mean "the areal extent of contamination and all suitable areas in very close proximity" (40 *CFR* 300.5). To ensure that CERCLA response actions proceed as rapidly as possible, the U.S. Environmental Protection Agency (EPA) has reaffirmed this position in the final National Contingency Plan (NCP) (55 *FR* 8756, March 8, 1990). ***Substantive requirements*** pertain directly to the actions or conditions at a site; ***administrative requirements*** facilitate their implementation. EPA recognizes that certain of the administrative requirements, such as consultation with state agencies and reporting, are accomplished through the state involvement and public participation requirements of the NCP. These administrative requirements should be observed if they are useful in ensuring environmental protection at the site (55 *FR* 8757). It is assumed for development of ARARs for the Clinch River/Poplar Creek OU that all remedial activities are "on-site."

I1. CHEMICAL-SPECIFIC ARARs

"Chemical-specific requirements set health- or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants" (53 *FR* 51437). These requirements generally set protective cleanup levels for the chemicals of concern in the designated media or else indicate a safe level of discharge that may be incorporated when a specific remedial activity is being considered. A comparison of analytical results for surface water in the Clinch River, Poplar Creek, and McCoy Branch to TDEC ambient water quality criteria (AWQC) for protection of human health and aquatic organisms may be found in Appendix Tables B5–B7 (in Vol. 2). Those analytes that appear to exceed a criterion at one or more location are discussed in Sect. 3.2 and summarized in Table 3.3 of the Remedial Investigation (RI) Report. Arsenic and mercury exceed one or more of the criteria in several reaches of the Clinch River/Poplar Creek OU.

The presence of man-made radionuclides was compared with AWQC for domestic water supply (4 mrem/year), and it was found that the summed dose did not exceed the criterion.

I1.1 SURFACE WATER

The purpose of the Tennessee Water Quality Control Act [Tennessee Code Annotated (TCA) 69-3-102(b)] is "to abate existing pollution of the waters of Tennessee, to reclaim polluted waters, to prevent the future pollution of waters and to plan for the future use of the waters ...." The Tennessee Water Quality Control Act (TCA 69-3-103(33) defines "waters" of the State as "any and all water, public or private, on or beneath the surface of the ground, which are (sic) contained within, flow through, or border upon Tennessee or any portion thereof...."

Tennessee has promulgated implementing regulations to fully protect existing uses of all surface waters as established under the Water Quality Control Act. Under the Tennessee Water Quality Control Act, the Tennessee Water Quality Control Board has classified the Clinch River for domestic water supply, industrial water supply, fish and aquatic life, recreation, irrigation, livestock watering and wildlife uses, and navigation [Chap. 1200-4-4 of the Rules of the Tennessee Department of Environment and Conservation (TDEC)]. Poplar Creek from mile 0.0 to 0.5 is classified for all but domestic water supply and navigation. Poplar Creek from mile 0.5 to 5.5 and McCoy Branch are classified for fish and aquatic life, recreation, irrigation, livestock watering and wildlife uses.

As part of the federal requirement for a triennial review of state water quality standards, the TDEC Division of Water Pollution Control has promulgated amendments to Chaps. 1200-4-3 and 1200-4-4 of the Rules of the TDEC, which incorporate the SDWA MCLs as WQC for domestic water supplies (effective date July, 1995). A WQC for consumption of aquatic organisms and drinking water for waters classified for both recreation and domestic water supply (the Clinch River) has been promulgated, effective July, 1995. Additional criteria for protection of recreational uses include a WQC for consumption of aquatic organisms alone. Table I1 lists AWQC for arsenic and mercury for the designated uses of domestic water supply, recreation, and fish and aquatic life; table I2 additionally lists the AWQC as ARARs for Alternative 2.

I1.2 SEDIMENT

There is no federal or state legislation available governing cleanup criteria for protection of either humans or ecological receptors from contaminated sediments.

Table I1. Tennessee water quality criteria for designated water uses (μg/L)[a]

Chemical	Domestic water supply	Recreation[b]	Recreation[c]	Fish and aquatic life	
				CMC[d]	CCC[e]
Arsenic	50	0.18	1.4[e]	360	190
Mercury	2	0.14	0.15	2.4	0.012

[a]Rules of the TDEC, Chapter 1200-4-3.
[b]Consumption of drinking water and aquatic organisms (applicable to the Clinch River, which is designated for both domestic water supply and recreation).
[c]Ingestion of aquatic organisms only (applicable to Poplar Creek and McCoy Branch, which are designated for recreation only).
[d]CMC = criterion maximum concentration.
[e]CCC = criterion continuous concentration.

I2. RADIATION PROTECTION STANDARDS

Very few applicable standards are available for the cleanup of radioactive contamination at CERCLA sites. The Atomic Energy Act (AEA) of 1954 and its amendments delegated authority for control of nuclear energy to DOE, the U.S. Nuclear Regulatory Commission (NRC), and EPA. The requirements of DOE Order 5400.5 and DOE Order 5820.2A may be considered guidance for residual radiactivity left in place in the Clinch River/Poplar Creek OU or for the storage/disposal of low-level waste (LLW), respectively. DOE Order 5820.2A is discussed in 4.3.5 as action-specific "to be considered" (TBC) guidance.

DOE has proposed radiation protection requirements for the public and environment for all sources of exposure and from all DOE sources of radiation [10 *CFR* 834, Notice of Proposed Rulemaking (NPRM) 58 *FR* 16268, March 25, 1993; final rule expected May 1995]. The proposed rule, when final, would codify the requirements of DOE Order 5400.5. The radiation exposure limits as defined in proposed 10 *CFR* 834, "Radiation Protection of the Public and the Environment," are an effective dose equivalent of 100 mrem/year from all exposure pathways and all sources of radiation from remedial activities and from all other sources (excluding dose from radon and its decay products, diagnostic or therapeutic medical radiation exposures, consumer products, and natural background). In addition, effluent releases to surface water must not result in exposures to aquatic organisms that exceed an absorbed dose of 1 rad/d. The overriding principle of the regulation is that all releases of radioactive material shall be "as low as reasonably achievable" (ALARA). Until this rule is promulgated, it or DOE Order 5400.5 may be considered TBC guidance.

Residual radioactive material is defined in DOE Order 5400.5 as that level of radioactive material that is acceptable for use of property without restrictions on use. Residual concentrations of radionuclides in soils or sediments shall be derived using the basic dose limit of 100 mrem/year, and the DOE RESRAD model (Yu et al., 1993) with site-specific input parameters or any other pathways analysis model, with DOE approval.

I3. LOCATION-SPECIFIC ARARs

Location-specific requirements "set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations" (53 *FR* 51437). Preconstruction activities performed for alternatives 3 and 4 (see Sect. 10.2.3 and Sect. 10.2.4 of the FS), such as building of access roads or removal of bank vegetation, as well as actual containment, construction, or dredging activities may trigger certain location-specific ARARs. The following location-specific ARARs will not apply to either the no-action (see Sect. 10.2.1 of the FS) or the institutional controls (See Sect. 10.2.2 of the FS) alternatives since no such activities will be performed.

I3.1 WETLANDS AND FLOODPLAINS

The Clinch River drainage basin includes a number of wetland areas that may require protection. If any preconstruction or construction activities would impact such wetlands, consideration should be given to Executive Order 11990 and 10 *CFR* 1022 for applicable requirements. In addition, a wetlands delineation of the area has identified federal jurisdictional wetlands in several reaches of the OU (see Sect. 2.7.2 of this RI Report). Action must be taken to avoid degradation or destruction of such federally delineated wetlands under §404 of the CWA, 33 *CFR* 323, and 40 *CFR* 230. Regulations protecting floodplains are found in Executive Order 11988 and 10 *CFR* 1022. Table I2 summarizes the substantive portions of these regulations.

I3.2 AQUATIC RESOURCES

As mentioned previously, CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA § 121(e)]. However, the Tennessee Valley Authority (TVA), the U. S. Army Corps of Engineers (USACE), and the TDEC Division of Water Pollution Control retain authority for approving activities impacting TVA lands, waters of the United States, or waters of the State, respectively.

I3.2.1 TVA Authority

The TVA Act § 26a regulates lands under TVA jurisdiction within the Tennessee River Valley. Sect. 26(a) requires that TVA approval be obtained prior to the "construction, operation, or maintenance of any dam, appurtenant works, or other obstruction affecting navigation, flood control, or public lands or reservations along or in the Tennessee River or any of its tributaries." On shore capping activities within the 100- or 500-year floodplain as well as other activities, such as road construction, may require a Section 26(a) authorization; use of TVA public use boat ramps for dredging operations might require land use permits.

I3.2.2 USACE Authority

The substantive requirements of the USACE authorization for activities occurring in navigable waters, under the authority of § 10 of the Rivers and Harbors Act (RHA), or waters of the United States, under the authority of § 404 of the Clean Water Act (CWA), may also be triggered (Table I2).

Table I2. ARARs[a] and TBC[b] guidance for alternatives 1-4 for the Clinch River/Poplar Creek OU

Actions	Requirements	Prerequisites	Citation
ALTERNATIVE 1 - NO ACTION	None	No remedial actions are implemented	OSWER[c] Directive 9234.2-01/FS-A
ALTERNATIVE 2 - INSTITUTIONAL CONTROLS			
Chemical- or radionuclide-specific	Must meet ambient water quality criteria for designated use. (See Table I1.)	Applicable to point source discharges to water of the state—relevant and appropriate for CERCLA remediation.	TDEC 1200-4-3 TDEC 1200-4-4
	Residual concentrations of radionuclides in soils shall be derived using the basic dose limit of 100 mrem/year, and the DOE[d] RESRAD[e] model with site-specific input paramenters	Residual radioactive materials left in place without restrictions - **TBC**	DOE Order 5400.5(IV)
	The general public must not receive an effective dose equivalent greater than 100 mrem/year	Dose received by the general public from all sources of radiation exposure and routine activities, including remedial action, at a DOE facility - **TBC**	DOE Order 5400.5
	All releases of radioactive material must be "as low as reasonably achievable" (ALARA)	Releases of radioactive material from DOE activities - **TBC**	DOE Order 5400.5
Location-specific	None		
Action-specific			
Institutional controls	Controls include periodic monitoring, as appropriate; appropriate shielding; physical barriers to prevent access, fences, warning signs, and restrictions on land use	Interim management of residual radioactive material above acceptable guidelines - **TBC**	DOE Order 5400.5(IV)(6)(c)
	Controls recommended for long-term management of contamination left in place include restrictions on land use, deed restrictions, well-drilling prohibitions, etc.	Long-term management of contamination left in place - **TBC**	40 CFR[f] 300.430(e)(3)
	DOE must supply existing sediment data and acquire additional data if needed.	In support of dredging operations - **applicable**	Interagency agreement for Watts Bar Reservoir Permit Coordination.
ALTERNATIVE 3 - CONTAINMENT, REMOVAL AND DISPOSAL			
Chemical- or radionuclide-specific	The general public must not receive an effective dose equivalent greater than 100 mrem/year	Dose received by the general public from all sources of radiation exposure and routine activities, including remedial action, at a DOE facility - **TBC**	DOE Order 5400.5

Table I2 (continued)

Actions	Requirements	Prerequisites	Citation
	All releases of radioactive material must be "as low as reasonably achievable" (ALARA)	Releases of radioactive material from DOE activities - **TBC**	DOE Order 5400.5
	Residual concentrations of radionuclides in soils shall be derived using the basic dose limit of 100 mrem/year, and the DOE RESRAD model with site-specific input paramenters	On-shore placement of residual radioactive materials without restrictions - **TBC**	DOE Order 5400.5(IV)
Location-specific			
Presence of wetlands as defined in Executive Order 11990 §7(c)	Whenever possible, actions involving federal activities and programs affecting land use must avoid or minimize adverse impacts on wetlands and act to preserve and enhance their natural and beneficial values. New construction in wetlands areas should be particularly avoided unless there are no practicable alternatives. Wetlands protection considerations shall be incorporated into planning, regulating, and decision-making processes	Actions taken in wetlands areas - **applicable**	Executive Order 11990; 10 CFR 1022
Presence of wetlands as defined in 40 *CFR* 230.3(t) and 33 *CFR* 328.3(b)	Action to avoid degradation or destruction of wetlands must be taken to the extent possible. Discharges for which there is a practicable alternative with less adverse impacts or those which would cause or contribute to significant degradation are prohibited	Actions taken in federally delineated wetlands areas - **applicable**	Clean Water Act §404 40 *CFR* 230 33 *CFR* 323
Activities in "waters of the U.S." as defined in 40 *CFR* 230.3	Compliance with the general and specific terms and conditions of NWP[g] 13 (*Bank Stabilization*), NWP 18 (*Minor Discharges*), NWP 38 (*Cleanup of Hazardous and Toxic Waste*), or others if authorized by COE[h] for minor adverse environmental effects *	Actions taken in "waters of the U.S." - **applicable**	33 CFR 330, Appendix A
	Notification to COE to ensure compliance with the substantive requirements of the individual permitting process for alterations to "waters of the U.S." which cause more than minimal individual or cumulative adverse environmental effects *	Actions taken in "waters of the U.S." - **applicable**	33 CFR 325.1
Within area encompassing or affecting waters of the state of Tennessee as defined in TCA[i] 69-3-103(32)	Discharge of "substances" into the waters of the state which "will result or will likely result in harm, potential harm or detriment to the health of animals, birds, fish, or aquatic life" is prohibited	Actions taken in "waters of the state" - **applicable**	TCA 69-3-101 *et seq.*
	Compliance with the substantive requirements of general or individual aquatic resource alteration permit process for bank stabilization, channel relocation, wetlands disturbance *	Actions taken in "waters of the state" - **applicable**	TDEC[j] 1200-4-7

Table I2 (continued)

Actions	Requirements	Prerequisites	Citation
Activities along or in waters regulated by the Tennessee Valley Authority (TVA)	TVA approval must be obtained for construction of any . . . obstruction affecting navigation, flood control, or public lands	Actions taken along or in the Tennessee River or any of its tributaries - **applicable**	TVA Act Para. 26(a)
Within "lowland and relatively flat areas adjoining inland and coastal waters and other flood-prone areas....." [Executive Order 11988 §6(c)	Action shall be taken to reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values of floodplains during federal activities involving acquisition, management, and disposition of lands and facilities or conducting any federal activities and programs affecting land use. The potential effects of actions in floodplains shall be evaluated and consideration of flood hazards and floodplain management ensured. If action is taken in floodplains, alternatives that avoid adverse effects and incompatible development and minimize potential harms shall be considered	Actions taken in floodplains - **applicable**	Executive Order 11988; 10 CFR 1022
Presence of endangered or threatened species or critical habitat of such species as designated in 50 CFR 17, 50 CFR 226, or 50 CFR 227	Actions that jeopardize species/habitats must be avoided or appropriate mitigation measures taken. Consultation with Department of Interior and/or state agencies is required for CERCLA off-site activities and recommended for CERCLA on-site activities*	Action that is likely to jeopardize or adversely modify critical habitat - **applicable**	Endangered Species Act (16 USC 1531 *et seq.*); 50 CFR 402; Tennessee Rare Plant Protection and Conservation Act (TCA 11-26-201 *et seq.*)
Location encompassing a state-designated natural area	The scientific, scenic, recreational, and educational values of these areas must be preserved and steps taken to prevent impairment	Actions which are likely to impact or adversely modify designated natural areas - **applicable**	TCA 11-14-101 *et seq.*
Presence of archaeological and historical resources on public land	Consultation with Tennessee State Historic Preservation Officer and Advisory Council on Historic Preservation before the initiation of any ground-breaking activities for CERCLA actions*. Steps must be taken to mitigate adverse effects on such resources.	Action that would affect archaeological or historical resources - **applicable**	National Historic Preservation Act (16 USC 470; 36 CFR 800 *et seq.*)
Presence of cemetery	It is unlawful to intentionally desecrate a place of burial	Actions which would impact a cemetery - **applicable**	TCA 39-17-311
Action-specific			
Institutional controls	Controls include periodic monitoring, as appropriate; appropriate shielding; physical barriers to prevent access, fences, warning signs, and restrictions on land use	Interim management of residual radioactive material above acceptable guidelines - **TBC**	DOE Order 5400.5(IV)(6)(c)
	Controls recommended for long-term management of contamination left in place include restrictions on land use, deed restrictions, well-drilling prohibitions, etc.	Long-term management of contamination left in place above approved limits - **TBC**	40 CFR 300.430(e)(3)

Table I2 (continued)

Actions	Requirements	Prerequisites	Citation
	DOE must supply existing sediment data and acquire additional data if needed	In support of dredging permit applications - **applicable**	Interagency Agreement for Watts Bar Reservoir Permit Coordination
Turbidity controls	Use sediment and erosion controls and best management practices to control run-off from construction activities at an industrial site that result in disturbances of 5 acres or greater total land	Construction activities disturbing 5 acres or greater total land at industrial sites - **applicable; relevant and appropriate for < 5 acres**	40 CFR 122 TDEC 1200-4-10-.05
	Prohibits the presence of turbidity in such amounts or of such character that will materially affect fish and' aquatic life	Containment activities in "waters of the state" - **applicable**	TDEC 1200-4-3-.03(d)
	Requires that all cost effective and reasonable best management practices for nonpoint source control shall be implemented	Containment activities in "waters of the state" - **applicable**	TDEC 1200-4-3-.06
Fugitive dust controls during preconstruction activities (road building, bank stabilization), containment, and sediment treatment	Take reasonable precautions to prevent particulate matter from becoming airborne; no visible emissions are permitted beyond property boundary lines for more than 5 min/hr or 20 min/day.	Fugitive dust emissions - **applicable**	TDEC 1200-3-8-.01
Dredging activities	See "location-specific" ARARs above		
Waste characterization (sediments, dewatering fluids, treatment residues)	A person who generates solid waste must determine whether the waste is hazardous using various methods, including TCLP or application of knowledge of the hazardous characteristics of the waste based on information regarding the materials or processes used.	Generation of solid waste - **applicable**	40 CFR 262.11(b) 40 CFR 268.7 TDEC 1200-1-11-.03(1)(b)
Storage/disposal of dewatering/decontamination fluids	Must meet waste acceptance criteria (WAC) for the receiving facility	Requirement established by the receiving facility for acceptance of LLW designated for discharge from a permitted treatment facility - **TBC**	
	Must meet National Pollutant Discharge Elimination System (NPDES) permit limitations for any discharge via permitted outfalls	Point source discharge to "waters of the state" from a permitted outfall - **applicable**	TDEC 1200-4-10-.03
	Must ensure in-stream water quality criteria for the designated uses are met.	Point source discharge to "waters of the state" - **applicable**	TDEC 1200-4-3 TDEC 1200-4-4
Storage/disposal of sediments or treatment residues	Dispose of solid waste that is RCRA hazardous waste in a RCRA Subtitle C permitted facility if it meets permit requirements	Disposal of RCRA hazardous waste - **applicable**	40 CFR 262.12 TDEC 1200-1-11-.03(1)(c)

Table I2 (continued)

Actions	Requirements	Prerequisites	Citation
	For treatment of wastes subject to the ban on land disposal, attain the Universal Treatment Standards (UTS) if waste is to be land disposed; Best Demonstrated Technology (BDT) or any other technology may be used to atain UTS	Disposal of RCRA restricted waste - **applicable**	40 CFR 268.40 40 CFR 268.48 TDEC 1200-1-11-10
	Dispose of solid waste not classified as RCRA hazardous waste in a RCRA Subtitle D permitted facility if it meets permit requirements; TDEC "special waste approval" may be necessary	Disposal of solid waste - **applicable**	TDEC 1200-1-7-.01 *et seq.*
	Permits the on-site storage of LDR[h]-mixed waste for purposes other than accumulation	On-site storage of LDR mixed wastes - **applicable**	TDEC Commissioner's Order for the ORR Site Treatment Plan, October 2, 1995
	Must meet waste acceptance criteria for LLW[j] disposal facility	On-site disposal of LLW - **TBC**	DOE Order 5820.2A
	Soil containing PCBs at concentrations <50 ppm may be disposed of in a solid waste landfill as approved by the state	Disposal of soils containing PCBs - **applicable**	TDEC 1200-1-7-.08 TDEC 1200-1-7-.03
Storage/treatment of fluids or sediments in tanks	Must meet the minimum technology requirements for tanks	Storage of RCRA hazardous waste in tanks - **applicable**	40 CFR 264.190 *et seq.* TDEC 1200-1-11-.06(10)
	At closure, remove all hazardous waste and hazardous waste residues from tanks, discharge control equipment, and discharge confinement structures and manage as hazardous waste	Clean closure of tanks used to store RCRA hazardous waste - **applicable**	40 CFR 264.197(a) TDEC 1200-1-11-.06(10)
Off-site shipments of LLW or mixed waste	Must meet manifesting, packaging, labeling, marking, placarding, and recordkeeping requirements	Transportation of RCRA hazardous waste - **applicable**	40 CFR 262 40 CFR 263
	The waste must meet packaging, labeling, marking, placarding, manifest and pretransport requirements in accordance with Department of Transportation (DOT) regulations.	Transportation of radioactive materials above exempt quantities - **applicable**	49 *CFR* 172, 173, 175, 178, and 179; DOE Order 5480.3 (TBC)
	Exemption from the TDEC radiation protection regulations for radioactive material in individual quantities which do not exceed the applicable quantity set forth in Schedule RHS 8-3	Handling of radioactive materials above exempt quantities - **applicable**	TDEC 1200-2-10-.04(3)
	Licensing requirements for shipment and delivery	Delivery of licensable quantities of radioactive material to a disposal facility within the state - **applicable**	TDEC 1200-2-10-.32(4)
	Packaging requirements are based on the maximum activity of radioactive material in a package	Packaging of radioactive materials above exempt quantities for public transport - **applicable**	49 *CFR* 173.431; 49 *CFR* 173.433; 49 *CFR* 173.435 49 *CFR* 173.411

Table I2 (continued)

Actions	Requirements	Prerequisites	Citation
	Generators must certify prior to the shipment that the waste meets the waste acceptance criteria of the receiving facility.	Off-site disposal of LLW - TBC	DOE Order 5820.2A(III.3e)
	Requirements for off-site shipment of low-level waste		DOE Order 5820.2A(III.3g)
	DOE low-level waste shall be disposed of on the site at which it is generated, if practicable		DOE Order 5820.2A(III.3)
	Off-site disposal of low-level waste to a commercial facility requires an exemption from the on-site disposal requirements of DOE Order 5820.2A; requests for exemption must be approved by the Field Office		Lytle and Whitfield, 1993
ALTERNATIVE 4 - REMOVAL AND DISPOSAL	All ARARs the same as for Alternative 3		

Note: The remedial action alternatives discussed in the FS do not address remediation of surface water (see Sect. 8.1 of the FS); therefore, TDEC ambient water quality criteria (AWQC) are not included as chemical-specific ARARs on this table. However, surface water ARARs are discussed in Sect. 1.1 of this Appendix. The use by TDEC of fish advisories per TDEC 1200-4-3-.03(j) as institutional controls to give notice to the public of the potential or actual dangers of specific uses of polluted waters will ensure protection of human health in the OU (see Sect. 4.2).

[a]ARARs = applicable or relevant and appropriate requirements.
[b]TBC = to be considered; all entries on table are potential ARARs unless noted as TBC.
[c]OSWER = EPA Office of Solid Waste and Emergency Response.
[d]DOE = U.S. Department of Energy.
[e]RESRAD = residual radioactive materials guidelines.
[f]CFR = Code of Federal Regulations.
[g]NWP = Nationwide Permit.
[h]COE = U.S. Army Corps of Engineers
[i]TCA - Tennessee Code Annotated.
[j]TDEC = Tennessee Department of Environment and Conservation.

* = Although administrative and procedural requirements are not ARARs for on-site CERCLA activities, adherence to these steps ares strongly recommended by EPA because of the effectiveness of these procedures in identifying and protecting sensitive resources.

CERCLA activities must comply with the substantive requirements of any permitting process. USACE Regulatory Guidance Letter 85-7 and its extension adopt this policy for on-site EPA or State response actions at the location of the release or threatened release pursued under the authority of CERCLA.

The USACE has established the ordinary high water mark for impoundments to be the normal summer pool elevation; for Watts Bar Lake, this elevation is El. 741.0 mean sea level (msl). A regional survey by the USACE identified "navigable waters" in the area (Public Notice ORNOR-F86-23, May 8, 1986); Poplar Creek from its mouth to River Mile 18.3 has been designated as navigable water. However, no tributaries to Poplar Creek have received such a designation.

The USACE Nationwide Permit (NWP) program establishes USACE authorization for activities having minimal impact on "waters of the U.S." (33 *CFR* 330, Appendix A). NWP 38 authorizes activities required to effect the containment, stabilization, or removal of hazardous and toxic materials by a government agency with established legal or regulatory authority, provided the USACE District Engineer is notified in accordance with the "Notification" general condition [33 *CFR* 330, Appendix A(C)(13)]. Other NWPs that might apply are NWP 13 (*Bank Stabilization*) and NWP 18 (*Minor Discharges*).

If an activity does not meet all the requirements of a NWP, or involves alterations that cause more than minimal individual or cumulative adverse effects to waters of the United States, consultation with the USACE is recommended to ensure that the substantive requirements of an individual permit are met (33 *CFR* 325.1). Note that as mentioned previously, administrative and procedural requirements are not ARARs for on-site CERCLA activities. However, adherence to the USACE notification process is strongly recommended by EPA because of the effectiveness of the USACE permitting process in identifying and protecting sensitive resources.

I3.2.3 TDEC Authority

The substantive requirements of the TDEC Aquatic Resource Alteration regulations found at Chapter 1200-4-7 may be applicable to preconstruction or construction activities. General permit requirements exist for activities that would cause minimal individual or cumulative impacts to water quality, and include such activities as bank stabilization and debris removal.Consultation with TDEC is necessary to determine the substantive requirements for activities that cannot meet the conditions of the general permits, which include a prohibition of activities in waterways containing contaminated sediments. If any remedial actions at the Clinch River/Poplar Creek OU cannot be accomplished under the substantive general permit conditions, consultation with TDEC is recommended to ensure that TDEC is aware of the portion of the river impacted and the character and scope of the project with sufficient detail to determine probable water quality impacts.

I3.3 ENDANGERED AND THREATENED SPECIES

No federally listed plant species or designated critical habitats for plants or animals have been identified on the ORR. Sect. 2.7.2 of this RI report discusses the results of rare and endangered plant surveys conducted at the ORR, with state-listed plant species identified on Table 2B of the RI. DOE has designated areas on the ORR as DOE-National Environmental Research Park (NERP) Natural Areas (NAs), which have been established to protect rare plant and animal species. One such area, NA-8, the McCoy embayment "barren" has also been registered as a state NA as it contains a state-listed endangered species of plant, the tall larkspur (*Delphinium exaltatum*). Construction activities that would impact this area must be avoided (TCA 11-14-101 *et seq.*).

The possibility exists that there may be other protected species of plants in the area of this OU. Consultation with the Department of Interior or Tennessee Wildlife Resources Agency is recommended to ensure that there are no federal or state protected species that will be impacted by remedial activities. Should any remedial activity in the Clinch River/Poplar Creek OU impact any federal-listed endangered or threatened plant species, the provisions found in the Endangered Species Act of 1973 (16 USC 1531 *et seq.*) and 50 *CFR* 402 may be applicable. State-listed plants may be protected under the Tennessee Rare Plant Protection and Conservation Act (TCA 11-26-201 *et seq.*).

I3.4 ARCHAEOLOGICAL AND HISTORICAL RESOURCES

There have been no known cultural resource surveys of the entire area found in the Clinch River/Poplar Creek OU; however, surveys that encompassed portions of the Clinch River indicate the presence of archaeological and historical resources. Therefore, before the start of any ground-breaking activities, consultation should be initiated with the Tennessee State Historic Preservation Officer and Advisory Council on Historic Preservation, pursuant to §106 of the National Historic Preservation Act (16 USC 470f) and its implementing regulations (36 *CFR* 800). Although such consultation is an administrative requirement, and not required for on-site activities, such consultation will ensure compliance with the substantive requirements of any other applicable cultural resource laws [Archaeological Resources Protection Act (16 USC 470aa-ll), 43 *CFR* 7, Archaeological and Historic Preservation Act (16 USC 469a-c)].

Several cemeteries can be found along Poplar Creek. Building of any access roads or general construction activities must avoid damaging any gravesites pursuant to TCA 39-17-311.

I4. ACTION-SPECIFIC ARARs

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to the management of hazardous waste (53 *FR* 51437). Selection of a particular remedial action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. Remediation alternatives include 1) no action; 2) institutional controls and advisories; 3) containment, removal, and disposal, combined with institutional controls; and 4) removal and disposal combined with institutional controls. Section 10 of the FS report presents a detailed analysis of these alternatives. Table I2 lists specific ARARs for alternatives 1-4. The remedial action alternatives discussed in the FS do not address remediation of contaminated surface water because the primary contributors are continuing releases from upstream sources (see Sect. 8.1 of the FS report). Therefore, although AWQC are applicable for remediation of surface water, they are not listed as ARARs for the remedial alternatives that address contaminated sediments only.

I4.1 NO ACTION RESPONSE

Under this alternative, no action would be implemented and the waste material in the Clinch River/Poplar Creek OU would be left in place without implementation of any containment, removal, treatment, or other mitigating actions.

As confirmed by EPA Guidance (OSWER Directive 9234.2-01/FS-A, June 1991, "ARARs Q's and A's"), there are no ARARs for the no action alternative.

I4.2 USE OF INSTITUTIONAL CONTROLS AND ADVISORIES

Institutional controls could be implemented to limit access and exposure. There are no regulatory requirements specifying institutional controls for CERCLA units. However, the NCP at 40 *CFR* 300.430(e)(3)(ii) suggests consideration of one or more alternatives that involve little or no treatment, but provide protection of human health and the environment through the use of institutional controls. The preamble to the NCP provides examples of institutional controls which include land and water use restrictions, deed restrictions, well-drilling prohibitions, building permits, and well use advisories and deed notices (55 *FR* 3706). In addition, DOE Order 5400.5, Chapter IV, requires administrative (institutional) controls for long-term management in areas containing residual radioactivity above guidance levels. Active controls specified in the Order which may be considered TBC guidance include land restrictions, fences, and warning signs.

Although not an ARAR for the Clinch River/Poplar Creek OU, institutional controls in the form of statutory authority of either TDEC or TVA and the USACE are already in place. An Interagency Agreement (IAG) for Watts Bar Reservoir Permit Coordination has been signed by TDEC, USACE, TVA, and DOE. Under this agreement, a screening list identifies three categories of actions disturbing sediments: no significant sediment disturbance (NSSD); marginal sediment disturbance (MSD); and potential major sediment disturbance (PMSD). The screening list of action categories was amended to include in the NSSD category all proposed projects (other than between CRM 4.3 and White Oak Creek) if the project does not have any sediment disturbance below Elev. 735 msl, and provided the work is accomplished when pool elevation is below the project site (Amendment 1, IAG Watt's Bar Reservoir Permit Coordination, January 28, 1992). For permit applications for activities that fall within the MSD

or PMSD categories, DOE must supply existing sediment data and acquire additional sediment data if needed [IAG, Sect. IV(C)].

Under the Tennessee Water Quality Control Act, § 69-3-107(15), authority is granted the Commission to "inspect waters of the state where good cause is shown that the public health is threatened by pollutants therein, and, upon verification by the commissioner, post or cause to be posted such signs as required to give notice to the public of the potential or actual dangers of specific uses of such waters or restrictions of uses thereof." To that end, posting of advisories is not an ARAR or TBC for DOE compliance following remediation of the Clinch River/Poplar Creek OU; however, it implements the institutional controls suggested for alternatives 2, 3, and 4; i.e., posting of warning signs by the TDEC.

The TDEC Division of Water Pollution Control revised Chap. 1200-4-3 of the TDEC Water Quality Standards (effective date July 1995) modifying and promulgating procedures for issuing fish advisories. The revision creates a new subparagraph regarding fish consumption advisories [TDEC 1200-4-3-.03(j)]. Such advisories would be warranted if the calculated risk of additional cancer risk exceeds 10^{-4} for typical consumers and 10^{-5} for atypical consumers. The revised rule includes a methodology for calculating risk. Notices are posted for "Do not consume advisories" and "Precautionary advisories."

I4.3 CONTAINMENT, REMOVAL, AND DISPOSAL

This alternative is proposed for contaminated sediments in the Clinch River, Poplar Creek, and upper and lower McCoy Branch. Source containment options include capping near-shore or on-shore contaminated sediments combined with institutional controls (see Sect. 4.2). Containment and removal activities will be combined with turbid water technologies to decrease the release of sediments into the streams. Removal is considered for deeper areas to reduce or eliminate ecological risk. All removal activities are combined with stream-side dewatering, treatment if necessary, and on-site disposal. Several action-specific ARARs may be triggered by these activities depending on the characterization of dredged sediments (i.e., whether they contain RCRA hazardous waste and/or LLW). Activities in wetlands and floodplains should be designed to minimize impacts and restore and preserve natural and beneficial uses (see Sect. 3.0 of this Appendix for location-specific ARARs).

I4.3.1 Turbidity Controls

Storm water discharges from activities at industrial sites involving construction operations that result in the disturbance of five acres or more total land have been included in the final rule for National Pollutant Discharge Elimination System (NPDES) permits for storm water discharges (40 *CFR* 122) and incorporated into the TDEC permitting regulations. Consultation with TDEC is required to ensure compliance with the substantive requirements of the NPDES permitting process for storm water discharges during construction activities (TDEC 1200-4-10-.05). These requirements are listed in Table I2 and would be applicable to remedial activities impacting five acres or more, and relevant and appropriate for those affecting less than five acres.

The Tennessee Antidegradation Statement (TDEC 1200-4-3-.06) requires that all cost effective and reasonable best management practices for nonpoint source control shall be implemented; this would

be applicable for turbidity control of sediments released during construction of containment areas. In addition, the TDEC narrative WQC for protection of aquatic life prohibits the presence of turbidity in such amounts or of such character that will materially affect fish and aquatic life [TDEC 1200-4-3-.03(d)].

I4.3.2 Fugitive Dust Control

Preconstruction activities such as building of access roads or equipment movement, as well as dredging activities, may result in airborne pollutants. The primary concern is elevation of particulate concentrations. The TDEC Division of Air Pollution Control has promulgated regulations governing fugitive dust emissions (TDEC 1200-3-8-.01). These are listed in Table I2, and are applicable to remedial activities at the OU.

I4.3.3 Dredging Activities

Dredging activities may be regulated by TVA, the USACE, or TDEC; the potentially applicable requirements are discussed in Sect. 3.2 as location-specific ARARs and listed in Table I2.

I4.3.4 Use of Shoreline Facility for Treatment and/or Packaging

Dredged slurries may be pumped to a shoreline facility for dewatering and sediment containerization. It is assumed that the slurries will contain low level radioactivity. Decontamination procedures will be implemented for all equipment and personnel. A waste analysis must be performed to determine whether the sediment and dewatering/decontamination fluids also contain RCRA hazardous waste [40 *CFR* 262.11(b); 40 *CFR* 264.13; 40 *CFR* 268.7], therefore becoming classified as mixed waste. If dewatering/decontamination fluids contain mixed waste, they must be transported to the ORR and treated or stored per the TDEC Commissioner's Order for the ORR Site treatment Plan (October 2, 1995). Dewatering fluids that do not contain RCRA waste will be trucked to the ORR for treatment of LLW at a permitted wastewater treatment facility. Any such fluids must meet the waste acceptance criteria (WAC) of the receiving facility to ensure compliance with the NPDES permit limits established for the treatment facility. There are no further ARARs for this scenario.

Dewatering/decontamination fluids that are tested and determined to contain no chemical or radionuclide contaminants may be discharged directly back into the water body if such discharge can be fully protective of the existing use classification of the surface water body (TDEC 1200-4-3; 1200-4-4).

On-site treatment of dried sediments will be implemented, if necessary to meet the RCRA land disposal restrictions (LDR). Any tanks used to treat RCRA hazardous waste must be managed and closed under 40 *CFR* 264.190 *et seq.*

I4.3.5 On-site Disposal of Dredged Materials

A waste analysis must be performed to determine whether dredged materials contain RCRA hazardous waste [40 *CFR* 262.11(b); 40 *CFR* 264.13; 40 *CFR* 268.7]. Transport of dredged materials to the ORR for storage or disposal may be regulated by the RCRA transportation (40 *CFR* 262 and 40 *CFR* 263) and LDR requirements (40 *CFR* 268) if the contaminated sediment contains RCRA-

characteristic waste as well as LLW. In addition, the U.S. Department of Transportation (DOT) Regulations for Transportation of Hazardous Materials and TDEC Radiation Protection Standards may apply to transportation of sediments containing radioactive materials above certain limits.

DOE is exempt from the licensing requirements of the TDEC Radiation Protection Standards for activities occurring within plant boundaries [TDEC 1200-2-10-.06(1)]. However, the TDEC requirements for packaging and transportation of radionuclide-containing materials above exempt quantities [as listed in Schedule RHS 8-3, TDEC 1200-2-10-.04(3)] will be applicable for transport of any sediments containing radioactivity from the Clinch River/Poplar Creek OU to the ORR for treatment or disposal [TDEC 1200-2-10-.30 *et seq.*]; compliance with the DOT regulations is made by reference.

The DOT regulations list general requirements for shipping and packaging at 49 *CFR* 172 and 173, and requirements for carriage by public highway at 49 *CFR* 177. Specific loading and unloading requirements for transportation of radioactive materials by public highway are in 49 *CFR* 177.842. DOE Order 5480.3, "Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes," also specifies packaging requirements.

Containerized sediments will be stored at either a permitted LLW facility at the ORR, or a mixed waste storage facility allowed under the TDEC Commissioner's Order for the ORR Site Treatment Plan (October 2, 1995).

I4.3.6 Off-site Disposal of Dredged Materials

In accordance with DOE Order 5820.2A, LLW is to be disposed of on the site where it is generated, if possible, or if off-site disposal is necessary due to lack of on-site capacity, disposal must be at another DOE facility. Mixed wastes are also to be disposed of at a DOE site. The RCRA, DOT, and TDEC Radiation Protection Standards may be triggered, as discussed in Sect. 4.3.5, depending on waste characterization.

On October 12, 1993, DOE provided an exemption to the on-site storage requirements of DOE Order 5820.2A for low-level and mixed waste, with certain conditions applied (Lytle and Whitfield 1993 memorandum, signed by T. P Grumbly). The specific exemption for mixed waste is limited to small quantities of such waste, determined on a case-by-case basis. Requests for exemption may be approved by the manager of the DOE-ORO field office. Wastes generated during remedial action activities may qualify for this exemption. DOE and Energy Systems procedures require preparation of documentation under NEPA, as well as CERCLA or RCRA, if applicable. Appropriate procurement or contracting documents must be prepared, and all permits, licenses, approvals, and regulatory history of any proposed disposal facility reviewed prior to execution of the contract. Any wastes that are restricted from land disposal must be treated to meet the applicable LDR before disposal. Prior to each shipment, EM-33 shall be notified of the waste type, total volume, and destination of the waste. The regulatory status of the facility must be confirmed prior to shipment, and a periodic review and/or audits must be performed on the facility. As previously mentioned, DOE Order 5820.2A allows off-site shipments of LLW to DOE facilities. There are avenues available for shipment of LLW from the ORR to off-site commercial facilities, but compliance with applicable DOE orders and Energy Systems procedures must be strictly adhered to, including Operational Readiness Review by Central WM Division.

I4.4 REMOVAL AND DISPOSAL

This alternative is proposed for Poplar Creek and McCoy Branch. It involves dredging of both shallow and deep contaminated sediments, shoreline dewatering and packaging of dredged materials, and storage or disposal of wastes either on-site at the ORR or off-site. Implementation of institutional controls in the form of TDEC fish advisories will also be used. All of the ARARs discussed in Sect 4.3 are potentially triggered for this activity.

REFERENCES

Lytle, J. E. and Whitfield, R. P. 1993. Commercial Disposal of Department of Energy Radioactive (By-Product and Low-level) and Mixed Waste. U.S. Department of Energy Memorandum, dated October 12, 1993.

Yu, C., A. J. Zielen, J. J. Cheng, Y. C. Yuan, L. G. Jones *et al.* 1993. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0*, (ANL/ESD/LD-2), September.

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Remedial Investigation/Feasibility Study of the Clinch River/Poplar Creek Operable Unit

Volume 5. Appendixes J, K, L, M, and N—Other Supporting Information

Other than inclusion of an updated executive summary, no changes have been requested or made to this volume from the D2 issue of this document.

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Energy Systems Environmental Restoration Program

Remedial Investigation/Feasibility Study of the Clinch River/Poplar Creek Operable Unit

Volume 5. Appendixes J, K, L, M, and N—Other Supporting Information

Date Issued—June 1996

Prepared by
Environmental Sciences Division
Oak Ridge National Laboratory

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U.S. Department of Energy
Office of Environmental Management
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Environmental Management Activities at the
OAK RIDGE Y-12 PLANT
Oak Ridge, Tennessee 37831-8169
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
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under contract DE-AC05-84OR21400

PREFACE

This Remedial Investigation/Feasibility Study Report of the Clinch River/Poplar Creek Operable Unit on the Oak Ridge Reservation (DOE/OR/01-1393/V1–V5&D3) was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act for reporting results of a site characterization for public review. This work was performed under Work Breakdown Structure 1.4.12.3.1.02.41 (Activity Data Sheet 9302, "Clinch River/Poplar Creek Operable Unit"). This document provides the Environmental Restoration Program with information about the Phase 1 and Phase 2 investigations (1988–1995) performed at the operable unit. It includes information on risk assessments that have evaluated impacts to human health and the environment, and it contains information about the development of the feasibility study. Information provided in the document forms the basis for the Record of Decision in the Clinch River/Poplar Creek Operable Unit.

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EXECUTIVE SUMMARY

This report presents the findings of an investigation into contamination of the Clinch River and Poplar Creek near the U.S. Department of Energy's (DOE's) Oak Ridge Reservation (ORR) in eastern Tennessee. For more than 50 years, various hazardous and radioactive substances have been released to the environment as a result of operations and waste management activities at the ORR. In 1989, the ORR was placed on the National Priorities List (NPL), established and maintained under the federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Under CERCLA, NPL sites must be investigated to determine the nature and extent of contamination at the site, assess the risk to human health and the environment posed by the site, and, if necessary, identify feasible remedial alternatives that could be used to clean the site and reduce risk. To facilitate the overall environmental restoration effort at the ORR, CERCLA activities are being implemented individually as distinct operable units (OUs). This document is the combined Remedial Investigation and Feasibility Study Report for the Clinch River/Poplar Creek OU.

This report is organized into five volumes, the first of which presents the main text. Chapter 1 describes the regulatory setting, and Chapter 2 broadly portrays the environmental setting. Chapter 3 depicts the operational and release history of the site and characterizes in detail the nature and extent of contamination. Chapter 4 briefly identifies other regulatory requirements that are applicable or appropriate to the site. Chapters 5 and 6 assess the risk to human health and the environment, respectively. Chapter 7 explains the purpose and organization of the feasibility study. Chapter 8 defines remedial action objectives for the site; identifies pathways and contaminants of concern; and screens general response actions, potential remedial technologies, and process options. Chapter 9 develops remedial alternatives based on the remedial action objectives, the screened technologies, and representative process options. Chapter 10 analyzes, evaluates, and compares the remedial alternatives. Chapter 11 lists the references cited in the main text.

Volumes 2–5 consist of appendices that contain supporting data and information. Volume 2 characterizes the biota on the ORR (Appendix A) and summarizes data related to contaminant concentrations in water (Appendix B), in sediment (Appendix C), and in biota (Appendix D). Volume 3 presents information related to the human health risk assessment (Appendix E) and the ecological risk assessments (Appendix F). Volume 4 focuses on the feasibility study, detailing the selection of remedial process options (Appendix G) and providing the basis for the cost estimates for each remedial alternative (Appendix H). Volume 4 (Appendix I) additionally presents the applicable or relevant and appropriate requirements (ARARs), which help define the extent of the remedial response. Volume 5 is a compilation of data from individual studies that were conducted as part of the overall remedial investigation. As such, the volume addresses the quality assurance objectives for measuring the data (Appendix J) and presents selected historical data (Appendix K), data from several discrete water characterization studies (Appendix L), data supporting the sediment characterization (Appendix M), and data related to several biota characterization studies (Appendix N).

BACKGROUND

The ORR is a 34,600-acre tract of land in Anderson and Roane counties, Tennessee. It is administered by DOE, and it houses three main facilities: the Oak Ridge Y-12 Plant, the K-25 Site (formerly known as the Oak Ridge Gaseous Diffusion Plant), and Oak Ridge National Laboratory (ORNL). Each facility was created in the early 1940s as part of the U.S. government's war effort. The K-25 Site was used for the large-scale production of enriched uranium until its shutdown in 1985. The Y-12 Plant had several missions, but it primarily manufactured nuclear weapons components; production there ended in 1992. ORNL was initially a pilot-scale plant for the production of plutonium, but its post-war mission has centered on nuclear reactor research and the production of radionuclides for use in medicine and science. In addition to these operations, each plant has housed large support operations, including maintenance shops; waste treatment, storage, and disposal areas; steam plants; storm and sewer drains; and infrastructure.

The Clinch River/Poplar Creek OU is located adjacent to the ORR and consists of the Clinch River and several tributary embayments in Melton Hill and Watts Bar reservoirs. Both reservoirs are large multipurpose impoundments created and maintained by the Tennessee Valley Authority. The OU extends from the upstream boundary of the ORR at Clinch River mile (CRM) 49 in Melton Hill Reservoir, downstream to the mouth of the Clinch River in Watts Bar Reservoir at Kingston. It also includes several embayments that extend up tributary streams, including the McCoy Branch embayment of Melton Hill Reservoir and the Poplar Creek embayment [up to Poplar Creek mile (PCM) 5.5] of Watts Bar Reservoir. Originally, the OU included all of Watts Bar Reservoir downstream of the confluence of the Clinch and Tennessee rivers, but this area was segregated into a new OU (the lower Watts Bar Reservoir OU) in 1994, and a CERCLA Record of Decision was reached in 1995. No action-based remedial alternatives were implemented in lower Watts Bar Reservoir. The OU is currently being monitored to ensure that exposure to contaminants remains low.

REMEDIAL INVESTIGATION

The remedial investigation had two primary objectives: (1) to characterize the nature and extent of contamination, and (2) to assess the baseline risk to human health and the environment. Under CERCLA, if site risks are too high, remedial action is generally warranted. This investigation was implemented in a phased approach. First, existing environmental data were used to develop a preliminary site model, which considered the known or suspected contaminant sources, the physical characteristics of the site, and the environmental fate of various contaminants. An initial round (Phase 1) of limited sampling of water, sediment, and fish was then conducted (in 1989) to confirm these historical data and to refine the site model. A much more extensive sampling effort (Phase 2) was conducted in 1994 to more definitively meet the objectives.

Nature and Extent of Contamination

Several contaminant sources were included in the site model. The waters of Poplar Creek were known to receive effluent from the Y-12 Plant (and the City of Oak Ridge) via East Fork Poplar Creek (EFPC), which enters the Poplar Creek at PCM 5.5. Large quantities of elemental mercury were released from the Y-12 Plant in the late 1950s, and small quantities currently continue to escape from contaminated buildings, equipment, and soils. Increased levels of mercury, therefore, were predicted in water, sediment, and biota of Poplar Creek downstream of EFPC. (Contamination at the Y-12 Plant and contamination in the EFPC floodplain have been addressed separately in efforts at

other ORR OUs). Other contaminants known to have been released from the Y-12 Plant include uranium, polychlorinated biphenyls (PCBs), and several metals. Poplar Creek also has historically received a variety of effluents from the K-25 Site, through which the creek flows. Numerous metals, uranium, PCBs, laboratory chemicals, and organic solvents are thought to have been released from the site. In addition, the downstream reaches of Poplar Creek formerly received coal ash from the K-770 steam plant at the K-25 Site, and sediment at this location was expected to contain elevated levels of several metals, particularly arsenic.

The contaminants of potential concern in the Clinch River below Melton Hill Dam are primarily man-made radionuclides, by-products of nuclear fission. Contaminants were released to the Clinch River via White Oak Creek, which enters at CRM 20.8. Studies in the 1960s demonstrated that water-soluble radionuclides were rapidly and greatly diluted upon entering the Clinch River and were quickly transported downstream, with little loss of contaminant mass (i.e., they remained in solution). However, those contaminants that adsorbed to particulate matter became bound to particles of suspended sediment and accumulated in areas of sediment deposition. Earlier studies indicated that the principal radionuclide of potential concern in Clinch River sediment at the beginning of this investigation was ^{137}Cs, which is strongly particle-associated and has a relatively long (30-year) half-life. Because peak releases of ^{137}Cs from ORNL occurred at the same time as peak releases of mercury from the Y-12 Plant, peak concentrations of each were known to co-occur in the lower Clinch River, buried under several inches of cleaner sediment. Although one would have expected sediment in the Clinch River below White Oak Creek to contain the highest levels of ^{137}Cs and other radionuclides, there was actually very little sediment in this portion of the river, most having been scoured and transported downstream by the periodic high-volume releases of water from Melton Hill Dam, located approximately 2 miles upstream.

Current contaminant releases from ORNL are much lower than those of the 1950s and 1960s and are largely due to leaching or runoff from waste disposal areas. Most of these areas are no longer in use and are themselves the focus of environmental restoration efforts at ORNL.

Fly ash from the Y-12 steam plant was formerly disposed of in a settling pond located near the headwaters of McCoy Branch on Chestnut Ridge. As a result, several contaminants associated with coal ash, particularly arsenic, were known to be present at elevated levels in surface water and sediment in the McCoy Branch embayment of Melton Hill Reservoir. Because the embayment is bisected by a road built on fill material, conditions were expected to be worse in the upper embayment, whose water had limited mixing (via a culvert) with waters of the lower embayment and the main reservoir.

In addition to these ORR-specific concerns, it was known that fish collected on and near the reservation contained more PCBs than fish found at most upstream reference areas. PCBs had been used at each of the three facilities. The ORR as a whole has likely been a source of PCBs to the environment. However, PCBs have been widely used in transformers and in industrial operations, and numerous potential sources exist throughout eastern Tennessee. The identification of sources is difficult because PCBs bioaccumulate in fish and other organisms to much greater levels than in water or sediment, where they are largely undetected. The extent to which the ORR had contributed to the problem was unclear.

The knowledge of these site conditions was used to guide the remedial investigation. Much of the sampling focused on Poplar Creek, where the combination of multiple sources and site conditions (e.g., areas of significant sedimentation, less water volume than in the Clinch River) were expected

to result in some of the highest levels of contamination. Sampling in the Clinch River focused on fish and sediment, media in which contaminants tend to accumulate. Sediment sampling was limited in the Clinch River between Melton Hill Dam and Poplar Creek because sediment was scarce there.

The results of the site characterization phase of the remedial investigation were consistent with the site model. The nature and extent of contamination were evaluated by identifying those study reaches in which levels of any contaminant in water, sediment, or biota were elevated in comparison with levels in upstream reference reaches. The nature and extent of contamination are described as follows.

- **Arsenic in surface water and sediment of upper McCoy Branch Embayment.** Average concentrations of arsenic (4.1 μg/L) in surface water exceeded the state of Tennessee's recreation-based Ambient Water Quality Criterion. This criterion is designed to protect persons who regularly consume fish taken from a particular body of water. In sediment, elevated levels of arsenic, vanadium, and boron were found throughout McCoy Branch Embayment, but concentrations were highest in the upper embayment.

- **Radionuclide levels in water, sediment, and biota of the Clinch River downstream of White Oak Creek.** Average gross alpha and gross beta levels and mean activities of ^{90}Sr and ^{3}H in surface water were a factor of ten higher than reference values. These data were extremely variable, probably as a result of the extreme variability in flow below Melton Hill Dam. A conservative evaluation of the radionuclide concentrations indicated that, even immediately below White Oak Creek, the state's Ambient Water Quality Criterion for protection of domestic supplies was not exceeded.

  Levels of ^{137}Cs were elevated in Clinch River sediment below the mouth of White Oak Creek. This radionuclide has a strong affinity for particles, particularly the clay minerals that make up a significant portion of Clinch River sediment. However, the discharge of water from Melton Hill Dam resulted in the scouring of most of the sediment from this portion of the river, creating larger inventories of ^{137}Cs in the lower Clinch River, where sedimentation is greater.

  Bluegill sunfish and largemouth bass collected in 1989 from the Clinch River near the mouth of White Oak Creek contained ^{137}Cs at levels 100 times that of fish from upstream reference areas. Catfish were found to have levels approximately ten times that of reference areas. Although elevated, these levels were not thought to pose a significant risk to persons or wildlife consuming these fish, and thus radionuclide analysis was discontinued after the initial round of sampling. However, the species-specific baseline human health risk assessment has identified ^{137}Cs as a contaminant of concern in largemouth bass. Additional bass and sunfish will be collected to determine whether concentrations have dropped since the Phase 1 data were collected.

- **Mercury in surface water, sediment, and biota of Poplar Creek downstream of East Fork Poplar Creek.** Average mercury concentrations in surface water, sediment, and biota were significantly elevated in Poplar Creek downstream of EFPC in comparison with average values upstream of EFPC. Elevated concentrations (up to 0.19 μg/L) measured in Poplar Creek surface water below EFPC and in the Clinch River downstream of Poplar Creek exceed the state's Criterion Continuous Concentration (CCC) (0.012 μg/L). This criterion is designed to protect aquatic life from chronic exposure to mercury. Although also elevated above reference values, mean mercury levels in fish did not exceed the Federal Drug Administration's action level (1.0 mg/kg) in any species sampled. Several individual largemouth bass, however, had mercury

levels that exceeded this value. Increased body burdens of mercury were also found in benthic organisms living in Poplar Creek, in heron eggs and chicks from a rookery near Poplar Creek, and in laboratory mink fed a diet high in fish from Poplar Creek. A decreasing gradient of biological effects, as measured by a suite of physiological and physical indices, was found to extend from upper Poplar Creek downstream through the Clinch River. This gradient in effects can be roughly correlated with a decreasing gradient in fish body burdens of mercury and PCBs in the downstream direction.

- **Metals and radionuclides in the sediment of Poplar Creek.** In addition to mercury, contaminants in Poplar Creek sediment that were elevated above reference levels were silver, arsenic, boron, cadmium, copper, chromium, nickel, vanadium, ^{238}U, ^{235}U, ^{234}U, ^{99}Tc, ^{137}Cs, and ^{60}Co. PCBs (Aroclor 1254), rarely detected in sediment anywhere in the system, were detected in Poplar Creek. As with mercury, concentrations of copper, cadmium, and chromium increased immediately below EFPC and likely represented releases from the Y-12 Plant. Concentrations of silver, nickel, ^{99}Tc, and the uranium isotopes were elevated below K-25 discharge points, and copper and chromium concentrations in this area were substantially increased above the already elevated levels found below EFPC. Increased levels of arsenic, vanadium, and boron were found in lower Poplar Creek and were associated with an area where the disposal of coal ash from the K-770 steam plant historically took place. The increased levels of ^{137}Cs and ^{60}Co were restricted to the last mile of Poplar Creek and are thought to be caused by backflow from the Clinch River, which regularly takes place as a result of reservoir operations.

- **PCBs in fish of Poplar Creek and the Clinch River.** Mean PCB levels in largemouth bass were highest in Poplar Creek. Although no bass were available from the reference reach of Poplar Creek, concentrations were still greater than at most other study and reference sites.

  Mean concentrations of PCBs in catfish were highest in Phase 1 samples collected from the White Oak Creek Embayment (now part of a separate OU) and in fish from the Clinch River immediately downstream. Levels were significantly increased over those in Melton Hill and Norris Reservoir catfish. Mean concentrations in catfish from Poplar Creek below the confluence with EFPC were greater than those in catfish from above the confluence. Mean total PCB concentrations in largemouth bass did not exceed the FDA action level (2.0 mg/kg) at any location. The mean concentration in catfish did not exceed this action level at any location (except at the White Oak Creek Embayment). However, individual fish from the Clinch River and Poplar Creek had concentrations that exceeded this level.

  The PCBs detected in fish flesh were almost exclusively Aroclor 1254 and Aroclor 1260. An analysis of individual PCB congeners in catfish did not reveal any patterns that could explain additional sources of PCB contamination.

Risk Assessment

The data used to characterize the nature and extent of contamination were also used to meet the second objective of the remedial investigation, risk assessment. The baseline risk assessment contained in this report consists of a human health risk assessment and an ecological risk assessment.

Risk to human health was evaluated for seven exposure scenarios, each of which contained one or more pathways through which exposure actually occurs. The seven scenarios were (1) the use of

surface water as an untreated drinking water source, (2) the consumption of fish, (3) the use of the reservoir shoreline during winter drawdown, (4) swimming, (5) the hunting and consumption of waterfowl that frequent the ORR, (6) the dredging and subsequent land disposal of sediment, and (7) the use of surface water for irrigation. In each scenario, risk from carcinogens was assessed by assuming a 30-year exposure duration, and risk from noncarcinogens was assessed by assuming a 6-year exposure period. Under CERCLA, media whose pathways result in either a cumulative excess cancer risk of 1.0E−04 or a Hazard Quotient of 1.0 (a measure of noncarcinogenic exposure) generally warrant remedial action at the site.

The human health risk assessment evaluated the risk from each contaminant for which sufficient data existed to obtain a representative concentration. Therefore, the human health risk assessment identified certain analytes whose presence did not appear to be the result of the ORR operations. Because these contaminants might have contributed significantly to overall risk, they generally were included in the risk assessment.

Thirty-five potential contaminants of concern were identified in Clinch River and Poplar Creek water, sediment, and fish. The majority of contaminants were found in deep sediment, and the greatest risks were identified through the agricultural pathways. Of the contaminants identified, only 2 in water, 7 in fish, and 19 in sediment were clearly site-related.

Eight contaminants of concern, all noncarcinogens, were identified in surface water in the OU. Five were identified in the drinking water scenario; the non-site-related analyte manganese drove the risk in all reaches except in upper McCoy Branch, where arsenic contributed most of the risk. Seven contaminants of concern were identified in the irrigation scenario, and two were identified in the swimming scenario (Poplar Creek only). The two contaminants identified in the swimming scenario (Di-n-octylphthalate and Aroclor 1254, also identified in the irrigation scenario) were detected infrequently and therefore might not be contaminants of concern. In general, the number of contaminants of concern in each scenario was greatest in Poplar Creek and least in McCoy Branch.

Seven contaminants of concern were identified in the shoreline-use scenario, which was based on contaminant concentrations in near-shore sediment only. Melton Hill Reservoir is managed in such a way that no prolonged drawdown occurs; therefore, assessment of this scenario was not conducted for the area. Noncarcinogenic risk was common throughout near-shore areas along both the Clinch River and Poplar Creek, and it was driven almost exclusively by manganese via inhalation of resuspended sediment. A significant (<1.0E−04) excess cancer risk existed in one subreach of Poplar Creek, primarily because of chromium exposure via the inhalation pathway.

Eleven contaminants of concern were found in fish. Most of the contaminants were organic compounds (PCBs and pesticide residues) and were found in catfish and largemouth bass from both the Clinch River and Poplar Creek. The excess cancer risk from the consumption of catfish exceeded 1.0E−03 in all study reaches, primarily as a result of Aroclor 1260. The excess cancer risk from the ingestion of largemouth bass was generally equal to or less than one half of that from the ingestion of catfish. Arsenic and Aroclor 1260 were the primary contributors to carcinogenic risk from the ingestion of largemouth bass. Several radionuclides were also identified as carcinogenic contaminants of concern, but they generally contributed only a small portion of the total risk. The exception was ^{137}Cs, which contributed a significant portion of the risk associated with the ingestion of largemouth bass from the Clinch River immediately below the mouth of White Oak Creek. Contaminants of concern that were important noncarcinogens included mercury, Aroclor 1254, and chlordane in one or more species in Poplar Creek and the Clinch River.

In the dredging scenario, 31 contaminants of concern were identified in sediment. This scenario assessed the risk from contaminant exposure that would occur if dredge spoil were placed on land where it was accessible to humans. Several direct exposure pathways were evaluated, as were several agricultural scenarios in which contaminant concentrations in produce, milk, and beef were modeled from sediment contaminant concentrations.

Of the direct pathways, external exposure to gamma-emitting radionuclides in spoil from throughout most of the Clinch River (including Melton Hill Reservoir) and at the mouth of Poplar Creek would result in an excess cancer risk greater than 1.0E-04. At all locations downstream of White Oak Creek, the primary contributor to risk via external exposure was ^{137}Cs. In Melton Hill Reservoir, the risk was primarily due to ^{60}Co from a non-DOE source (now closed) on Braden Branch. In all reaches for which data were available, manganese in spoil posed the greatest risk to adults and children via the inhalation of resuspended sediment. Barium similarly posed ubiquitous risk but generally only to children. In addition to this noncarcinogenic risk, the inhalation of resuspended spoil from lower Poplar Creek would result in an excess cancer risk of 2.1E-04, primarily due to arsenic and chromium. Finally, the incidental ingestion of arsenic and mercury in spoil from lower Poplar Creek would be potentially harmful to children.

In the three agricultural pathways evaluated under the dredging scenario, the milk and meat ingestion pathways showed the most carcinogenic potential. Evaluation of the majority of the reaches for which data were available indicated that the ingestion of milk and beef produced with vegetation grown on dredge spoil would result in an excess cancer risk greater than 1.0E-04 and that many reaches had risk values an order of magnitude greater. The contaminants responsible for the majority of this risk were members of a class of ubiquitous contaminants known as polycyclic aromatic hydrocarbons. In particular, benzo(a)pyrene and dibenz(a,h)anthracene drove this risk. In addition, in those reaches where it was detected, Aroclor 1260 contributed significantly to the risk. By contrast, the excess cancer risk in vegetables was generally lower, exceeding the 1.0 E-04 threshold in only two locations; in these locations the risk was driven by different analytes than in the other two pathways. In Poplar Creek adjacent to the K-25 Site, ^{99}Tc was the primary contributor to risk, although nine other analytes at this location were also of concern. At one location in the Clinch River, the organic analyte N-nitroso-di-n-propylamine was identified as a contaminant of concern but was detected in only one of three samples from that reach.

Evaluation of every subreach for which there were data indicated that one or more of the agricultural pathways posed an unacceptable risk under the dredging scenario. Fourteen noncarcinogenic contaminants of concern were identified. Risk in the milk and meat pathways was frequently driven by mercury and Aroclor 1254. Risk in the vegetable ingestion pathway was frequently driven by manganese, except in the Poplar Creek subreaches, where mercury was the concern.

The ecological baseline risk assessment estimated the ecological risk due to contaminants in the Clinch River/Poplar Creek OU. Seven assessment endpoints were evaluated during the assessment: (1) reduced species richness or abundance or the increased frequency of gross pathologies in fish; (2) reduced species richness or abundance of benthic macroinvertebrate communities; (3) reduced abundance or production of piscivorous wildlife populations; (4) reduced abundance or production of flying insectivorous wildlife populations; (5) reduced production in terrestrial plant communities; (6) reduced abundance or production of terrestrial wildlife populations; and (7) reduced viability of any individuals of a threatened or endangered species. For each endpoint, the reduction in the parameter was required to be 20% or more and to be the result of toxicity.

Three lines of evidence were used in the ecological risk assessment. First, the site and media-specific contaminant data used in the site characterization were evaluated against a series of benchmark values (e.g., the no-observed-effects level) to determine whether concentrations were great enough to cause adverse effects. Second, site-specific toxicity data were used to determine whether these levels were actually causing a toxic effect at a particular site. Finally, site-specific biological survey data (species richness and abundance) were used to help assess whether any toxicity was actually having an impact at the population or community level. When all lines of evidence were not available for each of the endpoints, risk assessment was usually based on contaminant data alone. The assessment for the fish endpoint used data on fish pathologies and fecundity as a fourth line of evidence.

The fish community in Poplar Creek was found to be at significant risk from episodically high concentrations of several metals (copper, mercury, nickel, and silver). Toxicity to fish was assessed by using several test protocols and organisms. Poplar Creek water was toxic to Japanese medaka and redbreast sunfish embryos, but not to fathead minnows or *Ceriodaphnia*. The fish community of Poplar Creek exhibited decreased species richness and abundance in comparison with a reference site with similar habitat (Bull Run Creek embayment of Melton Hill Reservoir). The results of the ecological risk assessment for fish indicated that, while individual fish were probably suffering some physiological impacts immediately below WOC, the fish community was not being significantly impacted in the Clinch River. In McCoy Branch, adverse impacts could not be ruled out, but data were unavailable for some of the lines of evidence (data on fish community, pathology, and fecundity).

The benthic macroinvertebrate community of Poplar Creek was identified as being at significant risk from several metals (arsenic, mercury, nickel, and silver) and PCBs in surface sediment. The benthic community contained fewer species and had less abundance of organisms than the communities at other sites. The toxicity data did not reveal consistently toxic effects, but in at least one test from each site a toxic response was observed in test organisms of at least one species. The benthic communities of the Clinch River and the McCoy Branch embayment were found not to be significantly impacted by contaminants.

Risks to piscivorous wildlife were assessed by using two avian species (great blue heron and osprey) and two mammalian species (mink and river otter). Two lines of evidence, biomonitoring data and contaminant data in whole fish, were available for assessing risk to heron and osprey. Partly because of their wide foraging behavior, osprey were found to be not at risk from contaminants even though mercury levels in Poplar Creek fish exceeded benchmark values. Although the data indicated that individual heron feeding exclusively in certain portions of Poplar Creek might be at risk, the local populations of the avian species were not expected to be impacted. This conclusion was supported by surveys of the reproductive success of osprey and great blue heron in Poplar Creek: the surveys found high reproduction and no increase in deformities. Mink were not identified as being at risk from contaminants in either Poplar Creek or the Clinch River. However, individual river otter feeding in Poplar Creek near the mouth of EFPC would be expected to have a significant risk of impaired reproduction. Although river otter do not currently exist within the OU, they have recently been reintroduced into east Tennessee, and the natural expansion of their range is expected to lead to their re-establishment on the ORR. Because the otter is a state threatened species, impacts to individual otter would be considered significant.

The risk to insectivorous wildlife was assessed by using one avian species, the rough-winged swallow, and two mammalian species, the gray and little brown bats. In each case, only one line of

evidence (contaminant concentrations in benthic insects) was available for the assessment. These data indicate that a colony of rough-winged swallows feeding in Poplar Creek near the mouth of EFPC could suffer impaired reproductive potential as a result of mercury exposure, but the magnitude of the effects could not be evaluated. Populations of neither species of bat were found to be at risk. Although mercury concentrations in Poplar Creek were high enough to put individual bats at risk if they were to forage exclusively within this area, the foraging range of bats is great enough that this possibility is unlikely.

The ecological risk assessment for terrestrial wildlife was based on a dredging scenario much like that used in the human health risk assessment. The assessment examined risk both to the plant community that would develop on dredge spoil and to a herbivorous mammal (eastern cottontail) foraging there. A single line of evidence (contaminant concentrations in sediment) was available for use in the assessment. In the sediment of one or more study reaches, 12 metals were found at concentrations that exceeded benchmarks indicative of plant toxicity. The greatest number of metals were found in lower Poplar Creek, which contained arsenic, boron, cadmium, chromium, mercury, nickel, selenium, uranium, and vanadium. Benchmark numbers for plants were not available for a large number (i.e., 37) of the organic compounds; therefore, these analytes could not be evaluated. Populations of cottontails foraging on future spoil from lower Poplar Creek or from the Clinch River immediately downstream of Poplar Creek would be at significant risk of impaired reproduction due to levels of mercury and cadmium. A number of other analytes from these (and most other) reaches might pose a risk to individual cottontails foraging on future spoil; however, population-level effects from these contaminants would not be expected.

Ecological risk from radiation exposure was assessed separately. Risks to many of the same endpoint species were assessed, including a benthic organism (a mayfly), epibenthic (bottom-dwelling) fish, piscivorous wildlife (great blue heron), and a terrestrial herbivore (eastern cottontail). The assessment used the contaminant data for radionuclides to calculate the total radiation dose to these organisms. The DOE limit of 1.0 rad/day was used to assess acceptable exposures for most organisms; the International Atomic Energy Agency's recommended limit of 0.1 rad/day for terrestrial organisms was used to assess exposure for cottontail rabbits. None of the calculated doses approached the appropriate benchmarks above; thus, the radiological contaminants in the various environmental media of the OU did not pose a significant ecological risk.

Based on the findings of the site characterization and risk assessments, a number of pathway and media-specific remedial goal options (RGOs) were developed for individual analytes, which represent concentrations corresponding to an ARAR or to an acceptable human health or ecological risk level. RGOs were developed only for those reaches containing one or more environmental media that exceeded one of the criteria and thus indicated the potential need for remedial action in that reach. In almost every reach studied, RGOs were developed for one or more analytes for each of the three media evaluated.

FEASIBILITY STUDY

On the basis of the remedial investigation, a feasibility study was conducted to identify remedial alternatives that would be effective in reducing contaminant concentrations or reducing or eliminating exposure and that could be feasibly implemented. The overall approach taken in the feasibility study was to focus on remedies for site-related contaminants as identified in the site characterization. Therefore, remedies were not evaluated for those reaches in which risk was

primarily the result of non-site-related contaminants (e.g., manganese-driven risks in surface sediment or in water). In addition, no remedies were evaluated for surface water contaminants. Remediation of surface water is best effected at the source of the contamination, which in each case is primarily in upstream OUs. Moreover, remediation of the large volumes of flowing water is not practical. The use of institutional controls is the only remedy considered for limiting human exposure to fish. Therefore, active remedies evaluated in the feasibility study focus on site-related contaminants of concern in sediment.

Four alternatives are evaluated in the feasibility study. Alternative 1, the no-action alternative, is required by CERCLA to be evaluated. As the name implies, this alternative would be easily implemented at no cost. However, the risk assessments indicate that the no-action alternative would not be protective of human health or the environment.

Alternative 2 consists of the use of institutional controls and advisories to reduce exposure to contaminants in fish and sediment. Although not empowered under CERCLA, the state of Tennessee, the Tennessee Valley Authority, and the U.S. Army Corps of Engineers each have separate regulatory authority to regulate activities that could result in the disturbance of sediment in the Clinch River and Poplar Creek. Each of these agencies is party to an interagency agreement with DOE that requires the multiagency review, on a case-by-case basis, of all permit applications that propose activities with the potential to disturb sediment. The state of Tennessee currently issues fish consumption advisories warning the public to avoid or limit consumption of certain species of fish in which contaminant levels are unacceptably high. The present worth cost of implementing alternative 2 for 30 years, including future monitoring and administrative costs, is estimated to be $3.6M.

Alternative 3 incorporates the institutional controls described in alternative 2 and in addition proposes the combined containment and removal of contaminated sediment from Poplar Creek. The presence of several contaminants in the sediment of Poplar Creek posed a risk to human health or benthic organisms. Seven separate locations in Poplar Creek would be remediated, through the use of a combination of sediment containment technologies in the near-shore areas (bottom elevation >733 ft msl) and sediment removal technologies in deep water areas (bottom elevation <733 ft msl). A total area of 388,800 ft^2 is proposed for containment, and a total of 179,250 yd^3 for removal (the top 3 ft of sediment), at a total present worth cost of $109.6M. Removal of the deep sediment would also address the potential for future risks to human health and the environment in the dredging scenario.

Alternative 4 also incorporates the institutional controls of alternative 2, but in addition it proposes the removal of contaminated sediment from Poplar Creek. Removal of those sediments in Poplar Creek that pose a human health or ecological risk would require the removal and safe disposal of approximately 226,500 yd^3 of sediment, at a total present worth cost of approximately $123.5M. Because benthic habitat extends bank-to-bank, addressing the existing ecological risk by removing sediment would also address both the existing human health risk in the near-shore scenario and the potential for future human health risk and ecological risk in the dredging scenario.

Appendix J

QUALITY ASSURANCE/QUALITY CONTROL DATA

J. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT OF DATA

The Quality Assurance/Quality Control (QA/QC) Program for Phase 2 of the Clinch River Remedial Investigation (CRRI) was designed to comply with both Department of Energy (DOE) Order 5700.6C and Environmental Protection Agency (EPA) QAMS-005/80 (EPA 1980a) guidelines. QA requirements and the general QA objectives for Phase 2 data were defined in the Phase 2 Sampling and Analysis Plan (SAP) (DOE/OR/01-1111&D3)-Quality Assurance Project Plan, and scope changes noted in the Phase 2 Sampling and Analysis Plan Addendum-DOE/OR/01-1254&D1). The QA objectives for Phase 2 data were the following:

- Scientific data generated will withstand scientific and legal scrutiny.
- Data will be gathered using appropriate procedures for sample collection, sample handling and security, chain of custody (COC), laboratory analyses, and data reporting.
- Data will be of known precision and accuracy.
- Data will meet data quality objectives (DQOs) defined in the Phase 2 SAP.

The QA objective for all data collected during Phase 2 was, therefore, to obtain reproducible, precise, and accurate measurements consistent with the intended use of the data and the limitations of the sampling and analytical procedures used. These objectives were met through the development and implementation of a thorough data assessment process that included data evaluation, data quality indicators, sampling uncertainty, field quality control, analytical laboratory quality control, data and records management systems, and a QA oversight program of audits and surveillances.

One hundred and thirty-four sampling events were conducted for sediment and water. Separate contaminant studies on heron, mink, geese, and fish were also conducted. Approximately 4,400 inorganic, 3,000 organic, and 2,000 radiological samples were analyzed by ten laboratories during the Phase 2 site characterization. Matrices included sediment, water, fish, heron, mink, mayflies, geese and duck. In addition, over 500 pH, alkalinity, and total suspended particle determinations were conducted by CRERP staff. Toxicity and bioindicator measurements were also performed by Environmental Sciences Division (ESD) staff for the Clinch River Environmental Restoration Program..

The data were compiled by the laboratories into over 900 sample data packages that contained raw sample data and all quality control associated with each sample for most of the samples collected prior to July 1994. After July 1994, approximately 90% of the sediment and water data were reported as Level C or Level III data packages. Level C packages contained signed chain-of-custody forms, case narratives, sample results, and all quality control information such as calibration, spike, blank, and duplicate data. The only difference between the Level C (or III) and Level D (or IV) packages was that the Level D packages contained raw data, sample preparation records, and copies of pertinent logbook information. Sample results were also received electronically by the project data base manager and loaded into a large working data base.

Both qualitative and quantitative criteria are used as indicators of the quality of the data. In determining whether the data are usable, especially for the decision process, the integrity and authenticity of the data must be evaluated, and the analytical uncertainty must be known. Indicators generally used

to assess the data quality are completeness, precision, accuracy, representativeness, comparability, and sensitivity.

J1. COMPLETENESS

The overall QA **completeness** goal for the program was to obtain valid analytical results for at least 90% of the samples collected during the program. Overall completeness for all Phase 2 media and analyses exceeded this goal. Less than one percent of the analyses were rejected. Rejected data occurred because of low spike recoveries and low sensitivity.

J2. PRECISION

Analysis of **laboratory replicates** provided an assessment of the **precision** associated with the laboratory method. Precision was expressed as relative percent difference (RPD) for inorganic and organic analyses. For the inorganic analyses performed by Lockheed for surface and pore water, approximately 62% of the duplicates had a mean relative percent difference (RPD) of <10%. Of the duplicates, 83% had a mean RPD of <20%. For the inorganic analyses performed by TMA-ARLI for sediment, approximately 48% of the duplicates had a mean RPD of <10%, while 70% had a mean RPD <20%. Mercury speciation analyses performed at Brooks Rand had an overall mean RPD of <10%. The duplicate error ratio (DER) was used to assess duplicate agreement for radiological analyses. The DER is the ratio of the absolute difference of duplicate results compared to the sum of the uncertainties for the results expressed as a percent. The DER should be less than one. For the ESD Radiological Analysis Laboratory that performed the gamma analyses, the DER was <0.3. For other radiological analyses performed at Oak Ridge Analytical Services, the DER was <0.4, except for gross alpha and gross beta where the DER was <0.8.

Because it includes both the field and laboratory variability, analysis of **field duplicates** provided a total assessment of the overall precision of the sample data . For sediment, 75% of the semivolatile field duplicates had a mean RPD between 20-40%. Of the pesticide/PCB field duplicates, 75% had a mean RPD greater than 40%. Of the inorganic field duplicates for sediment, 85% had a mean RPD<30%. Overall, 21% of the sediment field duplicates exceeded the 35% criteria. For filtered surface water, overall, 23% of the field duplicates exceeded the 20% criteria. Failure to meet criteria was most often attributed to antimony, boron, copper, or zinc. For total surface water, overall, 15% of the field duplicates exceeded the 20% criteria with aluminum, boron, copper, iron, and nickel showing low precision. For pore water, overall, 40% of the field duplicates exceeded 20%.

Evaluation of sampling precision may be determined from the difference between the overall precision and the analytical precision. The usefulness of the precision data is limited to samples that contain contaminants at concentrations above the method detection limit (DL). Also, the analytical process must be in statistical control or the estimates of precision will not be meaningful.

J3. ACCURACY

Accuracy was primarily evaluated in Phase 2 through holding times, blanks, calibrations, LCSs, matrix spikes, surrogate spikes, and performance evaluation samples. Percent recovery was used to express the common systematic error component of accuracy, bias.

Holding times were met for approximately 95% of the samples. Of the holding times that were missed, only 68 resulted in rejected data (sediment and water, mercury).

Blanks, both in the field and the analytical laboratory, were used to check for bias resulting from contamination. Blanks were treated the same as samples. No blank corrections were performed on the Phase 2 data. Aldrin, benzo(ghi)perylene, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, and diethylphthalate were found in the method blanks that were analyzed with the surface water and pore water samples. Benzoic acid, 1,4-dichlorobenzene, 4-nitrophenol, butylbenzylphthalate, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, diethylphthalate, methoxychlor, pentachlorophenol, pyrene, and alpha-BHC were detected in some of the method blanks that were analyzed with the sediment samples. No significant contamination was found in the inorganic blanks. A few compounds were reported at levels less than the required detection limit.

Calibration data were used to estimate data variability whenever possible because analytical error could be introduced from variability in calibration constants, infrequent recalibration or over-calibration of the analytical system, and unstable calibration standards. Most of the calibrations met criteria. Several batches exhibited continuing calibration criterion outside the acceptance limits in the sediment semivolatile data. For ^{90}Sr analyses, two of the instrument performance assessments were not within acceptance criteria which resulted in flagged data.

Evaluation of the laboratory control samples showed that most met criteria. None of the exceptions resulted in rejected data. Boron recovery for some sample results failed to meet requirements because of the use of borosilicate glassware in the laboratory. Deviations occurred with the semivolatile water LCSs for 4-chloroaniline, 2,4-dinitrotoluene, hexachloroethane, and diethylphthalate. Since none of these compounds were detected in the samples, no qualification of the data was necessary.

Analytical, matrix, and surrogate spikes were used to assess accuracy also. Metals, anions, total kjeldahl nitrogen, and total organic carbon recoveries ranged from 80-100%. For sediment, average recoveries for acidic semivolatile compounds ranged from 40-90%, basic semivolatile compounds ranged from 50-90%, pesticide/PCB compounds ranged from 65-80%, and metals ranged from 15-100%. The lowest metal average recoveries were for antimony, cadmium, and selenium. For surface water and pore water, average recoveries for acidic semivolatile compounds ranged around 60%, basic semivolatile compounds ranged from 15-65%, and pesticide/PCB compounds ranged around 60-80%.

Average recoveries for the organic surrogates are summarized below:

	Sediment	Water	Pore water	Fish
2-chlorophenol-d4	76%			
phenol-d5	82%	63%	58%	
2-fluorophenol	79%	71%	64%	
2,4,6-tribromophenol	84%	85%	75%	
1,2-dichlorobenzene-d4	68%			
nitrobenzene-d5	73%	78%	75%	
2-fluorobiphenyl	83%	74%	72%	
terphenyl-d14	97%	82%	52%	
tetrachloro-m-xylene	87%	63%	48%	90%
decachlorobiphenyl	92%	67%	41%	90%

J4. REPRESENTATIVENESS

All measures taken to ensure that bias was not introduced into the sampling and analysis also contributed to sample **representativeness.** Measures such as proper preservation, use of standard analytical methods, adherence to appropriate holding times, and use of field and laboratory blanks, equipment rinsates, and proper containers were utilized so that the data would accurately reflect the analyte of interest at the environmental site.

J5. COMPARABILITY

The use of accepted methods and SOPs and participation in intralaboratory performance evaluation testing demonstrated **comparability.** Sample collection, preservation, storage, preparation, analysis, and reporting were performed consistently so that the end user could confidently compare data sets generated by different sampling events or different laboratories.

J5.1 Comparison of Mercury Results

Results for total mercury from two different laboratories were compared (Brooks Rand and Lockheed for surface water, Brooks Rand and TMA-ARLI for sediment). Sediment samples were splits from the same core, while surface water samples were collected at the same site, on the same date, at approximately the same time. Eleven surface water and 70 sediment sample pairs were available for comparison.

Results for total mercury from Lockheed for surface water were consistently higher than Brooks Rand results. The correlation coefficient (r) when all samples are included is relatively low (0.286). This low correlation is due primarily to two observations. When observation 10 is removed from consideration, r increases to 0.524, and when both observation 6 and 10 are removed, r increases to 0.875. Samples sent to Brooks Rand were collected by a specialized technique requested by the laboratory, in order to minimize contamination. The consistently higher mercury values from Lockheed may be a result of contamination during sample collection and processing.

Of the 70 sediment sample pairs compared, results from both laboratories were always lower than 13 mg/kg with five exceptions. Results from four of those pairs showed higher than average values from both laboratories (30 to 141 mg/kg). The fifth sample pair had a high result from TMA-ARLI (104 mg/kg) and an approximately average value from Brooks Rand (3 mg/kg). The correlation coefficient, r, for all sediment sample pairs is 0.477. When the five sample pairs discussed above were removed from consideration, sample results from both pairs were relatively consistent ($r = 0.881$).

J5.2 Comparison of Total and Dissolved Concentrations

The total analyte concentration is the concentration determined on an unfiltered samples following vigorous digestion. The dissolved analyte is defined as the analyte present in a representative water sample which passes through a 0.45 micron membrane filter. Dissolved concentration of an analyte must not exceed total concentration in a sample analyzed by the same analytical method. The relative difference is calculated as the percent of the difference between the dissolved and total concentrations divided by the total concentration. The difference was only computed when both the dissolved and total concentrations were greater than the detection limit. Most of the differences between the concentrations can be attributed to the error associated with approaching the detection limit for antimony, arsenic, chromium, copper, lead, molybdenum, nickel,

uranium, vanadium, and zinc. Problems with boron may possibly be due to the use of borosilicate glass by the laboratory.

J6. SENSITIVITY

Sensitivity was achieved by requesting the lowest detection limits possible for each analysis, as well as meeting holding times and using the correct sample preservation. The ability to accurately report a contaminant of concern at or above the detection limits was a primary concern in evaluating false positives and false negatives. Early in the project, Brooks Rand failed to qualify data near the method detection limit. During evaluation of the data, the average of the trip blanks was used to qualify the data as detects or nondetects.

J7. CORRECTIVE ACTIONS

During the sampling and analysis process as well as the review process, problems were documented using a Programmatic Exception Report (PER) form (ER/CR-SOP1024). Approximately 400 PERs were filed containing ~850 individual exceptions. A FoxPro data base was used to track each exception and to provide responses back to the disposition team, composed of quality assurance staff, the Analytical Services Coordinator (ASC), the Data Base Manager, and other pertinent personnel. Each deficiency was tracked to closure by Clinch River personnel. Key words that summarized a type of quality problem were assigned to each exception to track quality control trends. The problems were further categorized into internal or external problems to denote those items which were internal to the program and thus root cause could be addressed. Root cause was not pursued for those items categorized as external problems. Several types of problems were considered repairable during the review process. These included missing information, transcription errors, illegible information, missing chain-of-custody forms, errors in calculation, and missing or incorrect units.

Two major quality control problems identified in internal PERs were data package and field errors. Root causes listed most frequently were inattention to detail, mistakes in specifications, and procedural problems. Externally, the most frequent quality control problems were errors in data packages, electronic data, sample identifications and sample results/units. Although these problems were corrected with no long-term effects on the data quality, the errors did create scheduling conflicts and increased chances of error during the data assessment.

J8. QUALIFICATION OF THE DATA

During review of the field and analytical data, two sets of qualifiers were assigned to the data. The first set was assigned by the analytical laboratory, as required by each individual method. The second set was assigned by the data reviewers. The review qualifiers were also accompanied by one or more reason codes. Analytical results included the concentration of the analyte in the sample if it was present and measurable. When an analyte was not detected in a sample, the sample minimum quantitation limit for that particular sample was reported accompanied by a "U" suffix. When spectral data indicated the presence of an organic compound that met the identification criteria but the result was less than the sample quantitation limit, a "J" qualifier was assigned, indicating that the result was an estimated value. In data analyses, these "J" values were treated as measurable results.

The result qualifiers assigned by the laboratories, validators, and electronic screening were summarized into an overall qualifier for end users. Only qualifiers which affected how the data are

used were included in the overall qualifier. Under the risk assessment guidelines used for the project, data were either rejected, treated as nondetects, or used as reported. Additional data checking was performed as the data were summarized and evaluated for the health and ecological baseline risk assessments.

An end result use flag was also assigned to each data result. The use flag was either "Y" to symbolize that the data were usable or "N" for unusable data. Although rejected data was assigned an "N" for unusable, the primary reason for unusable data was duplication of sample results because of dilution, reanalysis, analysis by another method, or second column confirmation analysis for pesticides/PCBs.

An overall summary of the quality control problems found during data validation using the assigned reason codes shows that the predominant reasons for rejected results were poor spike recoveries and holding times.

J9. DATA REVIEW

The primary goal of the Clinch River Environmental Restoration Program was to ensure that the analysis of all these environmental samples produced data of known quality. According to EPA, "the quality of data is known when all components associated with its derivation are thoroughly documented, with such documentation being verifiable and defensible" (EPA 1990). To meet this goal, data used in this CRRI report were evaluated using the following techniques, as applicable: **field data review, electronic data verification, data inventory, contract compliance screening, electronic review, manual review, and Level C or D validation**. During each level of review, if problems were found which might affect the useability of the data, the sample results were qualified. The origination of the qualifier and the reason for qualifying the data were also documented. These qualifiers were condensed into one final useability code for the end user. The final phase of the evaluation which entailed assessing the contaminant data by location and risk used these final qualifiers and useability codes as indicators of the quality of the data.

For the **field data review**, a field data package containing all field sampling related documentation was assembled for each water and sediment sampling event . The field sampling related documentation included the weekly sampling schedule, the Field COCs, the Field Collection Task Map (FCTM), the Laboratory Processing Task Map (LPTM), the Sample Collection Information form, site maps or geographic positioning system data, field data forms, the Field Sampling Review Checklist, and copies of pertinent field logbook pages. An internal inventory and field data review was initially conducted by the sampling team leader according to ER/CR-SOP2020. Documentation of the internal inventory and review was also included in the field data package. Following the internal review, an independent assessment was performed by a field validator. The field validator was a person experienced in field sample collection who was not a member of the sampling team. Field data obtained during the sample collection event were assigned qualifiers by the field validator.

The first five sampling events for Phase 2 occurred in November 1993. Seventy-two PER indices were initiated which pertained to the sample collection and processing activities for these five sampling events. Twenty-four indices pertained to improper/missing signature or corrections, twenty-three pertained to missing data, six pertained to inadequate sample volume, six pertained to incorrect task maps, and four pertained to COC problems. The remaining nine indices pertained to six other quality control categories.

The remaining 126 sampling events for Phase 2 occurred after November 1993. Only 24 additional PER indices were initiated which pertained to sample collection and processing activities. For the five quality control categories which accounted for 63 of the 72 PER indices initiated for the first five sampling events, only 5 additional PER indices were initiated for the subsequent 126 sampling events. Seven PER indices pertained to field equipment failure, three PER indices pertained to calibration problems, and three PER indices pertained to inadequate equipment backup. The remaining 11 PER indices pertained to 10 other quality control categories. The considerable reduction of PER indices initiated for the last 126 sampling events versus the first five sampling events demonstrates the value of both a field sample collection documentation/field data validation review process and a program level exception documentation and resolution process for environmental restoration activities. As a result of the field data review, the sampling events were completely and consistently documented.

During the **electronic data verification**, an evaluation of the project data base was performed to ensure accountability, traceability, correctness, and completeness. Accountability checks included confirming that data collectors and generators were identified and reviewing data transfer and data entry documentation. Data base entries were cross checked with hard copy sources such as COCs, Sample Collection forms, data packages and data validation reports. Correctness checks involved verification of data transfer processes, double data entry, and comparison of data base values with the source. Completeness checks verified that all required descriptors for both samples and individual results were present, correct, and consistent with applicable plans and procedures, and/or Oak Ridge Environmental Information System (OREIS) formats. These checks reviewed locations, coordinates, sample IDs, units, dates laboratory sample IDs, methods, parameter names, result formats, laboratory flags, and validation flags, among others.

Data inventory of all data packages was conducted to verify completeness and ensure that any missing deliverables could be obtained before the final report was compiled. Inventory was conducted according to procedure ER/CR-SOP1019.

A **manual review** of all data package batch narratives was conducted and summarized. These reviews were also used to flag data that did not meet criteria.

Contract compliance screening (CCS) was used initially for EPA Contract Laboratory Program (CLP) electronic deliverables to assess the adequacy of the electronic files. One hundred and twelve electronic deliverables were screened for potential formatting problems and CLP SOW compliance.

An **electronic review** of selected quality control information was conducted. Results of these checks were compared with other available information such as the CCS, inventory and validation. Data that did not meet criteria were flagged with the appropriate qualifiers and reason codes and the type of review was designated. Organic laboratory blank contamination for sediment and water samples was assessed electronically and the data were flagged according to the guidelines in ER/CR-SOP1020. Holding times, surrogates, matrix spikes, and detection limits were also evaluated for sediment and water data. Biota data were evaluated when available electronically.

Validation was conducted according to ER/CR-SOP1020 which was written to address EPA criteria, Clinch River data quality objectives as expressed in a given laboratory Statement of Work (SOW), and specific method requirements. Approximately 118 sample data packages were validated by an independent third-party subcontractor from the 900 data packages that were received. Subcontractor personnel performing the validation were required by the Clinch River ER Program SOW to be trained, experienced, and proven able to perform the review procedures. The Clinch River ER Program required,

reviewed, and approved resumes and work training records. Data review deliverables for the validation consisted of the following:

- A data validation narrative summarizing by fraction the problems found that affected the data quality and the potential impact on the sample results. (Each narrative includes the name and signature of the data reviewer.)
- A completed checklist that detailed the review elements and QC problems
- Report forms for each sample with validation qualifiers and reason codes assigned to each analyte result
- A list of data review qualifiers and their meanings for use in the data evaluation

After validation was completed, the subcontractor entered the validation qualifiers into the data base. Each qualifier was also accompanied by one or more reason codes that summarized the qualifier assignment as well as a code which identified the source of the qualifier.

J10. DATA MANAGEMENT SYSTEMS

A comprehensive Information Management System (IMS) was used to provide organization, integrity, security, traceability, and consistency of the data generated during Phase 2. Specifically, the IMS supported the project data life cycle, including field sampling preparation, field measurements, sample tracking, laboratory analyses of environmental samples, data verification and validation, data consolidation and storage, and data transfer to OREIS, data analysis and interpretation, summarization and reduction of data, risk assessment calculations, data presentation, and data and document archival.

An ORACLE® data base was used to implement the IMS. Constraints were defined in the data base to ensure proper linkage of sample collection and analysis data and to enforce use of standardized codes. The data base resides on the Clinch River Project SPARC 10 workstation. The data base is protected from unauthorized access, deletion and modification by the ORACLE® security. Daily and weekly backups of the data base were performed and the weekly backup tapes were stored off-site.

Records generated by the program that are required to (1) provide a complete and accurate history of sample collection, analysis, and data reporting; (2) document conduct of program business; and (3) support any future legal or administrative actions that may be taken are retained in the project files. Similarly, records that furnish documentation or evidence of quality (e.g., program work plans and results of QA oversight activities) were designated QA records and added to the project files.

Records identified for Phase 2 sampling and analysis activities included project plans and approvals, field and laboratory notebooks, chain-of-custody and request-for-analysis forms, instrument listings for gamma spectroscopy, analytical laboratory data packages, and data validation summary reports.

A hard-copy repository is maintained in the Clinch River ER Program Document Management Center (DMC), which is located at ORNL, Building 1505. This repository and associated index data base provide for the organization, protection, retrievability, and accountability of project records. The indexing system provides sufficient information to permit identification of the record and the items or activities to which it applies. A CERCLA administrative record file will be the recipient of officially designated documents.

J11. AUDITS AND SURVEILLANCES

Audits and surveillances were performed by DOE Oak Ridge Operations (DOE-ORO); Martin Marietta Energy Systems, Inc. Central QA; and the Energy Systems Environmental Restoration (ER) QA specialist who reviewed and evaluated the adequacy of field and laboratory performance and ascertained whether the QA/QC Plan was completely and uniformly implemented. Results of these audits and surveillances were documented and reported to management. Follow-up corrective actions were taken as needed. Implementation was monitored by the Clinch River QA specialist and verified by the auditing organization.

The chronology of Readiness Review Assessments, Audits and Surveillances was as follows:

March 23-25, 1993	93CRRI-Q1 Surveillance to assess the state of readiness for Phase-2 Biota Field Sampling and Analysis.
April 28, 1993	93CRRI-L1 Surveillance to determine the TVA-Chattanooga Environmental Chemistry Laboratory plans to document and track all corrective actions for internal and external problems associated with samples received from the CR-ERP.
April 30, 1993	93CRRI-Q2 Surveillance to assess the state of readiness for Phase-2 Sediment Field Sampling and Analysis(S&A) & Water Toxicity Testing.
May 26, 1993	93CRRI-Q3 Surveillance to assess the state of readiness for Phase-2 Expanded Water & Sediment Toxicity Field Sampling and Analysis.
June 23, 1993	93CRRI-M3 Surveillance to verify that Phase-2 Biota(fish) Field Sampling and Analysis is conducted in accordance with the Phase-2 S&A Plan & SOPs.
June 28–July 21, 1993	DOE-ER Annual CR-ER Program Audit to evaluate the overall effectiveness of the CR-RI in collecting data of sufficient quality for technically defensible site remediation decisions.
August 30, 1993	Readiness Assessment Meeting for Phase-2 of the CR-RI.
September 28, 1993	93CRRI-M4 Surveillance to monitor and assess Phase-2 Sediment Field Sampling.
October 26, 1993	93CRRI-M5 Surveillance to verify that Phase-2 Biota(fish) S&A done by the TVA-Norris Aquatic Biology Group is being accomplished in accordance with the CRRI-Phase-2 S&A Plan and SOPs.
November 18, 1993	93CRRI-M6 Surveillance conducted to verify that CR-ERP Phase-2 Expanded Water S&A Field Activities are being done in accordance with the CR-ERP Phase-2 S&A Plan and SOPs.
December 20, 1993	93CRRI-M7 Surveillance to verify that corrective actions for deficiencies identified in surveillance 93CRRI-M6 have been satisfactorily completed.
December 15-16, 1993	DOE-ER CR-ERP Field Surveillance to evaluate the overall effectiveness of the CR-RI Phase-2 Sampling Program in collecting data of sufficient quality for technically defensible site remediation decisions.
February 24, 1994	94CRRI-M1 Surveillance to verify that Phase-2 Sample Management/Tracking and Related Documentation are being conducted according to CR-ERP Phase-2 guidelines and procedures.
February 24-25, 1994	94CRRI-M2 Surveillance to verify the Traceability of Records from Phase-2 Field S&A activities are being maintained according to applicable sections of the CR-ERP Phase-2 Technical Management Plan.

March 30, 1994	94CRRI-M3 Surveillance to determine the Status of Corrective Actions that are due for completion from past DOE-ER, MMES-ER, and other Phase-2 internal/project audits/surveillances.
April 25-29, 1994	94CRRI-M4 Surveillance to verify that Phase-2 Multi-Head Ballchek Sediment Core S&A is conducted in accordance with the CRRI Phase-2 S&A Plan, Sect. 3.3, and CR-ERP Work Aid WA-93-SW-10.
May 9-23, 1994	94CRRI-M5 Surveillance to verify that Field Sampling Activities for Other Biota(Blue Heron, Woodduck, & Contaminant Pathways in Food webs-MayFlies & Crayfish) is being conducted in accordance with the CR-ERP S&A Plan, Sect.3,4 and pertinent Phase-2 CR-ERP Biota procedure or work aid.
June 10, 1994	94CRRI-M6 Surveillance to verify that Phase-2 Deliverables from Subcontracted Analytical laboratories are being tracked to assure Phase-2 Task/SOW requirements and time frames are met.
July, 1994–	DOE-ER Annual CR-ER Program Audit.
August 26, 1994	94CRRI-M7 Surveillance to evaluate the effectiveness of the system being used to track all types(i.e., QC) of Phase-2 samples for the QA/QC report.
Sept. 28-29,1994	94CRRI-M8 Surveillance to evaluate the Phase-2 Data Validation results and assessment to date.
October 26, 1994	94CRRI-M9 Surveillance to verify that Phase-2 Biota(fish-Biology Survey) Field S&A is conducted in accordance with the Phase-2 CR-ERP S&A and SOPs.
Nov. 29-30, 1994	94CRRI-M10 Surveillance to verify that all CR-ERP Phase-2 Task Leaders can account for all of their samples per requirements of Phase-2 S&A Plan, Addendum DOE/OR/01-1254&D1, Sect. 3.0.
December 19, 1994	94CRRI-M11 Surveillance to verify that all CR-ERP Phase-2 documentation and records are being maintained in a traceable manner to ensure the defensibility of all Phase-2 data.
January 27, 1995	95CRRI-M1 Surveillance to verify that all Phase-2 Deliverables from Subcontracted Analytical Laboratories, and Data Validation results are being completed and useability determined(per CR-ERP FY-95 milestone schedule for the RI/FS.
February 28, 1995	95CRRI-M2 Surveillance to determine if the Status and Schedule for the Preparation and Peer Review Process for the CR/Poplar Creek RI/FS Report has been established to ensure that all RI/FS sub-elements are completed in time to meet established dates.
March 30, 1995	95CRRI-M3 Surveillance to determine the Status of Corrective Actions that are due for completion from past DOE-ER, MMES-ER, and other internal/project audits/surveillances.

J12. STANDARD OPERATING PROCEDURES AND TRAINING

Whenever applicable, existing procedures were used for CRRI activities. Field sampling procedures from Kimbrough et al. (1990) were used, and many EPA Contract Laboratory Program (CLP) analytical procedures (field and laboratory) were specified. Procedures were developed to support technical and administrative activities of the CRRI when none existed. These activities included the following:

- Sampling processes
- Sample handling/custody
- Calibration of equipment used in obtaining samples and/or data
- Analytical processes
- Data reduction, validation, and reporting
- Internal QC checks
- Audits
- Surveillance and corrective action processes
- Specific routine functions required to assess data precision and completeness

The CRRI training program consisted of a training plan, which defined requirements for training frequency and trainer designation; a training needs assessment, which identified personnel to be trained; and the actual training on CRRI procedures. Training was completed as required in the appropriate SOP, and training records were maintained by the training coordinator for the CRRI. Generally, the extent of training was commensurate with the scope, complexity, and nature of the activity and the education, experience, and proficiency of the person.

J13. LESSONS LEARNED

Project Statements of Work

- Provide guidance/requirements in SOWs on how the laboratory should proceed if sample volume is insufficient to perform all requested analyses, including that the laboratory will be required to get guidance from CR-ERP as to which analyses are priority. This applies especially to biota samples, where volumes may vary depending on individual animals.

- Specify that the case narrative must list the IDs for samples reported in the package and must provide a cross-reference to laboratory sample IDs. Specify that any references to samples must include the project sample ID.

- Specify that the pages in the data package must be single-sided and on 8-1/2 x 11 paper and that notes should not be left on pages unless they are taped down so that they will go through the copier. (Response to TVA packages)

- In the future, the SOW should state that if the laboratory needs to report sample matrix/type other than as on COC (perhaps for software reasons), the laboratory should explain why in the case narrative (i.e., why the forms don't match COC). For example, if the sample matrix is listed as CART F on the COC and the laboratory had to report it as water due to software/program requirements, the case narrative should state that this occurred. (See PER-0228)

- All method numbers listed in SOWs should be verified before the SOW is final to ensure that the numbers referenced are for the desired method.

- Require that laboratories batch, analyze, and report no more than 20 samples in a batch. Check logins to ensure that no more than 20 are listed.

- Do not assign SDGs before samples are shipped. Track outgoing samples by the COC number. After the samples are logged in by the laboratory, track them by the SDG assigned by the laboratory.

- In results, laboratories sometimes discussed/referenced only pesticides or only PPCBs. Clarify the meaning of the acronym PPCB. (See response to PER-0093.)

- Resolve with Brooks Rand the question of the volume required for spikes. (Reference PER-0111.) They received what they requested but responded to PERs regarding batches of more than 20 samples by saying they had inadequate sample volume.

- Require the laboratory to more fully document the temperature and condition of cooler contents when they send confirmation of receipt of a shipment. Revise the sample login form to include a blank space for the laboratory to record temperature.

- To the extent possible, it is preferable to have only one SOW with a laboratory for like matrices and analyses (i.e., it would have been preferable to have SOWs 191 and 194 combined rather than separate.)

- To eliminate the possibility of misunderstanding, the SOWs with the laboratories should state that the due dates for deliverables are based on calendar days, not work days (i.e., 60 days means 60 calendar days, not 12 work weeks).

- Place more emphasis on and include specific instructions regarding how the laboratories should notify the project about problems, especially those discovered at receipt of samples.

APO Statements of Work

- Review of analytical laboratory SOWs needs to include a requirement that laboratories have back-up analytical equipment, parts, or access to back-up equipment in the event that primary equipment fails. (Ref. PER-94-CRRI-0108) (Suzanne Benson's file: 006769)

- The laboratory should prepare an EDD as part of the PE package. The ability of the laboratory to provide an acceptable EDD should be considered part of the qualification of the laboratory to provide services.

Field Data Validation

- Field validation proved to be very successful in identifying types of errors made at the beginning of field sample collection and processing. This enabled the field teams to proactively implement corrective actions that prevented recurrences of the errors.

- The proceduralized, real-time internal review by the sampling team of collection activities through examination of documentation precluded the need for programmatic exception reports.

Shipping

- The Coleman Sample Manager™ brand aluminum coolers proved to be more effective than the plastic coolers in consistently maintaining the samples at the desired temperature range of 4°C (+/- 2°) while in transit to the designated laboratory. Typically, these metal coolers were capable of maintaining the desired internal chamber temperature for one day longer than the plastic coolers.

- The metal coolers provided more protection for the glass sample containers, resulting in less breakage.

- For the first few months, glass sample containers were wrapped with plastic air-bubble packaging only once around the entire glass circumference, including the top and bottom. In response to the recurring problem of glass bottle breakage, sample containers were double wrapped with the bubble wrap material, and this significantly reduced instances of glass container breakage.

- Preparing coolers simultaneously for shipments to multiple analytical laboratories resulted in incorrect marking of the outside of one cooler, delivery to the wrong laboratory, and a two-day delay in delivery of samples to the correct laboratory. The temperatures of the affected samples were elevated above required preservation levels. To prevent this type of incident from recurring, whenever samples were shipped to two or more off-site laboratories on the same day, all shipping transactions were completed for one laboratory at a time.

- There was a total inventory of 25 coolers used for shipping Phase 2 samples to the various laboratories. This number was just barely adequate even under the scaled down volume of revised Phase 2 volume of sample collections. During each of the three separate "mega sampling events," the number of available coolers was less than adequate. CRERP should probably have had between 15 to 20 more coolers in order to have been able to consistently ship samples within one or two days after field collection rather than sometimes waiting three to four days to ship organic samples, and five to 8 days when shipping inorganic samples. Additionally, supplies of blue ice packs sometimes became a bigger issue than the coolers themselves during peak periods of shipping "mega sampling event" samples.

- Lockheed Analytical Services was the best of all the laboratories used during Phase 2 in returning coolers and ice pack supplies in a consistent, timely manner (i.e., return receipt usually within four days of leaving ORNL). The other out-of-state laboratories were slower, usually taking about ten to fourteen days for a cooler to return. There were several instances when the laboratory was contacted and faster turnaround times on returning CR-ERP coolers was requested. This resulted in only marginal, sporadic improvements. No consistent improvements were noticed. The only way to compensate for most of the laboratories being slow to return coolers would be to have more coolers and associated cooler supplies.

- Since the original sampling volume for Phase 2 was significantly scaled down, the available refrigerator storage space was always sufficient. The refrigerator storage space was sometimes a little tight, but nevertheless adequate. However, had there been no sample collection reduction for Phase 2, the existing refrigerator storage space would have been a problem. One large commercial TRUE™ refrigerator and two standard household-type refrigerators were used during Phase 2. Had the numbers of samples been collected as originally planned for Phase 2, one or more refrigerators would most likely have to have been procured and set up in the greenhouse.

- During Phase 2, leakage of water from sediments collected in the 8 oz. and 16 oz. plastic jars was a continuing problem even though there were internal adjustments to sample collection and processing. The root cause was determined to be excessive sediment on the threads of the sample jar even though CRERP personnel wiped the jar threads and lids. In the future, jars with wider openings will be used so that sediments can be put into the jars without getting grains of sample on the threads.

- Double bagging samples in plastic bags prevented liquid leaking out of the bags when sample containers broke or lids cracked during shipment.

- Include a temperature trip blank with shipments. Also include additional volume of chilled water in the cooler if only a few samples (i.e., 6-10) are shipped in a large cooler.

- During Phase 2, samples were wrapped the day before they were scheduled to be shipped from ORNL. This proved to be a good practice because it always allowed sufficient time to correct or compensate for any unplanned deviation or added work task associated with preparing a specific batch of samples for off-site shipment.

- Ensure that all samples, including biota samples, are shipped according to CRERP procedures or alternative procedures that have been reviewed and accepted by CRERP.

- Shipping work aids were written and implemented for preparation of required shipping records, sample tracking, and sample packaging and shipping. All three of these work aids proved to be very helpful.

- The use of a separate shipping folder for each day for each laboratory was very helpful.

- The establishment and use of a sample shipment checklist was very helpful to ensure a minimum number of errors or omissions when packing coolers and shipping to the associated analytical laboratory.

Data Package Receipt, Tracking, Handling

- For future projects, the data group assigned by the laboratory should be entered into the data base from the login faxed from the laboratory instead of when the data package is received.

- Improve review of the login for correct entry by the laboratory of sample ID, analysis, date received, etc.

- DMC photocopying errors indicate a need for upgraded photocopying equipment.

- In the future a space similar to that provided for the data base support staff would enable analytical services staff to work more efficiently. The space could also be used for the collection and maintenance of a project file.

- The use of colored folders was very helpful.

Data Base

- Do not start the project until the data base is ready.
- The use of data base-generated COC and SAR forms worked well. The project believes this approach contributed to quality by eliminating errors related to transcription, poor handwriting, or reproduction of handwritten COC or SAR forms.
- Consider supplying an electronic form of the COC to laboratories when samples are shipped. Having the laboratory use the electronic COC could eliminate transcription errors in IDs by the laboratory.
- Track all samples, including biota samples, in one data base.
- Use ORACLE rather than SAS for interactive data entry-type systems to avoid data base deadlock.

Electronic Data Deliverables

- The format of EDDs should be determined and communicated to the laboratory before the project begins.
- The laboratory should be required to demonstrate its ability to provide data in desired formats as part of qualification for the work.
- Memos transmitting EDDs to the Information Management Group should include the date the EDD was received.
- All copies of all disks should have the date received written on the label, including copies made by Information Management Group.
- Printing a list of files on diskette deliverables and taping the list to the diskette was a good idea.
- Lesson reinforced: All diskettes and data received by the project, including data received via modem, should be scanned for viruses.
- File EDDs and revised EDDs in diskette box holders by laboratory and SOW. After all diskettes are received, transfer to notebooks. This will enable all versions of a diskette to be filed together sequentially easily during the project. Don't attempt to submit EDDs to the DMC until the end of the project.
- Require the laboratories to submit a printed copy of the electronic files and verify in writing that the EDD has been checked against the hardcopy data package. Until no problems with the EDD exist, verify all electronic files against hardcopy packages.

Biota Samples

- Avoid the use of the following letters in sample IDs: "O," which may be incorrectly entered by the laboratory as a zero; "S," which may be entered as 5; "Z," which may be entered as 2; and "L" or

"I," which may be entered as 1. Handwritten zeroes should be crossed to avoid confusion with the letter "O."

- Ensure that biota samples are shipped according to CR-ERP procedures or alternative procedures that have been reviewed and accepted by CR-ERP.

- Generate Task Maps and COC and Sample Analysis Request forms for biota samples from the data base in the future.

Inventory

- Revise the inventory procedure, refining what is to be reviewed (e.g., CAS numbers?).

- Revise the inventory procedure to require that all handwritten PERs identify samples affected by the CRERP ID number, i.e., that the PER does just not say "a sample was _____" without identifying the sample by ID.

- Revise the inventory procedure to note that if a case narrative says all QC parameters were in control, the inventory specialist should take that to include calibration, continuing calibration, spikes, blanks, holding times.

- Revise inventory procedure to identify forms not required for a given analysis (e.g., Form 4 for tritium analyses, Form 11 for ICP/MS analyses.)

Validation

- Revise the validation procedure so that any detection limits that are below the method detection limits will be reviewed specifically for compliance to the SOW, not the method.

Programmatic Exception Reports

- Review and close PERs in a more timely manner.

- When items are identified as missing during inventory or validation, before contacting the laboratory review the hard copy original received from the laboratory to ensure that omission is not a project photocopying error.

- To avoid entering the same item twice in the PER tracking data base, write a program that will query the operator when a sample ID is entered and has already been entered once.

- Centralize the PER data base.

- Revise the PER procedure to lessen paperwork and redefine responsibilities.

Appendix K

SELECTED HISTORICAL CONTAMINANT DATA

Table K1. Selected metals concentrations in surface sediment

Parameter (ppm)[a]	East Fork Poplar Creek			Bear Creek			White Oak Creek			Poplar Creek		
	Max	Min (n=16)	Mean	Max	Min (n=3)	Mean	Max	Min (n=4)	Mean	Max	Min (n=3)	Mean
Mercury	165.0	11.0	40.0	0.7	<0.1	0.3	6.0	2.2	3.3	5.9	0.1	3.4
Arsenic	14.0	3.8	6.9	11.0	4.8	6.5	12.0	5.0	8.7	11.0	7.4	8.9
Cadmium	8.2	<0.5	1.6	8.6	<0.5	8.6	2.4	0.6	1.4	3.5	2.1	2.9
Chromium	58.0	24.0	37.0	35.0	16.0	22.0	290.0	66.0	163.0	38.0	19.0	27.0
Lead	170.0	36.0	80.0	85.0	35.0	52.0	51.0	33.0	40.0	38.0	23.0	32.0
Nickel	74.0	20.0	37.0	155.0	28.0	67.0	30.0	24.0	26.0	65.0	43.0	56.0
Silver	45.0	2.0	8.0	<1.0	<1.0	<1.0	10.0	2.0	6.0	2.0	<1.0	2.0
Zirconium	590.0	350.0	448.0	500.0	430.	500.0	480.0	260.0	365.0	470.0	220.0	340.0

Parameter (ppm)[a]	Clinch River Watts Bar			Background stations					
				Clinch River Melton Hill			Norris Reservoir[b]		
	Max	Min (n=4)	Mean	Max	Min (n=1)	Mean	Max	Min (n=3)	Mean
Mercury	2.8	0.3	0.8	<0.1	<0.1	<0.1	0.1	0.1	0.1
Arsenic	11.0	5.1	8.1	17.0	17.0	17.0	26.0	16.0	22.0
Cadmium	4.2	0.7	1.8	0.5	0.5	0.5	<0.5	<0.5	<0.5
Chromium	25.0	9.0	16.0	25.0	25.0	25.0	23.0	21.0	22.0
Lead	38.0	14.0	30.0	28.0	28.0	28.0	77.0	58.0	67.0
Nickel	38.0	14.0	21.0	36.0	36.0	36.0	28.0	24.0	26.0
Silver	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zircomium	890.0	400.0	650.0	230.0	230.0	230.0	270.0	180.0	220.0

[a]ppm is equivalent to mg/kg
[b]Values for Norris Reservoir include Clinch River miles 85.3 and 94.1 and Powell River mile 6.0.
Source: Tennessee Valley Authority. 1985. *Instream Contaminant Study–Task 2, Sediment Characterization*, Vol. II. Office of Natural Resources and Economic Development, Knoxville, Tenn.

Table K2. Maximum concentrations (pCi/g) in fine-particle surface sediment

	Clinch River	East Fork Poplar Creek	Bear Creek	White Oak Creek	Poplar Creek	Norris Reservoir Control Station		Comparison data	
						Clinch River	Powell River	Tennessee River[a]	Clinch River[b]
Analysis/isotope									
Gross alpha	11	160	32	3	11	4	3	15	100
Gross beta	398	110	150	6600	60	42	37	65	91
Uranium (mg/kg)	7	90	200	4.1	14	5.9	2.3	[c]	2.0
Sr-89	4	0.7	0.5	0	1	4	1	14	12.1
Sr-90	1.8	0.1	0.1	900	0.2	0.4	0.5	0.6	0.6
Gamma Spectral Analysis									
Co-60	1.2	-[d]	-	184	-	-	-	0.6	2.7
Cs-134	-	-	-	1.2	-	-	-	0.13	0.01
Cs-137	167	8.6	0.2	12100	1.9	0.9	0.7	5.5	83
K-40	27	21	18	25	16	27	16	27	84
Ra-226	0.7	-	-	-	-	-	-	2.3	1.4
Th-234	4	23	63	-	3.8	-	-	-	-
Eu-152	-	-	-	8	-	-	-	-	-
Eu-154	-	-	-	7	-	-	-	-	-
Am-241	-	-	-	4	-	-	-	-	-
Ac-228	2.2	2	1.8	4	1.1	2.2	1.8	2.7	2.1
Pa-234	-	-	-	-	-	-	-	4.6	4.8
Transuranics									
Pu-239	0.73	0.10	0.001	1.08	0.02				
Pu-238	0.03	0.02	0.001	0.007	<0.0002				
Am-241	0.51	0.05	0.04	0.46	0.02				
Cm-244	0.02	0.01	0.009	0.01	<0.0008				

[a]Maximum concentrations reported by the Tennessee Valley Authority in surface sediment samples collected from the Tennessee River from 1981-1983
[b]Maximum concentrations reported by the Tennessee Valley Authority in surface sediment samples collected from the Clinch River from 1974-1983
[c]Blank cell indicates no analysis was performed
[d]Dash indicates isotope was not detected
NOTE: The lower limits of detection for all isotopes are typically 1 pCi/g, dry weight
Source: Tennessee Valley Authority. 1985. Instream Contaminant Study–Task 2, Sediment Characterization, Vol. II, Appendices. Office of Natural Resources and Economic Development, Knoxville, Tenn.

Table K3. Concentrations of ^{137}Cs and selected metals in sediment at recreation area beaches and at water intakes in the Clinch River. All units are mg/kg unless otherwise noted.

	Location			
Analyte	Emory River Mile 2 - Kingston Steam Plant intake	Clinch River Mile 13 - K-25 intake	Clinch River Mile 17 - campground beach	Upstream (maximum of all upstream sites)
^{137}Cs (pCi/g)	2.05	23.74	0.19	0.18 - CRM[a] 36 and 52.5
Arsenic	19	15	3.8	20 - CRM 36
Chromium	28	22	56	87 - CRM 120
Copper	18	13	17	25 - CRM 120
Lead	30	29	35	150 - CRM 87.5
Mercury	0.5	0.45	<0.1	0.16 - CRM 36
Nickel	17	29	42	61 - CRM 36
Phenanthrene	ND[b]	1.1	ND	0.44 - CRM 52.5
Pyrene	ND	0.96	ND	0.48 - CRM 52.5
Bis (2-ethyl-hexyl) phthalate	ND	0.42	ND	1.8 - CRM 41.5
Benzo(a)-anthracene	ND	0.44	ND	ND
Flouranthene	ND	ND	ND	0.63 - CRM 52.5

[a]CRM = Clinch River mile
[b]ND = Not Detected

Source: Tennessee Valley Authority. 1991. *Results of Sediment and Water Sampling for Inorganic, Organic, and Radionuclide Analysis at Recreation Areas and Water Intakes–Norris, Melton Hill, and Watts Bar Lakes–Data Report*. Water Resources. Chattanooga, Tenn.

Table K4. Concentration of radionuclides in Clinch River fish (pCi/kg fresh weight)

Fish species	Sample period	^{90}Sr		^{137}Cs		^{106}Ru		^{60}Co	
		Flesh	Total[a]	Flesh	Total[a]	Flesh	Total[a]	Flesh	Total[a]
Carp	1960–1962	(17)[b] 500±140	(40) 5100±1700	(71) 510±57	(39) 560±79	(69) 170±18	(39) 290±78	(67) 66±6.1	(39) 49±9.9
	1963	(20) 91±22		(20) 320±110					
Carpsucker	1960–1962	(18) 540±190	(39) 940±120	(122) 1200±460	(37) 640±67	(22) 120±30	(37) 56±16	(22) 120±19	(37) 32±6.8
	1963	(20) 22±4.4	(39) 4800	(20) 460±82					
Buffalo	1960–1962	(3) 240±89	(30) 830±110	(5) 480±94	(30) 590±92	(5) 110±32	(30) 150±38	(5) 78±21	(30) 32±6.8
	1963	(20) 43±14		(21) 560±84					
Sight feeders[c]	1960–1962	(109) 180±83		(126) 680±120		(127) 120±32		(127) 22±11	

[a]flesh and carcasses, including bones, combined
[b]Number of samples
[c]white crappie, bluegill, white bass, largemouth bass, sauger, and drum

Source: Cowser, K. E. And W. S. Snyder. 1966. *Safety Analysis of Radionuclide Release to the Clinch River.* ORNL-3271 Suppl. 3. Oak Ridge National Laboratory, Oak Ridge, Tenn.

Table K5. Comparison of mean values for various chemical parameters in fish in the lower Clinch River below Melton Hill Dam[a]

Parameter	Bluegill	Largemouth Bass	Gizzard Shad	Lepomis	Approximate range of background concentrations[b, c]	Food and Drug Administration action level
Mercury	0.30	0.23	0.05	0.37	0.05–0.20	1.0
Cadmium	0.01	0.01	0.01	0.01	0.02–0.07	—
Chromium	0.05	0.08	0.17	0.03	0.03–0.10	—
Copper	0.25	0.33	0.63	0.30	0.15–0.90	—
Lead	0.07	0.12	0.10	0.14	0.03–0.70	[d]
Nickel	0.72	0.55	0.51	0.60	0.20–0.60	—
Zinc	6.4	5.8	4.1	11.1	5–10	[d]
PCB	—	0.20	0.22	0.15	<0.10	5.0

[a]Numbers given are averages of the available data, 1976–1983.
[b]All concentrations given in $\mu g/g$ (ppm).
[c]Based primarily on the statewide mean concentrations for trace metals in fish and on average concentrations in Melton Hill Reservoir at CRM 52.2.
[d]The U.S. Food and Drug Administration has no recommended action level for lead or zinc, but the Canadian Food and Drug Directorate has set standards of 10 and 100 ppm, respectively, for these metals.

Source: Tennessee Valley Authority. 1983. Summary of Existing Water, Sediment, Fish, and Soil Data in the Vicinity of the Oak Ridge Reservation. Report to the Department of Energy from the Tennesee Valley Authority Water Quality Control Branch.

Table K6. Comparison of average concentrations for selected parameters in fish from Poplar Creek[a]

Species	Mercury	Chromium	Nickel	PCB
Bluegill	0.31	0.16	0.78	0.17
Largemouth Bass	0.59	0.19	0.56	0.38
Gizzard Shad	0.04	0.07	1.28	0.27
Lepomis	0.43	0.03	0.66	0.30
Channel Catfish	0.39	0.33	1.42	1.6
Approximate range of background concentrations[b]	(0.05–0.20)	(0.03–0.10)	(0.20–0.60)	<0.10

[a]Numbers given are averages of the available data, 1976–1983. All concentrations given in $\mu g/g$ (ppm).
[b]Based primarily on statewide mean concentrations for trace metals in fish and on average concentrations in Melton Hill Reservoir at CRM 52.2.
Source: Tennessee Valley Authority. 1983. Summary of Existing Water, Sediment, Fish, and Soil Data in the Vicinity of the Oak Ridge Reservation. Report to the Department of Energy from the Tennessee Valley Authority Water Quality Control Branch.

Table K7. Instream contaminant study – task 4, total PCBs in fish flesh samples from 16 sites in the vicinity of Oak Ridge, Tennessee**

						Individuals						
Sample Site	**Species**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Scarboro Creek	Channel catfish	U	U	U	U	U	U	U	U	U	U	–
McCoy Branch	Channel catfish Yellow bullhead	U U	1.0	U	U	U	U	U	U	U		0.1 –
Melton Hill Dam	Channel catfish Yellow bullhead	U U	U U	4.7* U	 U							1.6 –
White Oak Creek Mile 0.2	Channel catfish Black bullhead	3.0* U	2.4 U	2.2	5.6*	2.7	3.5*	2.8	2.8			3.1* –
White Oak Lake	Common carp	U	0.2	0.6	U	1.0	U	U	0.4			0.3
Clinch River Mile 11.0	Channel catfish	1.1	1.5	0.3	2.1	0.9	0.4	1.7	0.7	0.5	U	0.9
Clinch River Mile 6.0	Channel catfish	0.4	0.6	1.1	0.2	0.6	0.5	0.6	1.6	0.8	1.0	0.7
Clinch River Mile 2.0	Channel catfish	0.3	0.4	0.9	0.6	0.7	1.5	0.6	0.7	0.7	U	0.6
Emory River Mile 1.0	Channel catfish	0.6	1.0	0.8	1.4	0.9	U	U	0.5	0.3	U	0.6
TRM 572	Channel catfish	U	0.3	U	0.2	0.2	0.5	U	0.4	0.4	0.3	0.2
TRM 558	Channel catfish	1.3	0.2	U	0.6	1.4	1.1	0.8	0.5	0.3	U	0.6
EFPC Mile 13.8	Bluegill Largemouth bass Common carp	U U 3.1*	U 0.5 3.7*	 0.9 2.0								– 0.5 2.9
EFPC Mile 8.8	Rock bass	U	U	U	U	U	U	U	U	U	U	–
EFPC Mile 4.0	Channel catfish Spotted sucker Northern hog sucker	0.6 U U										0.6 – –
Bear Creek Mile 0.4	Rock bass	U	U	U	U	U	U	U	U	U	0.2	Trace
Poplar Creek Mile 0.2	Channel catfish	U	U	2.1	U	U	U	0.7	1.8	2.5	3.4*	1.1

U – Undetectable level; * – Above FDA action level; ** – Total concentrations obtained by summing detectable levels. Source: Same as Table K6.

Table K8. Instream contaminant study – Task 4, significant maximum concentrations for radioisotopes in fish flesh samples – pCi/g, dry weight

Analysis/isotope	NRC reporting level[a]	Tennessee River[b]	Lower limit of detection[c]	Clinch River	East Fork Poplar Creek	White Oak Lake	White Oak Embayment	Bear Creek
Gross Alpha	[d]	5	0.1	.07	.9	.05	.07	.02
Gross Beta	[d]	45	0.1	64	74	76	40	29
Sr-89	[d]	1.2	0.5	.1	.2	.2	-1.6[e]	[f]
Sr-90	[d]	0.3	0.3	.01	.06	.25	1.3	[f]
Gamma spectral analysis[g]								
Co-60	40	.03	.01	–	.03	.12	.07	–
Cs-134	4	–	.08	–	.11	.04	–	–
Cs-137	8	.2	.02	18	2.6	26	9.7	.4
K-40	[d]	20	1.00	18	22	17	14	18

[a]Reporting levels for radioactivity concentrations in environmental samples as outlined in Draft NUREG-0472, Rev. 3, *Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors*, January 1983.
[b]Maximum concentrations reported by TVA in fish samples collected from the Tennessee River from 1981–1983.
[c]Lower limit of detection as determined by the method developed by Pasternack and Harley and described in Nucl. Instr. Methods 91. 533-4- (1971).
[d]No reporting level given.
[e]Negative value is an artifact of counting statistics and does not infer a negative activity.
[f]Analysis not performed.
[g]Dash indicates isotope not identified in gamma spectral analysis.

Source: Tennessee Valley Authority. 1985. *Instream Containment Study–Task 5, Summary Report.* Office of Natural Resources and Economic Development. Knoxville, Tenn.

Appendix L

SURFACE WATER CHARACTERIZATION–SUPPORTING STUDIES

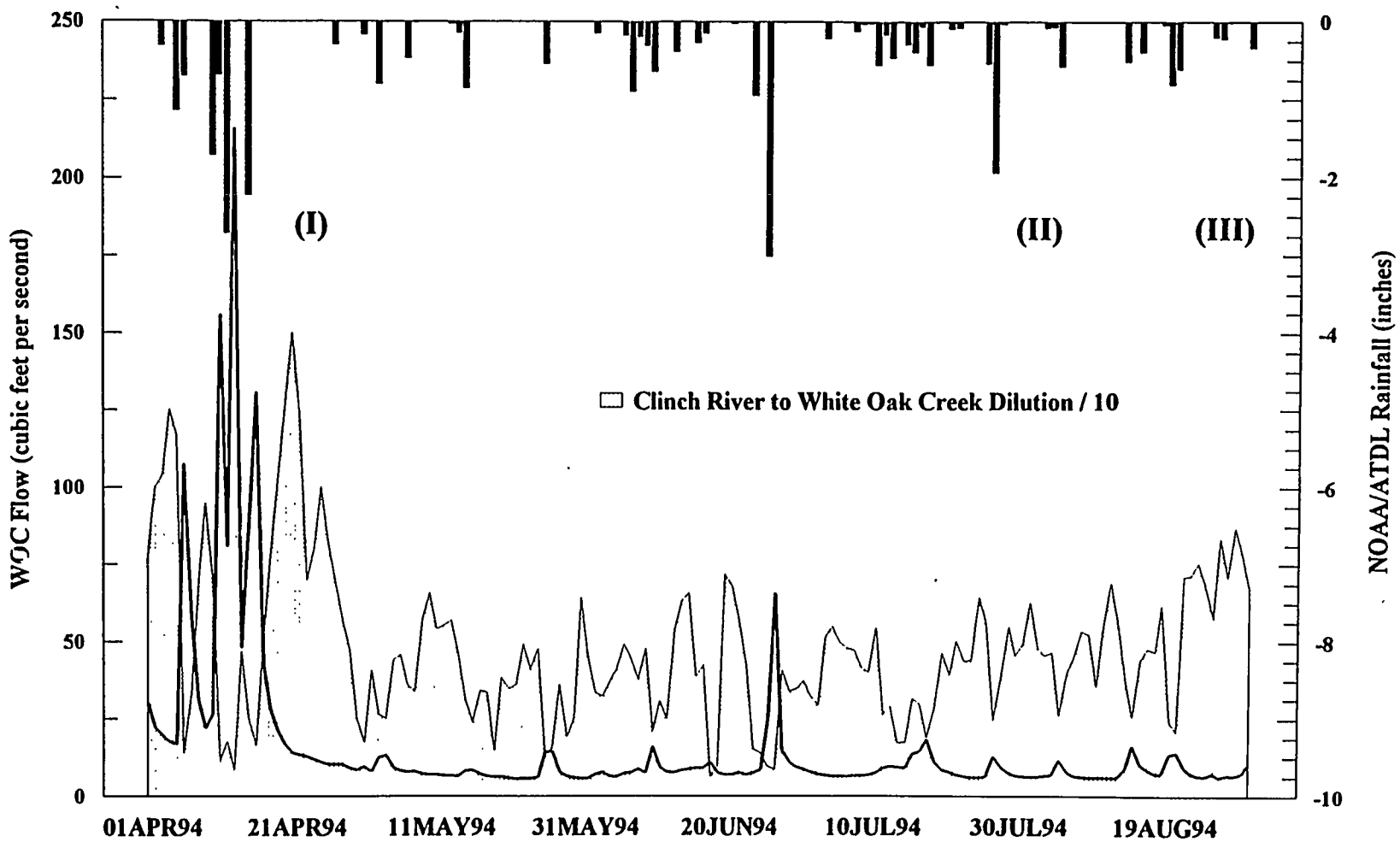

Fig. L1. Relationship between precipitation, flow in White Oak Creek, and flow in the Clinch River during Phase 2 biased event sampling. Rainfall at NOAA/ATDL (top), flow rates at White Oak Dam (solid line), dilution of White Oak Creek water by the Clinch River (shading), and sampling events (Roman numerals). April–August 1994.

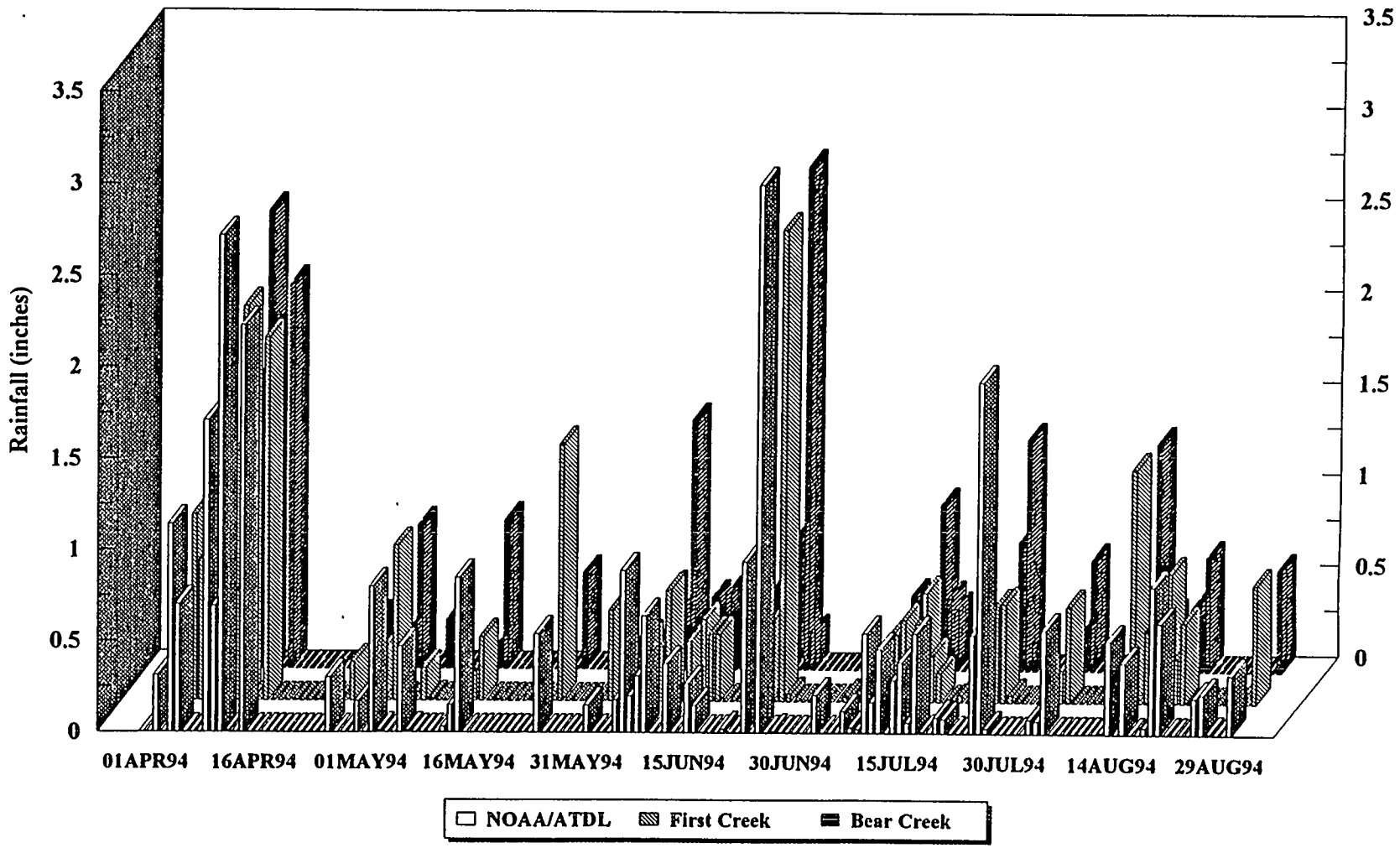

Fig. L2. Plots of rainfall, April–August 1994, at three gauges (see legend) on the Oak Ridge Reservation.

Table L1. Analytical results for the study of the distribution of contaminants downstream from the Central Neutralization Facility (PCM 3.4)

Distance downstream (m)	Media	Analyte	Qtr full	Half full	Full channel	Units
			LOW FLOW PCM 3.4			
1	WHOL	Alkalinity as C	1.30E+00	1.40E+00	1.30E+00	MEQ/L
1	WHOL	Gross Alpha act	2.53E+00	1.24E+00	2.23E+00	PCI/L
10	WHOL	Gross Alpha act	1.34E+00	.	1.24E+00	PCI/L
100	WHOL	Gross Alpha act	1.62E+00	1.41E+00	1.19E+00	PCI/L
1000	WHOL	Gross Alpha act	1.90E+00	.	1.73E+00	PCI/L
1	WHOL	Gross Beta acti	3.99E+00	1.98E+00	1.70E+00	PCI/L
10	WHOL	Gross Beta acti	1.76E+00	.	2.24E+00	PCI/L
100	WHOL	Gross Beta acti	3.48E+00	2.85E+00	1.74E+00	PCI/L
1000	WHOL	Gross Beta acti	2.79E+00	.	1.98E+00	PCI/L
1	WHOL	pH	7.80E+00	7.60E+00	7.60E+00	
1	RE	Suspend particl	3.40E+00	8.00E-01	8.00E-01	MG/L
10	RE	Suspend particl	2.20E+00	.	6.00E-01	MG/L
100	RE	Suspend particl	2.20E+00	2.00E+00	1.00E+00	MG/L
1000	RE	Suspend particl	1.20E+00	.	1.60E+00	MG/L
1	WHOL	Turbidity	9.00E+00	3.90E+00	3.40E+00	NTU
10	WHOL	Turbidity	3.90E+00	.	3.50E+00	NTU
100	WHOL	Turbidity	3.60E+00	3.50E+00	3.30E+00	NTU
1000	WHOL	Turbidity	3.60E+00	.	3.80E+00	NTU
			HIGH FLOW PCM 3.4			
1	WHOL	Gross Alpha act	2.51E+00	1.99E+00	2.00E+00	PCI/L
10	WHOL	Gross Alpha act	1.60E+00	.	1.29E+00	PCI/L
100	WHOL	Gross Alpha act	1.85E+00	2.25E+00	1.82E+00	PCI/L
1000	WHOL	Gross Alpha act	1.80E+00	.	1.58E+00	PCI/L
1	WHOL	Gross Beta acti	3.57E+00	4.94E+00	1.74E+00	PCI/L
10	WHOL	Gross Beta acti	2.69E+00	.	2.25E+00	PCI/L
100	WHOL	Gross Beta acti	2.50E+00	2.84E+00	6.99E+00	PCI/L
1000	WHOL	Gross Beta acti	2.17E+00	.	2.37E+00	PCI/L
1	RE	Suspend particl	2.60E+01	1.92E+01	1.96E+01	MG/L
10	RE	Suspend particl	2.08E+01	.	2.08E+01	MG/L
100	RE	Suspend particl	2.28E+01	2.08E+01	2.04E+01	MG/L
1000	RE	Suspend particl	1.96E+01	.	3.20E+01	MG/L
1	WHOL	Turbidity	.	2.10E+01	2.20E+01	NTU
10	WHOL	Turbidity	2.30E+01	.	2.00E+01	NTU
100	WHOL	Turbidity	2.10E+01	2.40E+01	2.20E+01	NTU
1000	WHOL	Turbidity	2.20E+01	.	.	NTU

Table L2. Analytical results for the study of the distribution of contaminants downstream from the mouth of Mitchell Branch (PCM 4.6)

Distance downstream (m)	Media	Analyte	Qtr full	Half full	Full channel	Units
LOW FLOW						
1	WHOL	Alkalinity as C	1.80E+00	1.50E+00	1.50E+00	meq/L
1	WHOL	Gross Alpha act	2.82E+00	2.65E+00	9.81E-01	pCi/L
10	WHOL	Gross Alpha act	2.03E+00	.	1.74E+00	pCi/L
100	WHOL	Gross Alpha act	2.72E+00	1.98E+00	1.92E+00	pCi/L
1000	WHOL	Gross Alpha act	1.62E+00	.	2.22E+00	pCi/L
1	WHOL	Gross Beta acti	4.34E+00	4.00E+00	2.10E+00	pCi/L
10	WHOL	Gross Beta acti	6.13E+00	.	3.72E+00	pCi/L
100	WHOL	Gross Beta acti	3.42E+00	5.92E+00	4.46E+00	pCi/L
1000	WHOL	Gross Beta acti	2.10E+00	.	9.39E+00	pCi/L
1	WHOL	pH	7.60E+00	7.60E+00	7.60E+00	
10	WHOL	pH	7.30E+00	.	7.32E+00	
100	WHOL	pH	7.39E+00	7.41E+00	7.46E+00	
1000	WHOL	pH	7.49E+00	.	7.50E+00	
1	RE	Suspend particl	4.20E+00	4.20E+00	4.00E+00	mg/L
10	RE	Suspend particl	4.80E+00	.	4.80E+00	mg/L
100	RE	Suspend particl	4.00E+00	4.80E+00	5.20E+00	mg/L
1000	RE	Suspend particl	5.20E+00	.	5.80E+00	mg/L
1	WHOL	Turbidity	4.10E+00	4.00E+00	4.40E+00	NTU
10	WHOL	Turbidity	4.10E+00	.	4.00E+00	NTU
100	WHOL	Turbidity	4.10E+00	4.50E+00	4.40E+00	NTU
1000	WHOL	Turbidity	4.20E+00	.	4.60E+00	NTU

Table L3. Analytical results for the study of the distribution of contaminants downstream from the mouth of East Fork Poplar Creek (PCM 5.5)

Distance downstream (m)	Media	Analyte	Qtr full	Half full	Full channel	Units
			LOW FLOW, PCM 5.5			
1	WHOL	Alkalinity as C	2.40E+00	1.80E+00	1.20E+00	meq/L
1	WHOL	Aluminum	5.05E-02	1.44E-01	1.60E-01	mg/L
10	WHOL	Aluminum	1.32E-01	.	2.06E-01	mg/L
100	WHOL	Aluminum	1.43E-01	1.91E-01	1.86E-01	mg/L
1000	WHOL	Aluminum	1.83E-01	.	1.40E-01	mg/L
1	WHOL	Antimony	1.00E-03	1.00E-03	1.00E-03	mg/L
1	WHOL	Barium	3.34E-02	3.39E-02	3.45E-02	mg/L
10	WHOL	Barium	3.33E-02	.	3.45E-02	mg/L
100	WHOL	Barium	3.35E-02	3.40E-02	3.43E-02	mg/L
1000	WHOL	Barium	3.33E-02	.	3.35E-02	mg/L
1	WHOL	Boron	4.11E-02	2.01E-02	1.69E-02	mg/L
10	WHOL	Boron	1.99E-02	.	3.00E-03	mg/L
100	WHOL	Boron	5.20E-03	3.01E-02	2.32E-02	mg/L
1000	WHOL	Boron	1.65E-02	.	7.00E-03	mg/L
1	WHOL	Calcium	4.45E+01	2.83E+01	2.31E+01	mg/L
10	WHOL	Calcium	3.17E+01	.	2.52E+01	mg/L
100	WHOL	Calcium	3.05E+01	2.94E+01	2.82E+01	mg/L
1000	WHOL	Calcium	3.07E+01	.	2.84E+01	mg/L
1	WHOL	Chromium	1.79E-03	1.70E-03	1.60E-03	mg/L
10	WHOL	Chromium	1.60E-03	.	1.50E-03	mg/L
100	WHOL	Chromium	1.30E-03	2.10E-03	1.40E-03	mg/L
1000	WHOL	Chromium	1.70E-03	.	1.30E-03	mg/L
1	WHOL	Copper	1.86E-03	2.00E-03	2.20E-03	mg/L
10	WHOL	Copper	1.40E-03	.	1.40E-03	mg/L
100	WHOL	Copper	1.60E-03	1.50E-03	1.70E-03	mg/L
1000	WHOL	Copper	1.60E-03	.	1.40E-03	mg/L
1	WHOL	Iron	4.41E-01	4.24E-01	4.44E-01	mg/L
10	WHOL	Iron	4.49E-01	.	4.55E-01	mg/L
100	WHOL	Iron	4.55E-01	4.52E-01	4.47E-01	mg/L
1000	WHOL	Iron	4.68E-01	.	4.51E-01	mg/L
1	WHOL	Magnesium	7.66E+00	6.89E+00	6.88E+00	mg/L
10	WHOL	Magnesium	7.25E+00	.	7.06E+00	mg/L
100	WHOL	Magnesium	7.13E+00	7.30E+00	7.28E+00	mg/L
1000	WHOL	Magnesium	7.24E+00	.	7.28E+00	mg/L
1	WHOL	Manganese	2.43E-02	7.53E-02	9.35E-02	mg/L
10	WHOL	Manganese	6.71E-02	.	9.03E-02	mg/L
100	WHOL	Manganese	6.88E-02	7.57E-02	7.99E-02	mg/L
1000	WHOL	Manganese	6.98E-02	.	7.82E-02	mg/L

Table L3 (continued)

Distance downstream (m)	Media	Analyte	Qtr full	Half full	Full channel	Units
1	WHOL	Mercury	6.89E-05	5.33E-05	4.69E-06	mg/L
10	WHOL	Mercury	4.56E-05	.	1.61E-05	mg/L
100	WHOL	Mercury	3.50E-05	2.42E-05	2.10E-05	mg/L
1000	WHOL	Mercury	3.23E-05	.	2.71E-05	mg/L
1	WHOL	Methyl Mercury	1.54E-07	1.09E-07	5.00E-08	mg/L
10	WHOL	Methyl Mercury	1.04E-07	.	6.50E-08	mg/L
100	WHOL	Methyl Mercury	1.01E-07	8.20E-08	7.70E-08	mg/L
1000	WHOL	Methyl Mercury	1.08E-07	.	9.40E-08	mg/L
1	WHOL	Nickel	3.53E-03	4.40E-03	4.10E-03	mg/L
10	WHOL	Nickel	3.90E-03	.	4.30E-03	mg/L
100	WHOL	Nickel	4.40E-03	4.30E-03	4.30E-03	mg/L
1000	WHOL	Nickel	4.20E-03	.	4.20E-03	mg/L
1	WHOL	pH	7.75E+00	7.66E+00	7.47E+00	
10	WHOL	pH	7.37E+00	.	7.19E+00	
100	WHOL	pH	7.50E+00	7.47E+00	7.50E+00	
1000	WHOL	pH	7.53E+00	.	7.59E+00	
1	WHOL	Potassium	1.76E+00	1.24E+00	1.06E+00	mg/L
10	WHOL	Potassium	1.32E+00	.	1.14E+00	mg/L
100	WHOL	Potassium	1.32E+00	1.31E+00	1.28E+00	mg/L
1000	WHOL	Potassium	1.32E+00	.	1.24E+00	mg/L
1	WHOL	Sodium	1.02E+01	4.98E+00	3.27E+00	mg/L
10	WHOL	Sodium	6.03E+00	.	3.76E+00	mg/L
100	WHOL	Sodium	5.62E+00	5.13E+00	4.79E+00	mg/L
1000	WHOL	Sodium	5.53E+00	.	4.84E+00	mg/L
1	RE	Suspend particl	8.00E-01	2.20E+00	3.00E+00	mg/L
10	RE	Suspend particl	2.20E+00	.	3.40E+00	mg/L
100	RE	Suspend particl	3.20E+00	2.80E+00	2.80E+00	mg/L
1000	RE	Suspend particl	3.20E+00	.	2.80E+00	mg/L
1	WHOL	Uranium	1.03E-02	2.70E-03	1.00E-03	mg/L
10	WHOL	Uranium	4.00E-03	.	1.00E-03	mg/L
100	WHOL	Uranium	3.50E-03	2.70E-03	2.10E-03	mg/L
1000	WHOL	Uranium	3.50E-03	.	2.30E-03	mg/L
1	WHOL	Zinc	9.69E-03	6.60E-03	7.00E-03	mg/L
10	WHOL	Zinc	5.40E-03	.	5.90E-03	mg/L
100	WHOL	Zinc	6.20E-03	5.90E-03	6.10E-03	mg/L
1000	WHOL	Zinc	6.10E-03	.	6.00E-03	mg/L
HIGH FLOW						
1	WHOL	Alkalinity as C	1.30E+00	1.20E+00	6.00E-01	meq/L
10	WHOL	Alkalinity as C	1.00E+00	.	8.00E-01	meq/L

Table L3 (continued)

Distance downstream (m)	Media	Analyte	Qtr full	Half full	Full channel	Units
100	WHOL	Alkalinity as C	8.00E-01	8.00E-01	7.00E-01	meq/L
1000	WHOL	Alkalinity as C	1.30E+00	.	6.00E-01	meq/L
1	WHOL	Aluminum	6.97E-01	6.34E-01	1.00E+00	mg/L
10	WHOL	Aluminum	6.15E-01	.	7.19E-01	mg/L
100	WHOL	Aluminum	8.20E-01	7.39E-01	8.73E-01	mg/L
1000	WHOL	Aluminum	9.14E-01	.	1.18E+00	mg/L
1	WHOL	Barium	3.06E-02	2.82E-02	3.25E-02	mg/L
10	WHOL	Barium	3.04E-02	.	3.10E-02	mg/L
100	WHOL	Barium	3.17E-02	3.18E-02	3.30E-02	mg/L
1000	WHOL	Barium	3.19E-02	.	3.37E-02	mg/L
1	WHOL	Boron	7.00E-03	7.00E-03	7.00E-03	mg/L
10	WHOL	Boron	7.00E-03	.	7.00E-03	mg/L
100	WHOL	Boron	7.00E-03	8.50E-03	7.00E-03	mg/L
1000	WHOL	Boron	7.00E-03	.	7.00E-03	mg/L
1	WHOL	Calcium	2.30E+01	1.98E+01	1.13E+01	mg/L
10	WHOL	Calcium	2.01E+01	.	1.46E+01	mg/L
100	WHOL	Calcium	1.49E+01	1.53E+01	1.29E+01	mg/L
1000	WHOL	Calcium	1.54E+01	.	1.27E+01	mg/L
1	WHOL	Chromium	1.90E-03	2.00E-03	2.90E-03	mg/L
10	WHOL	Chromium	1.80E-03	.	2.10E-03	mg/L
100	WHOL	Chromium	1.90E-03	2.30E-03	1.90E-03	mg/L
1000	WHOL	Chromium	2.00E-03	.	2.40E-03	mg/L
1	WHOL	Cobalt	1.00E-03	1.00E-03	1.70E-03	mg/L
10	WHOL	Cobalt	1.00E-03	.	1.20E-03	mg/L
100	WHOL	Cobalt	1.20E-03	1.20E-03	1.30E-03	mg/L
1000	WHOL	Cobalt	1.00E-03	.	1.30E-03	mg/L
1	WHOL	Copper	5.72E-03	4.00E-03	4.50E-03	mg/L
10	WHOL	Copper	5.00E-03	.	4.80E-03	mg/L
100	WHOL	Copper	3.90E-03	4.70E-03	4.60E-03	mg/L
1000	WHOL	Copper	4.40E-03	.	4.80E-03	mg/L
1	WHOL	Iron	9.37E-01	1.04E+00	1.68E+00	mg/L
10	WHOL	Iron	9.69E-01	.	1.23E+00	mg/L
100	WHOL	Iron	1.33E+00	1.34E+00	1.47E+00	mg/L
1000	WHOL	Iron	1.33E+00	.	1.62E+00	mg/L
1	WHOL	Lead	2.70E-03	2.20E-03	2.50E-03	mg/L
10	WHOL	Lead	2.00E-03	.	2.30E-03	mg/L
100	WHOL	Lead	2.40E-03	2.20E-03	1.90E-03	mg/L
1000	WHOL	Lead	1.80E-03	.	2.10E-03	mg/L
1	WHOL	Magnesium	4.26E+00	4.08E+00	4.41E+00	mg/L
10	WHOL	Magnesium	4.25E+00	.	4.19E+00	mg/L

Table L3 (continued)

Distance downstream (m)	Media	Analyte	Qtr full	Half full	Full channel	Units
100	WHOL	Magnesium	4.38E+00	4.24E+00	4.48E+00	mg/L
1000	WHOL	Magnesium	4.41E+00	.	4.59E+00	mg/L
1	WHOL	Manganese	4.86E-02	5.94E-02	1.24E-01	mg/L
10	WHOL	Manganese	6.63E-02	.	9.52E-02	mg/L
100	WHOL	Manganese	9.80E-02	9.57E-02	1.12E-01	mg/L
1000	WHOL	Manganese	9.43E-02	.	1.13E-01	mg/L
1	WHOL	Mercury	5.52E-04	3.74E-04	7.27E-06	mg/L
10	WHOL	Mercury	2.26E-04	.	2.20E-04	mg/L
100	WHOL	Mercury	1.09E-04	1.39E-04	5.16E-05	mg/L
1000	WHOL	Mercury	1.30E-04	.	3.84E-05	mg/L
1	WHOL	Methyl Mercury	2.39E-07	2.27E-07	6.70E-08	mg/L
10	WHOL	Methyl Mercury	4.94E-07	.	1.27E-07	mg/L
100	WHOL	Methyl Mercury	2.21E-07	2.52E-07	1.23E-07	mg/L
1000	WHOL	Methyl Mercury	3.13E-07	.	8.70E-08	mg/L
1	WHOL	Nickel	4.33E-03	4.40E-03	6.70E-03	mg/L
10	WHOL	Nickel	5.30E-03	.	4.90E-03	mg/L
100	WHOL	Nickel	5.60E-03	5.10E-03	5.80E-03	mg/L
1000	WHOL	Nickel	5.00E-03	.	5.60E-03	mg/L
1	WHOL	pH	7.60E+00	7.60E+00	7.30E+00	
10	WHOL	pH	7.20E+00	.	7.90E+00	
100	WHOL	pH	7.80E+00	7.80E+00	7.60E+00	
1000	WHOL	pH	7.50E+00	.	7.80E+00	
1	WHOL	Potassium	1.46E+00	1.37E+00	1.49E+00	mg/L
10	WHOL	Potassium	1.42E+00	.	1.40E+00	mg/L
100	WHOL	Potassium	1.41E+00	1.40E+00	1.49E+00	mg/L
1000	WHOL	Potassium	1.43E+00	.	1.51E+00	mg/L
1	WHOL	Sodium	3.96E+00	3.49E+00	2.91E+00	mg/L
10	WHOL	Sodium	3.87E+00	.	3.24E+00	mg/L
100	WHOL	Sodium	3.01E+00	3.69E+00	3.11E+00	mg/L
1000	WHOL	Sodium	3.22E+00	.	3.15E+00	mg/L
1	RE	Suspend particl	2.12E+01	1.80E+01	1.52E+01	mg/L
10	RE	Suspend particl	1.92E+01	.	3.24E+01	mg/L
100	RE	Suspend particl	3.40E+01	3.52E+01	3.56E+01	mg/L
1000	RE	Suspend particl	3.20E+01	.	3.80E+01	mg/L
1	WHOL	Thallium	1.00E-03	1.00E-03	1.00E-03	mg/L
10	WHOL	Thallium	1.00E-03	.	1.00E-03	mg/L
100	WHOL	Thallium	1.00E-03	1.00E-03	1.00E-03	mg/L
1000	WHOL	Thallium	1.00E-03	.	1.00E-03	mg/L
1	WHOL	Turbidity	1.60E+01	1.90E+01	2.10E+01	NTU
10	WHOL	Turbidity	1.80E+01	.	2.20E+01	NTU

Table L3 (continued)

Distance downstream (m)	Media	Analyte	Qtr full	Half full	Full channel	Units
100	WHOL	Turbidity	1.70E+01	2.20E+01	2.60E+01	NTU
1000	WHOL	Turbidity	1.80E+01	.	1.80E+01	NTU
1	WHOL	Uranium	7.45E-03	5.60E-03	1.00E-03	mg/L
10	WHOL	Uranium	4.90E-03	.	2.30E-03	mg/L
100	WHOL	Uranium	2.40E-03	2.40E-03	1.00E-03	mg/L
1000	WHOL	Uranium	2.30E-03	.	1.00E-03	mg/L
1	WHOL	Vanadium	1.18E-03	1.50E-03	2.40E-03	mg/L
10	WHOL	Vanadium	1.40E-03	.	2.00E-03	mg/L
100	WHOL	Vanadium	1.20E-03	1.70E-03	1.30E-03	mg/L
1000	WHOL	Vanadium	1.90E-03	.	2.30E-03	mg/L
1	WHOL	Zinc	1.63E-02	1.36E-02	2.24E-02	mg/L
10	WHOL	Zinc	2.13E-02	.	1.86E-02	mg/L
100	WHOL	Zinc	2.05E-02	2.34E-02	2.40E-02	mg/L
1000	WHOL	Zinc	1.96E-02	.	2.45E-02	mg/L

Table L4. Description of subtasks, listing of requested analyses, locations, and sample collection frequency during the Phase 2 RI on the Clinch River and Poplar Creek Operable Units

Description	Analytical Classes[a]	Locations (reach)	Number of sites sampled
Water contaminant concentrations and water quality in Poplar Creek	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH,	PCM 1 (3.04)	n=12[b] (includes 3 W1.1T for TOX)
		PCM 2.9 (3.03)	n=14[b] (includes 3 W1.1T for TOX)
		PCM 4.3 (3.02)	n=14[b] (includes 3 W1.1T for TOX)
		PCM 5.1 (3.01)	n=13[b] (includes 3 W1.1T for TOX)
		PCM 6 (13)	n=14[b] (includes 3 W1.1T for TOX)
		PCM 6.5 (13)	n=12[b]
		PCM 7 (13)	n=12[b]
		PCM 7.5 (13)	n=11[b]
Water contaminant concentrations and ambient toxicity testing	W1.1T: Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH W2: *C. dubia*, Fathead minnow, Japanese medaka, chromotest[c]	CRM 22 (2.01)	W1.1T n=3, W2, n=6
		CRM 19 (2.03)	W1.1T n=3, W2 n= 6
		PCM 5.1 (3.01)	W1.1T see above, W2 n=6
		PCM 4.3 (3.02)	W1.1T see above, W2 n=6
		PCM 2.9 (3.03)	W1.1T see above, W2 n=6
		PCM 1 (3.04)	W1.1T see above, W2 n= 6
		CRM 9 (4.01)	W1.1T n=3, W2 n= 6
		PCM 6 (13)	W1.1T see above, W2 n= 6
		PCM 11.3 (13)	W2 n=6

Table L4 (continued)

Description	Analytical Classes[a]	Locations (reach)	Number of sites sampled
		MBM 0.2 (7.02)	W1.1T n=2, W2 n=2[d]
		MBM 0.4 (7.01)	W1.1Tn=2, W2 n=2[d]
		Walker Branch (WBM) 0.4 (8)	W1.1T n=2, W2 n=2[d]
Mixing of contaminants with distance from EFPC (PCM 5.5)	Total ICP-MS metals, Hg-spec, TSP, Alkalinity, NTU, pH	PCM 5.5: 10 sites (transects at 0, 10, 100 and 1000 m)	n=20 (1 set during winter low flow and 1 during winter high flow)
Mixing of contaminants with distance from Mitchell Branch (PCM 4.6)	Gross Alpha- Beta, TSP, Alkalinity, NTU, pH	PCM 4.6: 10 sites (transects at 0, 10, 100 and 1000 m)	n=10 (1 set during winter low flow)
Mixing of contaminants with distance from CNF outfall (PCM 3.4)	Gross Alpha- Beta, TSP, Alkalinity, NTU, pH	PCM 3.4:10 sites, (transects at 0, 10, 100 and 1000 m)	n=20 (1 set during winter low flow and 1 during winter high flow)
Biased Event Sampling, McCoy Branch	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH	CRM 36.9B[c] (1)	n=3, April 19, July 28, August 29
		MBM 0.2A (7.02)	n=3, April 19, July 28, August 29
		MBM 0.2B (7.02)	n=3, April 19, July 28, August 29
		MBM 0.2C (7.02)	n=3, April 19, July 28, August 29
		MBM 0.4B (7.01)	n=3, April 19, July 28, August 29
Biased Event Sampling, White Oak Creek	Total + Filtered (SVOA, PPCB, ICP-MS metals, Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH **Note: no mercury speciation data were collected at this source.**	CRM 19B (2.03)	n=3, April 19, July 28, August 29
		CRM 20.2A (2.02)	n=3, April 19, July 28, August 29
		CRM 20.2B (2.02)	n=3, April 19, July 28, August 29

Table L4 (continued)

Description	Analytical Classes[a]	Locations (reach)	Number of sites sampled
		CRM 20.2C (2.02)	n=3, April 19, July 28, August 29
		WOCM 0B (2.02)	n=3, April 19, July 28, August 29
Biased Event Sampling, Poplar Creek	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH	CRM 9B (4.01)	n = 3, April 20, July 29, August 30
		CRM 11.8A (4.01)	n = 3, April 20, July 29, August 30
		CRM 11.8B (4.01)	n = 3, April 20, July 29, August 30
		CRM 11.8C (4.01)	n = 3, April 20, July 29, August 30
		PCM 0.25B (3.04)	n = 3, April 20, July 29, August 30
Biased Event Sampling, Reference area	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH	CRM 41.5B (1)	n=3, April 20, July 29, August 30
		CRM 43B (1)	n=3, April 20, July 29, August 30
		CRM 46B (1)	n=3, April 20, July 29, August 30
		CRM 1B (4.04)	n=3, April 20, July 29, August 30
Contaminant remobilization from sediments (samples collected from 1m above sediment surface)	Total + Filtered (SVOA, PPCB, ICP-MS metals, Hg-spec., Cyanide, Gamma spec.), Gross Alpha-Beta, ^{3}H, ^{90}Sr, Anions, Ammonia, NO_3+NO_4, TSP, Alkalinity, NTU, pH	CRM 41.5 (1)	n=6, 3 samples per season[d]
		MBM 0.2 (7.02)	n=6, 3 samples per season[d]
		CRM 6 (4.02)	n=6, 3 samples per season[d]
		CRM 1 (4.04)	n=6, 3 samples per season[d]
Oak Ridge Reservation Environmental Monitoring Program	General water quality, total metals, radionuclides, including ^{241}Am, ^{244}Cm, ^{238}Pu, ^{239}Pu, ^{99}Tc, ^{234}U, ^{235}U, ^{238}U and total U activity, volatile organic analytes.	see DOE/OR-1066	see DOE/OR-1066

Table L4 (continued)

Description	Analytical Classes[a]	Locations (reach)	Number of sites sampled
TVA Collection of water samples from source areas to Melton Hill and Watts Bar Reservoir (Task 4.2 of DE-A105-91OR22007)	Total + Filtered (ICP metals, AA metals, CVAA - Hg, Cyanide), ^{3}H, TSP	see Task 4.2 of DE-A105-91OR22007	once per site

[a]See Appendix B in ORNL/ER-218 for analytical methods. Applicable to all listed subtasks except for non-CR-ERP and Historic data.
[b]Winter, spring, and summer seasons sampled.
[c]See DOE/OR/01-1111&D3 for toxicity testing information.
[d]Spring and summer seasons sampled.
[e]Letter designation following location indicates lateral position in the stream channel relative to the outfall position: "A"= one-quarter distance from outfall shore to mid-channel, "B" = mid-channel, "C"= three-quarters distance from outfall shore to opposite shore.

Table L5. Unfiltered and filtered metal concentrations (mg/L) for biased sampling events (April 18-19, 1994, July 28-29, 1994, and August 29-30, 1994). One sample per site per event. Analytes at a given site that were below detection for all events were omitted from this table.

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
McCoy	MBM 0.4B	Unfiltered	Arsenic	3.300E-03	5.400E-03	2.400E-03
McCoy	MBM 0.4B	Unfiltered	Barium	3.440E-02	3.240E-02	3.110E-02
McCoy	MBM 0.4B	Unfiltered	Boron	8.520E-02	6.130E-02	3.000E-02
McCoy	MBM 0.4B	Unfiltered	Chromium	<0.002	<0.001	1.900E-03
McCoy	MBM 0.4B	Unfiltered	Copper	5.300E-03	1.700E-03	2.360E-02
McCoy	MBM 0.4B	Unfiltered	Iron	2.910E-01	2.000E-01	1.440E-01
McCoy	MBM 0.4B	Unfiltered	Lead	1.200E-03	<0.001	1.300E-03
McCoy	MBM 0.4B	Unfiltered	Manganese	4.240E-02	5.100E-02	6.040E-02
McCoy	MBM 0.4B	Unfiltered	Molybdenum	1.500E-03	<0.005	<0.005
McCoy	MBM 0.4B	Unfiltered	Nickel	3.000E-03	<0.001	5.500E-03
McCoy	MBM 0.4B	Unfiltered	Vanadium	1.300E-03	1.600E-03	<0.001
McCoy	MBM 0.4B	Unfiltered	Zinc	1.550E-02	7.200E-03	1.750E-02
McCoy	MBM 0.4B	Filtered	Aluminum	<0.0010	<0.006	1.140E-02
McCoy	MBM 0.4B	Filtered	Antimony	5.600E-03	4.400E-03	6.900E-03
McCoy	MBM 0.4B	Filtered	Arsenic	3.400E-03	5.100E-03	1.700E-03
McCoy	MBM 0.4B	Filtered	Barium	2.910E-02	2.730E-02	2.630E-02
McCoy	MBM 0.4B	Filtered	Boron	6.630E-02	5.160E-02	3.350E-02
McCoy	MBM 0.4B	Filtered	Chromium	<0.002	<0.001	1.400E-03
McCoy	MBM 0.4B	Filtered	Copper	2.100E-03	2.700E-03	4.000E-03
McCoy	MBM 0.4B	Filtered	Iron	2.140E-02	<0.0018	<0.0018
McCoy	MBM 0.4B	Filtered	Manganese	2.080E-02	<0.001	2.500E-03
McCoy	MBM 0.4B	Filtered	Molybdenum	1.600E-03	<0.005	<0.005
McCoy	MBM 0.4B	Filtered	Nickel	2.900E-03	1.000E-02	1.200E-03
McCoy	MBM 0.4B	Filtered	Vanadium	<0.001	1.300E-03	<0.001
McCoy	MBM 0.4B	Filtered	Zinc	4.200E-03	5.500E-03	3.800E-03
McCoy	MBM 0.2A	Unfiltered	Aluminum	2.590E-01	3.350E-02	1.010E-01
McCoy	MBM 0.2A	Unfiltered	Arsenic	1.300E-03	1.000E-03	<0.001
McCoy	MBM 0.2A	Unfiltered	Barium	2.640E-02	2.850E-02	3.240E-02
McCoy	MBM 0.2A	Unfiltered	Boron	4.190E-02	1.130E-01	5.200E-02
McCoy	MBM 0.2A	Unfiltered	Chromium	<0.002	<0.001	1.900E-03
McCoy	MBM 0.2A	Unfiltered	Copper	5.600E-03	1.400E-03	2.270E-02
McCoy	MBM 0.2A	Unfiltered	Iron	4.340E-01	3.230E-02	1.460E-01
McCoy	MBM 0.2A	Unfiltered	Lead	1.500E-03	<0.001	1.300E-03
McCoy	MBM 0.2A	Unfiltered	Manganese	4.560E-02	3.120E-02	6.540E-02
McCoy	MBM 0.2A	Unfiltered	Nickel	2.800E-03	<0.001	5.500E-03
McCoy	MBM 0.2A	Unfiltered	Vanadium	1.100E-03	<0.001	<0.001
McCoy	MBM 0.2A	Unfiltered	Zinc	1.180E-02	6.200E-03	2.250E-02
McCoy	MBM 0.2A	Filtered	Aluminum	1.420E-02	1.020E-02	8.800E-03
McCoy	MBM 0.2A	Filtered	Antimony	1.900E-03	1.300E-03	3.000E-03

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
McCoy	MBM 0.2A	Filtered	Arsenic	<0.001	1.500E-03	1.000E-03
McCoy	MBM 0.2A	Filtered	Barium	2.070E-02	3.210E-02	2.520E-02
McCoy	MBM 0.2A	Filtered	Boron	5.350E-02	1.100E-01	3.380E-02
McCoy	MBM 0.2A	Filtered	Chromium	<0.002	<0.001	1.700E-03
McCoy	MBM 0.2A	Filtered	Copper	9.500E-03	2.500E-03	3.700E-03
McCoy	MBM 0.2A	Filtered	Iron	3.300E-02	1.800E-02	<0.0018
McCoy	MBM 0.2A	Filtered	Manganese	5.900E-03	<0.001	1.500E-03
McCoy	MBM 0.2A	Filtered	Nickel	1.800E-03	1.400E-03	1.400E-03
McCoy	MBM 0.2A	Filtered	Zinc	8.600E-03	2.700E-03	3.800E-03
McCoy	MBM 0.2B	Unfiltered	Aluminum	2.870E-01	4.810E-02	6.580E-02
McCoy	MBM 0.2B	Unfiltered	Barium	2.340E-02	2.830E-02	2.810E-02
McCoy	MBM 0.2B	Unfiltered	Boron	4.120E-02	9.250E-02	4.100E-02
McCoy	MBM 0.2B	Unfiltered	Chromium	<0.002	<0.001	1.900E-03
McCoy	MBM 0.2B	Unfiltered	Copper	5.100E-03	1.300E-03	3.220E-02
McCoy	MBM 0.2B	Unfiltered	Iron	4.640E-01	4.860E-02	1.080E-01
McCoy	MBM 0.2B	Unfiltered	Lead	<0.001	<0.001	1.300E-03
McCoy	MBM 0.2B	Unfiltered	Manganese	4.050E-02	2.870E-02	4.130E-02
McCoy	MBM 0.2B	Unfiltered	Nickel	1.500E-03	<0.001	8.700E-03
McCoy	MBM 0.2B	Unfiltered	Zinc	8.200E-03	3.000E-03	2.340E-02
McCoy	MBM 0.2B	Filtered	Aluminum	1.200E-02	<0.006	1.350E-02
McCoy	MBM 0.2B	Filtered	Antimony	2.800E-03	<0.001	3.800E-03
McCoy	MBM 0.2B	Filtered	Arsenic	1.100E-03	<0.001	<0.001
McCoy	MBM 0.2B	Filtered	Barium	2.070E-02	2.800E-02	2.520E-02
McCoy	MBM 0.2B	Filtered	Boron	3.340E-02	1.160E-01	4.780E-02
McCoy	MBM 0.2B	Filtered	Chromium	<0.002	<0.001	1.800E-03
McCoy	MBM 0.2B	Filtered	Copper	2.900E-03	3.000E-03	4.200E-03
McCoy	MBM 0.2B	Filtered	Iron	2.690E-02	<0.0018	<0.0018
McCoy	MBM 0.2B	Filtered	Manganese	4.800E-03	<0.001	1.500E-03
McCoy	MBM 0.2B	Filtered	Nickel	1.400E-03	4.200E-03	1.100E-03
McCoy	MBM 0.2B	Filtered	Selenium	3.200E-03	<0.001	<0.001
McCoy	MBM 0.2B	Filtered	Zinc	5.100E-03	2.000E-03	3.900E-03
McCoy	MBM 0.2C	Unfiltered	Aluminum	5.330E-01	5.370E-02	6.940E-02
McCoy	MBM 0.2C	Unfiltered	Barium	2.890E-02	2.890E-02	3.010E-02
McCoy	MBM 0.2C	Unfiltered	Boron	4.508E-02	1.120E-01	4.320E-02
McCoy	MBM 0.2C	Unfiltered	Chromium	<0.002	2.500E-03	2.100E-03
McCoy	MBM 0.2C	Unfiltered	Copper	5.260E-03	1.800E-03	3.680E-02
McCoy	MBM 0.2C	Unfiltered	Iron	4.400E-01	5.670E-02	1.040E-01

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
McCoy	MBM 0.2C	Unfiltered	Lead	1.440E-03	<0.001	1.700E-03
McCoy	MBM 0.2C	Unfiltered	Manganese	3.829E-02	2.890E-02	3.840E-02
McCoy	MBM 0.2C	Unfiltered	Nickel	3.620E-03	<0.001	1.000E-02
McCoy	MBM 0.2C	Unfiltered	Selenium	<0.003	<0.001	1.100E-03
McCoy	MBM 0.2C	Unfiltered	Zinc	1.683E-02	3.900E-03	1.590E-02
McCoy	MBM 0.2C	Filtered	Aluminum	<0.0010	<0.006	6.000E-03
McCoy	MBM 0.2C	Filtered	Antimony	5.300E-03	<0.001	2.400E-03
McCoy	MBM 0.2C	Filtered	Arsenic	1.300E-03	<0.001	<0.001
McCoy	MBM 0.2C	Filtered	Barium	2.170E-02	2.790E-02	2.300E-02
McCoy	MBM 0.2C	Filtered	Boron	2.610E-02	6.820E-02	4.040E-02
McCoy	MBM 0.2C	Filtered	Chromium	<0.002	<0.001	1.500E-03
McCoy	MBM 0.2C	Filtered	Copper	3.000E-03	2.000E-03	3.200E-03
McCoy	MBM 0.2C	Filtered	Iron	3.460E-02	<0.0018	<0.0018
McCoy	MBM 0.2C	Filtered	Manganese	3.700E-03	1.200E-03	<0.001
McCoy	MBM 0.2C	Filtered	Nickel	1.300E-03	4.300E-03	1.100E-03
McCoy	MBM 0.2C	Filtered	Zinc	2.000E-03	<0.002	3.700E-03
McCoy	CRM 39.6B	Unfiltered	Aluminum	2.070E-01	6.730E-02	7.140E-02
McCoy	CRM 39.6B	Unfiltered	Barium	2.690E-02	2.790E-02	2.420E-02
McCoy	CRM 39.6B	Unfiltered	Boron	4.310E-02	9.980E-02	6.430E-02
McCoy	CRM 39.6B	Unfiltered	Chromium	<0.002	1.100E-03	2.400E-03
McCoy	CRM 39.6B	Unfiltered	Copper	6.500E-03	2.100E-03	2.900E-03
McCoy	CRM 39.6B	Unfiltered	Iron	3.770E-01	7.560E-02	7.400E-02
McCoy	CRM 39.6B	Unfiltered	Lead	1.400E-03	<0.001	<0.001
McCoy	CRM 39.6B	Unfiltered	Manganese	8.630E-02	5.000E-02	3.690E-02
McCoy	CRM 39.6B	Unfiltered	Nickel	2.100E-03	<0.001	1.300E-03
McCoy	CRM 39.6B	Unfiltered	Zinc	1.800E-02	4.300E-03	5.400E-03
McCoy	CRM 39.6B	Filtered	Aluminum	<0.0010	3.371E-02	3.188E-02
McCoy	CRM 39.6B	Filtered	Antimony	4.600E-03	<0.001	3.520E-03
McCoy	CRM 39.6B	Filtered	Barium	2.320E-02	2.505E-02	2.215E-02
McCoy	CRM 39.6B	Filtered	Boron	3.690E-02	7.463E-02	8.393E-02
McCoy	CRM 39.6B	Filtered	Chromium	<0.002	1.360E-03	2.260E-03
McCoy	CRM 39.6B	Filtered	Copper	7.400E-03	2.520E-03	5.080E-03
McCoy	CRM 39.6B	Filtered	Iron	3.910E-02	<0.0018	<0.0018
McCoy	CRM 39.6B	Filtered	Manganese	1.200E-02	<0.001	1.650E-03
McCoy	CRM 39.6B	Filtered	Nickel	1.800E-03	1.660E-03	1.860E-03
McCoy	CRM 39.6B	Filtered	Zinc	1.490E-02	4.790E-03	8.260E-03

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Poplar Cr.	PCM 0.1 B	Unfiltered	Aluminum	1.320E-01	2.260E-01	1.480E-01
Poplar Cr.	PCM 0.1 B	Unfiltered	Antimony	1.900E-03	<0.001	<0.001
Poplar Cr.	PCM 0.1 B	Unfiltered	Arsenic	1.400E-03	<0.001	<0.001
Poplar Cr.	PCM 0.1 B	Unfiltered	Barium	3.050E-02	2.990E-02	2.440E-02
Poplar Cr.	PCM 0.1 B	Unfiltered	Boron	2.250E-02	9.260E-02	1.080E-01
Poplar Cr.	PCM 0.1 B	Unfiltered	Chromium	<0.002	1.300E-03	1.600E-03
Poplar Cr.	PCM 0.1 B	Unfiltered	Copper	2.100E-03	3.300E-03	1.900E-03
Poplar Cr.	PCM 0.1 B	Unfiltered	Iron	3.220E-01	3.060E-01	1.670E-01
Poplar Cr.	PCM 0.1 B	Unfiltered	Lead	<0.001	1.300E-03	<0.001
Poplar Cr.	PCM 0.1 B	Unfiltered	Manganese	6.230E-02	5.250E-02	4.530E-02
Poplar Cr.	PCM 0.1 B	Unfiltered	Nickel	3.700E-03	1.900E-03	1.400E-03
Poplar Cr.	PCM 0.1 B	Unfiltered	Uranium	1.600E-03	<0.001	<0.001
Poplar Cr.	PCM 0.1 B	Unfiltered	Zinc	1.410E-02	1.980E-02	2.700E-03
Poplar Cr.	PCM 0.1 B	Filtered	Aluminum	2.190E-02	3.060E-02	1.450E-02
Poplar Cr.	PCM 0.1 B	Filtered	Antimony	1.300E-03	2.600E-03	8.400E-03
Poplar Cr.	PCM 0.1 B	Filtered	Arsenic	1.100E-03	<0.001	1.100E-03
Poplar Cr.	PCM 0.1 B	Filtered	Barium	2.820E-02	2.620E-02	2.310E-02
Poplar Cr.	PCM 0.1 B	Filtered	Boron	3.550E-02	1.300E-02	6.120E-02
Poplar Cr.	PCM 0.1 B	Filtered	Chromium	<0.002	<0.001	1.100E-03
Poplar Cr.	PCM 0.1 B	Filtered	Copper	1.200E-03	6.120E-02	7.900E-03
Poplar Cr.	PCM 0.1 B	Filtered	Iron	1.710E-01	<0.0018	<0.0018
Poplar Cr.	PCM 0.1 B	Filtered	Manganese	4.930E-02	6.300E-03	2.000E-03
Poplar Cr.	PCM 0.1 B	Filtered	Nickel	3.400E-03	1.600E-03	2.200E-03
Poplar Cr.	PCM 0.1 B	Filtered	Uranium	1.600E-03	<0.001	<0.001
Poplar Cr.	PCM 0.1 B	Filtered	Zinc	3.700E-03	1.280E-01	3.600E-03
Poplar Cr.	CRM 11.8 A	Unfiltered	Aluminum	9.870E-02	3.560E-01	1.120E-01
Poplar Cr.	CRM 11.8 A	Unfiltered	Barium	2.610E-02	3.080E-02	2.440E-02
Poplar Cr.	CRM 11.8 A	Unfiltered	Boron	1.800E-02	6.030E-02	5.390E-02
Poplar Cr.	CRM 11.8 A	Unfiltered	Chromium	<0.002	1.300E-03	1.500E-03
Poplar Cr.	CRM 11.8 A	Unfiltered	Copper	1.200E-03	8.140E-02	1.700E-03
Poplar Cr.	CRM 11.8 A	Unfiltered	Iron	3.200E-01	4.390E-01	1.320E-01
Poplar Cr.	CRM 11.8 A	Unfiltered	Lead	<0.001	2.400E-03	<0.001
Poplar Cr.	CRM 11.8 A	Unfiltered	Manganese	5.080E-02	5.380E-02	4.080E-02
Poplar Cr.	CRM 11.8 A	Unfiltered	Nickel	3.200E-03	2.500E-03	1.100E-03
Poplar Cr.	CRM 11.8 A	Unfiltered	Zinc	4.100E-03	1.860E-01	3.000E-03
Poplar Cr.	CRM 11.8 A	Filtered	Aluminum	2.350E-02	3.800E-02	9.000E-03
Poplar Cr.	CRM 11.8 A	Filtered	Antimony	<0.001	3.400E-03	7.300E-03
Poplar Cr.	CRM 11.8 A	Filtered	Barium	2.220E-02	2.640E-02	2.390E-02
Poplar Cr.	CRM 11.8 A	Filtered	Boron	2.780E-02	2.090E-02	5.130E-02

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Poplar Cr.	CRM 11.8 A	Filtered	Chromium	3.000E-03	<0.001	1.300E-03
Poplar Cr.	CRM 11.8 A	Filtered	Copper	2.200E-03	6.570E-02	3.200E-03
Poplar Cr.	CRM 11.8 A	Filtered	Iron	2.350E-01	<0.0018	1.800E-02
Poplar Cr.	CRM 11.8 A	Filtered	Manganese	9.400E-03	3.500E-03	2.100E-03
Poplar Cr.	CRM 11.8 A	Filtered	Nickel	3.000E-03	1.700E-03	1.800E-03
Poplar Cr.	CRM 11.8 A	Filtered	Zinc	4.300E-03	1.280E-01	2.800E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Aluminum	9.310E-02	5.230E-01	9.430E-02
Poplar Cr.	CRM 11.8 B	Unfiltered	Antimony	<0.001	<0.001	1.700E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Arsenic	<0.001	<0.001	1.000E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Barium	2.390E-02	3.390E-01	2.500E-02
Poplar Cr.	CRM 11.8 B	Unfiltered	Boron	<0.0018	7.590E-02	5.880E-02
Poplar Cr.	CRM 11.8 B	Unfiltered	Chromium	<0.002	2.200E-03	1.700E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Copper	1.100E-03	5.100E-03	2.000E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Iron	2.960E-01	6.990E-01	1.170E-01
Poplar Cr.	CRM 11.8 B	Unfiltered	Lead	<0.001	2.100E-03	<0.001
Poplar Cr.	CRM 11.8 B	Unfiltered	Manganese	4.560E-02	6.460E-02	4.130E-02
Poplar Cr.	CRM 11.8 B	Unfiltered	Nickel	2.800E-03	2.900E-03	1.200E-03
Poplar Cr.	CRM 11.8 B	Unfiltered	Uranium	<0.001	1.500E-03	<0.001
Poplar Cr.	CRM 11.8 B	Unfiltered	Vanadium	<0.001	1.400E-03	<0.001
Poplar Cr.	CRM 11.8 B	Unfiltered	Zinc	2.800E-03	3.290E-02	4.200E-03
Poplar Cr.	CRM 11.8 B	Filtered	Aluminum	1.570E-02	2.970E-02	1.100E-02
Poplar Cr.	CRM 11.8 B	Filtered	Antimony	<0.001	4.600E-03	6.300E-03
Poplar Cr.	CRM 11.8 B	Filtered	Arsenic	1.100E-03	<0.001	<0.001
Poplar Cr.	CRM 11.8 B	Filtered	Barium	2.090E-02	2.740E-02	2.320E-02
Poplar Cr.	CRM 11.8 B	Filtered	Boron	1.800E-02	8.150E-02	7.130E-02
Poplar Cr.	CRM 11.8 B	Filtered	Chromium	<0.002	1.600E-03	<0.001
Poplar Cr.	CRM 11.8 B	Filtered	Copper	1.200E-03	1.030E-02	3.400E-03
Poplar Cr.	CRM 11.8 B	Filtered	Iron	2.130E-01	2.280E-02	<0.0018
Poplar Cr.	CRM 11.8 B	Filtered	Manganese	3.600E-03	1.000E-02	1.900E-03
Poplar Cr.	CRM 11.8 B	Filtered	Nickel	2.900E-03	3.700E-03	2.600E-03
Poplar Cr.	CRM 11.8 B	Filtered	Selenium	<0.005	1.100E-03	1.200E-03
Poplar Cr.	CRM 11.8 B	Filtered	Uranium	<0.001	1.500E-03	<0.001
Poplar Cr.	CRM 11.8 B	Filtered	Zinc	4.800E-03	7.400E-03	3.800E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Aluminum	9.310E-02	8.610E-01	2.840E-01
Poplar Cr.	CRM 11.8 C	Unfiltered	Arsenic	<0.001	<0.001	1.300E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Barium	2.480E-02	3.630E-02	2.920E-02
Poplar Cr.	CRM 11.8 C	Unfiltered	Boron	4.450E-02	8.620E-02	6.830E-02

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Poplar Cr.	CRM 11.8 C	Unfiltered	Chromium	<0.002	2.300E-03	2.000E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Copper	1.700E-03	8.320E-02	1.800E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Iron	3.060E-01	9.710E-01	3.230E-01
Poplar Cr.	CRM 11.8 C	Unfiltered	Lead	<0.001	3.200E-03	<0.001
Poplar Cr.	CRM 11.8 C	Unfiltered	Manganese	4.500E-02	7.340E-02	6.540E-02
Poplar Cr.	CRM 11.8 C	Unfiltered	Nickel	2.800E-03	4.300E-03	1.700E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Uranium	<0.001	2.000E-03	1.300E-03
Poplar Cr.	CRM 11.8 C	Unfiltered	Vanadium	<0.001	1.900E-03	<0.001
Poplar Cr.	CRM 11.8 C	Unfiltered	Zinc	7.900E-03	2.000E-01	4.700E-03
Poplar Cr.	CRM 11.8 C	Filtered	Aluminum	1.750E-02	2.770E-02	1.090E-02
Poplar Cr.	CRM 11.8 C	Filtered	Antimony	<0.001	4.100E-03	7.100E-03
Poplar Cr.	CRM 11.8 C	Filtered	Arsenic	1.200E-03	<0.001	1.200E-03
Poplar Cr.	CRM 11.8 C	Filtered	Barium	2.290E-02	2.910E-02	2.600E-02
Poplar Cr.	CRM 11.8 C	Filtered	Boron	<0.0018	6.050E-02	8.030E-02
Poplar Cr.	CRM 11.8 C	Filtered	Chromium	<0.002	4.900E-03	1.200E-03
Poplar Cr.	CRM 11.8 C	Filtered	Copper	1.000E-03	9.700E-03	4.000E-03
Poplar Cr.	CRM 11.8 C	Filtered	Iron	2.260E-01	5.340E-02	1.800E-02
Poplar Cr.	CRM 11.8 C	Filtered	Lead	1.400E-03	1.300E-03	<0.001
Poplar Cr.	CRM 11.8 C	Filtered	Manganese	3.800E-03	1.500E-02	2.900E-03
Poplar Cr.	CRM 11.8 C	Filtered	Nickel	4.000E-03	5.200E-03	1.700E-03
Poplar Cr.	CRM 11.8 C	Filtered	Selenium	<0.005	<0.001	1.100E-03
Poplar Cr.	CRM 11.8 C	Filtered	Uranium	<0.001	1.700E-03	1.100E-03
Poplar Cr.	CRM 11.8 C	Filtered	Zinc	3.800E-03	1.740E-02	4.100E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Aluminum	1.120E-01	1.050E-01	9.500E-02
Poplar Cr.	CRM 9.0 B	Unfiltered	Antimony	<0.001	<0.001	2.000E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Arsenic	<0.001	<0.001	1.100E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Barium	2.660E-02	2.820E-02	2.470E-02
Poplar Cr.	CRM 9.0 B	Unfiltered	Boron	<0.0018	4.130E-02	1.270E-01
Poplar Cr.	CRM 9.0 B	Unfiltered	Chromium	<0.002	1.400E-03	1.700E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Copper	1.300E-03	2.840E-02	2.300E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Iron	3.590E-01	1.190E-01	9.120E-02
Poplar Cr.	CRM 9.0 B	Unfiltered	Lead	<0.001	1.800E-03	<0.001
Poplar Cr.	CRM 9.0 B	Unfiltered	Manganese	5.160E-02	3.530E-02	3.640E-02
Poplar Cr.	CRM 9.0 B	Unfiltered	Molybdenum	1.800E-03	<0.005	<0.005
Poplar Cr.	CRM 9.0 B	Unfiltered	Nickel	2.900E-03	2.500E-03	1.200E-03
Poplar Cr.	CRM 9.0 B	Unfiltered	Zinc	3.800E-03	6.390E-02	3.400E-03
Poplar Cr.	CRM 9.0 B	Filtered	Aluminum	1.560E-02	3.280E-02	1.631E-02
Poplar Cr.	CRM 9.0 B	Filtered	Antimony	<0.001	4.720E-03	7.730E-03
Poplar Cr.	CRM 9.0 B	Filtered	Arsenic	1.200E-03	<0.001	<0.001

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Poplar Cr.	CRM 9.0 B	Filtered	Barium	2.130E-02	2.518E-02	2.421E-02
Poplar Cr.	CRM 9.0 B	Filtered	Boron	2.040E-02	2.145E-02	6.587E-02
Poplar Cr.	CRM 9.0 B	Filtered	Chromium	<0.002	<0.001	1.450E-03
Poplar Cr.	CRM 9.0 B	Filtered	Copper	1.400E-03	5.605E-02	3.730E-03
Poplar Cr.	CRM 9.0 B	Filtered	Iron	2.570E-01	1.800E-02	3.219E-02
Poplar Cr.	CRM 9.0 B	Filtered	Manganese	5.200E-03	<0.001	2.520E-03
Poplar Cr.	CRM 9.0 B	Filtered	Nickel	3.300E-03	1.610E-03	1.950E-03
Poplar Cr.	CRM 9.0 B	Filtered	Zinc	3.300E-03	1.116E-01	4.820E-03
Reference	CRM 46.0 B	Unfiltered	Aluminum	6.470E-02	9.370E-02	8.900E-02
Reference	CRM 46.0 B	Unfiltered	Arsenic	<0.001	<0.001	1.100E-03
Reference	CRM 46.0 B	Unfiltered	Barium	2.440E-02	2.620E-02	2.940E-02
Reference	CRM 46.0 B	Unfiltered	Boron	<0.0018	1.160E-02	7.780E-02
Reference	CRM 46.0 B	Unfiltered	Chromium	<0.002	1.600E-03	5.100E-03
Reference	CRM 46.0 B	Unfiltered	Copper	1.500E-03	6.900E-03	8.800E-03
Reference	CRM 46.0 B	Unfiltered	Iron	3.410E-01	1.320E-01	1.200E-01
Reference	CRM 46.0 B	Unfiltered	Lead	<0.001	1.400E-03	2.500E-03
Reference	CRM 46.0 B	Unfiltered	Manganese	5.010E-02	5.780E-02	6.050E-02
Reference	CRM 46.0 B	Unfiltered	Nickel	3.000E-03	2.600E-03	4.700E-03
Reference	CRM 46.0 B	Unfiltered	Zinc	3.900E-03	2.640E-02	2.550E-02
Reference	CRM 46.0 B	Filtered	Aluminum	1.910E-02	3.200E-02	5.670E-02
Reference	CRM 46.0 B	Filtered	Antimony	<0.001	4.700E-03	8.400E-03
Reference	CRM 46.0 B	Filtered	Arsenic	<0.001	<0.001	1.700E-03
Reference	CRM 46.0 B	Filtered	Barium	2.250E-02	2.300E-02	2.810E-02
Reference	CRM 46.0 B	Filtered	Boron	2.180E-02	2.570E-02	6.720E-02
Reference	CRM 46.0 B	Filtered	Chromium	<0.002	1.500E-03	5.500E-03
Reference	CRM 46.0 B	Filtered	Copper	1.100E-03	3.600E-03	2.040E-02
Reference	CRM 46.0 B	Filtered	Iron	2.560E-01	<0.0018	5.100E-02
Reference	CRM 46.0 B	Filtered	Lead	<0.001	<0.001	3.000E-03
Reference	CRM 46.0 B	Filtered	Manganese	1.090E-02	6.200E-03	2.380E-02
Reference	CRM 46.0 B	Filtered	Molybdenum	2.200E-03	<0.005	<0.005
Reference	CRM 46.0 B	Filtered	Nickel	3.200E-03	2.000E-03	8.000E-03
Reference	CRM 46.0 B	Filtered	Zinc	4.200E-03	5.500E-03	3.450E-02
Reference	CRM 43.0 B	Unfiltered	Aluminum	8.720E-02	1.250E-01	8.750E-02
Reference	CRM 43.0 B	Unfiltered	Arsenic	<0.001	<0.001	1.100E-03
Reference	CRM 43.0 B	Unfiltered	Barium	4.710E-02	2.680E-02	2.770E-02
Reference	CRM 43.0 B	Unfiltered	Boron	2.880E-02	5.000E-02	7.330E-02
Reference	CRM 43.0 B	Unfiltered	Chromium	<0.002	1.300E-03	4.300E-03

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Reference	CRM 43.0 B	Unfiltered	Copper	1.700E-03	8.290E-02	1.380E-02
Reference	CRM 43.0 B	Unfiltered	Iron	3.390E-01	1.370E-01	1.250E-01
Reference	CRM 43.0 B	Unfiltered	Lead	<0.001	2.600E-03	1.700E-03
Reference	CRM 43.0 B	Unfiltered	Manganese	7.670E-02	6.620E-02	5.260E-02
Reference	CRM 43.0 B	Unfiltered	Nickel	3.500E-03	2.800E-03	4.000E-03
Reference	CRM 43.0 B	Unfiltered	Zinc	4.000E-03	1.910E-01	2.350E-02
Reference	CRM 43.0 B	Filtered	Aluminum	1.640E-02	8.400E-03	2.770E-02
Reference	CRM 43.0 B	Filtered	Antimony	<0.001	2.200E-03	6.100E-03
Reference	CRM 43.0 B	Filtered	Arsenic	<0.001	<0.001	1.300E-03
Reference	CRM 43.0 B	Filtered	Barium	2.470E-02	2.310E-02	2.490E-02
Reference	CRM 43.0 B	Filtered	Boron	3.040E-02	3.460E-02	6.800E-02
Reference	CRM 43.0 B	Filtered	Chromium	<0.002	1.200E-03	3.000E-03
Reference	CRM 43.0 B	Filtered	Copper	2.200E-03	2.400E-03	1.440E-02
Reference	CRM 43.0 B	Filtered	Iron	2.530E-01	1.800E-02	3.430E-02
Reference	CRM 43.0 B	Filtered	Lead	<0.001	<0.001	1.200E-03
Reference	CRM 43.0 B	Filtered	Manganese	1.080E-02	<0.001	1.730E-02
Reference	CRM 43.0 B	Filtered	Nickel	3.400E-03	1.100E-03	3.600E-03
Reference	CRM 43.0 B	Filtered	Zinc	7.300E-03	2.100E-03	1.900E-02
Reference	CRM 41.5 B	Unfiltered	Aluminum	6.660E-02	8.550E-02	9.560E-02
Reference	CRM 41.5 B	Unfiltered	Arsenic	<0.001	<0.001	1.500E-03
Reference	CRM 41.5 B	Unfiltered	Barium	5.630E-02	2.640E-02	2.860E-02
Reference	CRM 41.5 B	Unfiltered	Boron	4.160E-02	1.120E-01	1.070E-01
Reference	CRM 41.5 B	Unfiltered	Chromium	<0.002	2.600E-03	3.900E-03
Reference	CRM 41.5 B	Unfiltered	Copper	3.100E-03	6.100E-03	1.180E-02
Reference	CRM 41.5 B	Unfiltered	Iron	3.390E-01	1.000E-01	1.340E-01
Reference	CRM 41.5 B	Unfiltered	Lead	<0.001	1.300E-03	1.300E-03
Reference	CRM 41.5 B	Unfiltered	Manganese	6.490E-02	4.780E-02	5.050E-02
Reference	CRM 41.5 B	Unfiltered	Nickel	3.500E-03	2.800E-03	3.100E-03
Reference	CRM 41.5 B	Unfiltered	Zinc	6.700E-03	1.420E-02	2.050E-02
Reference	CRM 41.5 B	Filtered	Aluminum	1.524E-02	2.248E-02	1.360E-02
Reference	CRM 41.5 B	Filtered	Antimony	1.240E-03	3.820E-03	8.700E-03
Reference	CRM 41.5 B	Filtered	Arsenic	<0.001	<0.001	1.200E-03
Reference	CRM 41.5 B	Filtered	Barium	2.150E-02	2.270E-02	2.020E-02
Reference	CRM 41.5 B	Filtered	Boron	2.576E-02	7.410E-02	5.160E-02
Reference	CRM 41.5 B	Filtered	Chromium	<0.002	1.850E-03	1.700E-03
Reference	CRM 41.5 B	Filtered	Copper	<0.001	3.880E-03	1.010E-02
Reference	CRM 41.5 B	Filtered	Iron	2.352E-01	<0.0018	<0.0018
Reference	CRM 41.5 B	Filtered	Manganese	1.043E-02	<0.001	8.400E-03
Reference	CRM 41.5 B	Filtered	Nickel	2.950E-03	1.880E-03	2.100E-03

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Reference	CRM 41.5 B	Filtered	Zinc	1.444E-02	3.390E-03	3.700E-03
Reference	CRM 41.5 B	Unfiltered	Aluminum	9.640E-02	1.240E-01	1.190E-01
Reference	CRM 41.5 B	Unfiltered	Arsenic	1.400E-03	1.000E-03	2.800E-03
Reference	CRM 41.5 B	Unfiltered	Barium	2.520E-02	2.700E-02	2.860E-02
Reference	CRM 41.5 B	Unfiltered	Boron	1.800E-02	3.490E-02	1.130E-01
Reference	CRM 41.5 B	Unfiltered	Chromium	<0.002	2.500E-03	8.200E-03
Reference	CRM 41.5 B	Unfiltered	Copper	1.800E-03	6.000E-03	1.200E-02
Reference	CRM 41.5 B	Unfiltered	Iron	2.920E-01	1.820E-01	1.730E-01
Reference	CRM 41.5 B	Unfiltered	Lead	<0.001	1.400E-03	1.800E-03
Reference	CRM 41.5 B	Unfiltered	Manganese	4.540E-02	4.760E-02	5.690E-02
Reference	CRM 41.5 B	Unfiltered	Nickel	3.000E-03	2.500E-03	5.600E-03
Reference	CRM 41.5 B	Unfiltered	Vanadium	<0.001	1.400E-03	1.200E-03
Reference	CRM 41.5 B	Unfiltered	Zinc	3.900E-03	2.620E-02	2.310E-02
Reference	CRM 41.5 B	Filtered	Aluminum	2.690E-02	2.770E-02	3.380E-02
Reference	CRM 41.5 B	Filtered	Antimony	<0.001	3.600E-03	4.400E-03
Reference	CRM 41.5 B	Filtered	Arsenic	1.700E-03	<0.001	2.300E-03
Reference	CRM 41.5 B	Filtered	Barium	2.330E-02	2.240E-02	2.810E-02
Reference	CRM 41.5 B	Filtered	Boron	5.140E-02	8.040E-02	7.790E-02
Reference	CRM 41.5 B	Filtered	Chromium	<0.002	1.400E-03	4.700E-03
Reference	CRM 41.5 B	Filtered	Copper	1.800E-03	3.400E-03	1.120E-02
Reference	CRM 41.5 B	Filtered	Iron	2.120E-01	<0.0018	3.330E-02
Reference	CRM 41.5 B	Filtered	Lead	<0.001	<0.001	1.600E-03
Reference	CRM 41.5 B	Filtered	Manganese	1.800E-02	1.400E-03	4.700E-03
Reference	CRM 41.5 B	Filtered	Nickel	3.400E-03	1.600E-03	3.400E-03
Reference	CRM 41.5 B	Filtered	Selenium	<0.005	<0.001	1.600E-03
Reference	CRM 41.5 B	Filtered	Zinc	5.700E-03	4.600E-03	2.400E-02
Reference	CRM 1.0 B	Unfiltered	Aluminum	9.640E-02	1.240E-01	1.190E-01
Reference	CRM 1.0 B	Unfiltered	Arsenic	1.400E-03	1.000E-03	2.800E-03
Reference	CRM 1.0 B	Unfiltered	Barium	2.520E-02	2.700E-02	2.860E-02
Reference	CRM 1.0 B	Unfiltered	Boron	1.800E-02	3.490E-02	1.130E-01
Reference	CRM 1.0 B	Unfiltered	Chromium	<0.002	2.500E-03	8.200E-03
Reference	CRM 1.0 B	Unfiltered	Copper	1.800E-03	6.000E-03	1.200E-02
Reference	CRM 1.0 B	Unfiltered	Iron	2.920E-01	1.820E-01	1.730E-01
Reference	CRM 1.0 B	Unfiltered	Lead	<0.001	1.400E-03	1.800E-03
Reference	CRM 1.0 B	Unfiltered	Manganese	4.540E-02	4.760E-02	5.690E-02
Reference	CRM 1.0 B	Unfiltered	Nickel	3.000E-03	2.500E-03	5.600E-03
Reference	CRM 1.0 B	Unfiltered	Potassium	1.310E+00	1.420E+00	1.700E+00
Reference	CRM 1.0 B	Unfiltered	Sodium	2.630E+00	5.950E+00	6.700E+00
Reference	CRM 1.0 B	Unfiltered	Vanadium	<0.001	1.400E-03	1.200E-03

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
Reference	CRM 1.0 B	Unfiltered	Zinc	3.900E-03	2.620E-02	2.310E-02
Reference	CRM 1.0 B	Filtered	Aluminum	2.690E-02	2.770E-02	3.380E-02
Reference	CRM 1.0 B	Filtered	Antimony	<0.001	3.600E-03	4.400E-03
Reference	CRM 1.0 B	Filtered	Arsenic	1.700E-03	<0.001	2.300E-03
Reference	CRM 1.0 B	Filtered	Barium	2.330E-02	2.240E-02	2.810E-02
Reference	CRM 1.0 B	Filtered	Boron	5.140E-02	8.040E-02	7.790E-02
Reference	CRM 1.0 B	Filtered	Cadmium	<0.001	<0.001	<0.001
Reference	CRM 1.0 B	Filtered	Chromium	<0.002	1.400E-03	4.700E-03
Reference	CRM 1.0 B	Filtered	Copper	1.800E-03	3.400E-03	1.120E-02
Reference	CRM 1.0 B	Filtered	Iron	2.120E-01	<0.0018	3.330E-02
Reference	CRM 1.0 B	Filtered	Lead	<0.001	<0.001	1.600E-03
Reference	CRM 1.0 B	Filtered	Manganese	1.800E-02	1.400E-03	4.700E-03
Reference	CRM 1.0 B	Filtered	Nickel	3.400E-03	1.600E-03	3.400E-03
Reference	CRM 1.0 B	Filtered	Selenium	<0.005	<0.001	1.600E-03
Reference	CRM 1.0 B	Filtered	Zinc	5.700E-03	4.600E-03	2.400E-02
White Oak	WOCM 0.0B	Unfiltered	Aluminum	4.350E-01	1.360E-01	1.550E-01
White Oak	WOCM 0.0B	Unfiltered	Arsenic	<0.001	<0.001	1.100E-03
White Oak	WOCM 0.0B	Unfiltered	Barium	2.740E-02	2.820E-02	3.630E-02
White Oak	WOCM 0.0B	Unfiltered	Boron	2.600E-02	0.000E+00	4.080E-02
White Oak	WOCM 0.0B	Unfiltered	Chromium	<0.002	<0.001	1.700E-03
White Oak	WOCM 0.0B	Unfiltered	Copper	4.100E-03	1.400E-03	5.900E-03
White Oak	WOCM 0.0B	Unfiltered	Iron	6.080E-01	1.660E-01	1.950E-01
White Oak	WOCM 0.0B	Unfiltered	Lead	1.600E-03	<0.001	1.000E-03
White Oak	WOCM 0.0B	Unfiltered	Manganese	6.310E-02	6.210E-02	7.550E-02
White Oak	WOCM 0.0B	Unfiltered	Nickel	3.200E-03	1.300E-03	1.900E-03
White Oak	WOCM 0.0B	Unfiltered	Vanadium	1.300E-03	<0.001	<0.001
White Oak	WOCM 0.0B	Unfiltered	Zinc	1.620E-02	4.100E-03	1.810E-02
White Oak	WOCM 0.0B	Filtered	Aluminum	2.190E-02	<0.006	1.000E-02
White Oak	WOCM 0.0B	Filtered	Antimony	3.500E-03	5.300E-03	6.800E-03
White Oak	WOCM 0.0B	Filtered	Barium	2.200E-02	2.570E-02	2.740E-02
White Oak	WOCM 0.0B	Filtered	Boron	3.670E-02	0.000E+00	6.290E-02
White Oak	WOCM 0.0B	Filtered	Chromium	<0.002	<0.001	1.200E-03
White Oak	WOCM 0.0B	Filtered	Copper	2.300E-03	2.500E-03	5.900E-03
White Oak	WOCM 0.0B	Filtered	Iron	2.600E-02	<0.0018	<0.0018
White Oak	WOCM 0.0B	Filtered	Manganese	2.480E-02	7.400E-03	8.100E-03
White Oak	WOCM 0.0B	Filtered	Nickel	2.300E-03	2.200E-03	1.200E-03
White Oak	WOCM 0.0B	Filtered	Zinc	4.900E-03	4.000E-03	4.700E-03

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
White Oak	CRM 20.2A	Unfiltered	Aluminum	5.050E-01	9.100E-02	6.530E-02
White Oak	CRM 20.2A	Unfiltered	Barium	2.770E-02	2.850E-02	2.620E-02
White Oak	CRM 20.2A	Unfiltered	Boron	2.780E-02	0.000E+00	4.310E-02
White Oak	CRM 20.2A	Unfiltered	Chromium	<0.002	1.100E-03	1.900E-03
White Oak	CRM 20.2A	Unfiltered	Copper	5.000E-03	4.700E-03	2.700E-03
White Oak	CRM 20.2A	Unfiltered	Iron	7.050E-01	1.420E-01	8.180E-02
White Oak	CRM 20.2A	Unfiltered	Lead	1.600E-03	<0.001	<0.001
White Oak	CRM 20.2A	Unfiltered	Manganese	5.850E-02	5.850E-02	4.020E-02
White Oak	CRM 20.2A	Unfiltered	Nickel	2.600E-03	2.900E-03	<0.001
White Oak	CRM 20.2A	Unfiltered	Vanadium	1.200E-03	<0.001	<0.001
White Oak	CRM 20.2A	Unfiltered	Zinc	1.780E-02	2.640E-02	4.200E-03
White Oak	CRM 20.2A	Filtered	Aluminum	1.120E-02	<0.006	7.300E-03
White Oak	CRM 20.2A	Filtered	Antimony	1.130E-02	5.400E-03	7.400E-03
White Oak	CRM 20.2A	Filtered	Barium	2.020E-02	2.690E-02	2.380E-02
White Oak	CRM 20.2A	Filtered	Boron	2.530E-02	0.000E+00	4.220E-02
White Oak	CRM 20.2A	Filtered	Chromium	<0.002	2.200E-03	1.100E-03
White Oak	CRM 20.2A	Filtered	Copper	1.700E-03	3.600E-03	5.300E-03
White Oak	CRM 20.2A	Filtered	Iron	1.760E-02	4.080E-01	1.800E-02
White Oak	CRM 20.2A	Filtered	Manganese	4.200E-03	3.400E-03	1.800E-03
White Oak	CRM 20.2A	Filtered	Nickel	2.200E-03	5.700E-03	1.200E-03
White Oak	CRM 20.2A	Filtered	Uranium	3.100E-03	0.000E+00	<0.001
White Oak	CRM 20.2A	Filtered	Zinc	2.800E-03	4.800E-03	3.000E-03
White Oak	CRM 20.2B	Unfiltered	Aluminum	5.530E-01	4.620E-02	5.900E-02
White Oak	CRM 20.2B	Unfiltered	Barium	2.670E-02	2.760E-02	3.000E-02
White Oak	CRM 20.2B	Unfiltered	Boron	2.590E-02	0.000E+00	6.060E-02
White Oak	CRM 20.2B	Unfiltered	Chromium	<0.002	1.500E-03	1.700E-03
White Oak	CRM 20.2B	Unfiltered	Copper	4.500E-03	4.800E-03	2.010E-02
White Oak	CRM 20.2B	Unfiltered	Iron	6.180E-01	7.080E-02	8.580E-02
White Oak	CRM 20.2B	Unfiltered	Lead	1.700E-03	<0.001	1.000E-03
White Oak	CRM 20.2B	Unfiltered	Manganese	5.850E-02	4.470E-02	4.080E-02
White Oak	CRM 20.2B	Unfiltered	Nickel	3.000E-03	3.400E-03	4.900E-03
White Oak	CRM 20.2B	Unfiltered	Vanadium	1.200E-03	<0.001	<0.001
White Oak	CRM 20.2B	Unfiltered	Zinc	1.100E-02	1.670E-02	1.810E-02
White Oak	CRM 20.2B	Filtered	Aluminum	1.930E-02	<0.006	2.040E-02
White Oak	CRM 20.2B	Filtered	Antimony	1.190E-02	5.300E-03	6.300E-03
White Oak	CRM 20.2B	Filtered	Barium	1.980E-02	2.520E-02	2.610E-02
White Oak	CRM 20.2B	Filtered	Boron	2.480E-02	0.000E+00	1.500E-01

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
White Oak	CRM 20.2B	Filtered	Chromium	<0.002	<0.001	2.600E-03
White Oak	CRM 20.2B	Filtered	Copper	2.600E-03	2.500E-03	4.400E-03
White Oak	CRM 20.2B	Filtered	Iron	2.470E-02	<0.0018	<0.0018
White Oak	CRM 20.2B	Filtered	Manganese	5.300E-03	1.100E-03	2.100E-03
White Oak	CRM 20.2B	Filtered	Nickel	2.400E-03	4.900E-03	<0.001
White Oak	CRM 20.2B	Filtered	Zinc	4.000E-03	3.500E-03	<0.002
White Oak	CRM 20.2C	Unfiltered	Aluminum	4.920E-01	4.680E-02	4.550E-02
White Oak	CRM 20.2C	Unfiltered	Barium	2.630E-02	2.790E-02	2.560E-02
White Oak	CRM 20.2C	Unfiltered	Boron	3.350E-02	0.000E+00	5.280E-02
White Oak	CRM 20.2C	Unfiltered	Chromium	<0.002	<0.001	2.300E-03
White Oak	CRM 20.2C	Unfiltered	Copper	1.050E-02	5.300E-03	2.000E-03
White Oak	CRM 20.2C	Unfiltered	Iron	6.670E-01	7.980E-02	4.860E-02
White Oak	CRM 20.2C	Unfiltered	Lead	1.500E-03	1.400E-03	<0.001
White Oak	CRM 20.2C	Unfiltered	Manganese	5.990E-02	4.280E-02	3.220E-02
White Oak	CRM 20.2C	Unfiltered	Nickel	3.200E-03	5.300E-03	<0.001
White Oak	CRM 20.2C	Unfiltered	Vanadium	1.200E-03	<0.001	<0.001
White Oak	CRM 20.2C	Unfiltered	Zinc	1.500E-02	3.710E-02	4.500E-03
White Oak	CRM 20.2C	Filtered	Aluminum	1.860E-02	<0.006	1.330E-02
White Oak	CRM 20.2C	Filtered	Antimony	7.200E-03	4.200E-03	5.100E-03
White Oak	CRM 20.2C	Filtered	Arsenic	<0.001	<0.001	1.100E-03
White Oak	CRM 20.2C	Filtered	Barium	2.000E-02	2.580E-02	2.580E-02
White Oak	CRM 20.2C	Filtered	Boron	4.100E-02	0.000E+00	4.940E-02
White Oak	CRM 20.2C	Filtered	Chromium	<0.002	<0.001	1.700E-03
White Oak	CRM 20.2C	Filtered	Copper	2.500E-03	1.600E-03	3.000E-03
White Oak	CRM 20.2C	Filtered	Iron	2.030E-02	<0.0018	1.800E-02
White Oak	CRM 20.2C	Filtered	Manganese	5.100E-03	<0.001	1.400E-03
White Oak	CRM 20.2C	Filtered	Nickel	2.600E-03	1.800E-03	<0.001
White Oak	CRM 20.2C	Filtered	Zinc	5.000E-03	5.200E-03	3.300E-03
White Oak	CRM 19.0 B	Unfiltered	Aluminum	5.100E-01	4.560E-02	6.420E-02
White Oak	CRM 19.0 B	Unfiltered	Barium	2.920E-02	2.840E-02	3.140E-02
White Oak	CRM 19.0 B	Unfiltered	Boron	4.190E-02	0.000E+00	5.970E-02
White Oak	CRM 19.0 B	Unfiltered	Chromium	<0.002	<0.001	2.300E-03
White Oak	CRM 19.0 B	Unfiltered	Copper	6.200E-03	3.900E-03	2.210E-02
White Oak	CRM 19.0 B	Unfiltered	Iron	7.230E-01	7.870E-02	9.700E-02
White Oak	CRM 19.0 B	Unfiltered	Lead	1.900E-03	<0.001	1.700E-03
White Oak	CRM 19.0 B	Unfiltered	Manganese	6.040E-02	4.590E-02	4.020E-02
White Oak	CRM 19.0 B	Unfiltered	Nickel	2.900E-03	3.200E-03	7.300E-03

Table L5 (continued)

Source	Site	Process	Analyte	Spring Rain mg/L	Summer Rain mg/L	Summer Dry mg/L
White Oak	CRM 19.0 B	Unfiltered	Zinc	2.020E-02	2.040E-02	1.330E-02
White Oak	CRM 19.0 B	Filtered	Aluminum	1.270E-02	<0.006	6.190E-03
White Oak	CRM 19.0 B	Filtered	Antimony	8.600E-03	6.380E-03	9.670E-03
White Oak	CRM 19.0 B	Filtered	Barium	2.050E-02	2.437E-02	2.516E-02
White Oak	CRM 19.0 B	Filtered	Boron	3.480E-02	0.000E+00	4.137E-02
White Oak		Filtered	Chromium	<0.002	1.280E-03	1.510E-03
White Oak	CRM 19.0 B	Filtered	Copper	1.700E-03	1.950E-03	6.100E-03
White Oak	CRM 19.0 B	Filtered	Iron	2.270E-02	<0.0018	1.800E-02
White Oak	CRM 19.0 B	Filtered	Manganese	3.900E-03	1.120E-03	2.690E-03
White Oak	CRM 19.0 B	Filtered	Nickel	2.100E-03	4.170E-03	1.110E-03
White Oak	CRM 19.0 B	Filtered	Zinc	5.600E-03	5.460E-03	3.340E-03

Table L6. Organic analytes detected (mg/L) in association with the water biased event study

Reach	River Mile		Season	Analyte	Process	Result
1	CRM	41.5	summer	Bis(2-ethylhexyl)phthalate	Filtered	2.70E-02
4.02	CRM	6	spring	Bis(2-ethylhexyl)phthalate	Filtered	1.00E-03
4.04	CRM	1	summer	Bis(2-ethylhexyl)phthalate	Filtered	3.00E-02
7.02	MBM	0.2	summer	Bis(2-ethylhexyl)phthalate	Total	6.00E-03
1	CRM	41.5	spring	Di-n-butylphthalate	Filtered	1.00E-03
4.02	CRM	6	summer	Di-n-butylphthalate	Filtered	1.00E-03
7.02	MBM	0.2	spring	Di-n-butylphthalate	Filtered	1.00E-03
1	CRM	41.5	spring	Di-n-butylphthalate	Total	1.00E-03
7.02	MBM	0.2	summer	Di-n-butylphthalate	Total	4.00E-03
7.02	MBM	0.2	spring	alpha-BHC	Filtered	1.80E-05
7.02	MBM	0.2	spring	alpha-BHC	Total	1.30E-05

Table L7. Radionuclide concentrations for the water biased event study

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
Source: MCoy Branch										
1	CRM 36.9B	Particle associated Co-60		-5.57E+00	3.53E+01	-6.33E+01	1.60E+02	7.97E+00	2.56E+02	pCi/G
1	CRM 36.9B	Particle associated Cs-137		1.22E+01	3.77E+01	7.39E+01	1.62E+02	-4.50E+00	2.39E+02	pCi/G
1	CRM 36.9B	Cesium-137	Dissolved	1.18E+01	1.25E+01	7.30E-01	4.95E+00	-4.03E+00	5.16E+00	pCi/L
1	CRM 36.9B	Cobalt-60	Dissolved	-7.10E-01	9.05E+00	1.41E+00	4.34E+00	2.38E+00	4.69E+00	pCi/L
1	CRM 36.9B	Cesium-137	Residue	2.20E-01	6.80E-01	3.70E-01	8.10E-01	-1.00E-02	7.20E-01	pCi/L
1	CRM 36.9B	Cobalt-60	Residue	-1.00E-01	6.30E-01	-3.20E-01	8.00E-01	2.00E-02	7.70E-01	pCi/L
1	CRM 36.9B	Gross alpha activity	Total	1.15E+00	5.70E-01	-6.56E+00	2.36E+00	-4.26E+00	3.06E+00	pCi/L
1	CRM 36.9B	Gross beta activity	Total	7.12E+00	1.37E+00	5.88E+00	2.98E+00	4.32E+00	4.66E+00	pCi/L
1	CRM 36.9B	Strontium-90	Total	9.50E-01	1.93E+00	2.40E+00	1.30E+00	2.10E-01	2.31E+00	pCi/L
1	CRM 36.9B	Tritium	Total	0.00E+00	2.20E+02	4.30E+01	2.56E+02	-7.19E+01	2.43E+02	pCi/L
7.01	MBM 0.4B	Particle associated Co-60		2.44E+01	6.25E+01	-2.72E+01	9.67E+01	-2.47E+01	1.22E+02	pCi/G
7.01	MBM 0.4B	Particle associated Cs-137		1.81E+00	5.85E+01	-2.39E+01	8.64E+01	-1.57E+01	1.06E+02	pCi/G
7.01	MBM 0.4B	Cesium-137	Dissolved	-3.63E+00	1.07E+01	6.26E+00	1.12E+01	-2.00E+00	1.08E+01	pCi/L
7.01	MBM 0.4B	Cobalt-60	Dissolved	4.14E+00	1.01E+01	8.90E-01	1.00E+01	5.75E+00	1.05E+01	pCi/L
7.01	MBM 0.4B	Cesium-137	Residue	2.00E-02	6.80E-01	-1.70E-01	6.20E-01	-9.00E-02	6.30E-01	pCi/L
7.01	MBM 0.4B	Cobalt-60	Residue	2.80E-01	7.20E-01	-2.00E-01	7.00E-01	-1.50E-01	7.30E-01	pCi/L
7.01	MBM 0.4B	Gross alpha activity	Total	1.27E+00	7.40E-01	-7.34E+00	2.47E+00	-6.50E-01	3.16E+00	pCi/L
7.01	MBM 0.4B	Gross beta activity	Total	1.56E+00	1.39E+00	6.63E+00	2.86E+00	3.57E+00	4.51E+00	pCi/L
7.01	MBM 0.4B	Strontium-90	Total	6.90E-01	2.65E+00	1.42E+00	1.49E+00	1.30E+00	1.75E+00	pCi/L
7.01	MBM 0.4B	Tritium	Total	1.13E+02	2.19E+02	2.04E+02	2.56E+02	-1.53E+01	2.43E+02	pCi/L
7.02	MBM 0.2A	Particle associated Co-60		9.12E+00	2.35E+01	-6.00E+01	1.44E+02	-3.43E+01	1.91E+02	pCi/G
7.02	MBM 0.2A	Particle associated Cs-137		.	.	.	.	.	.	pCi/G
7.02	MBM 0.2A	Cesium-137	Dissolved	6.30E-01	1.03E+01	7.00E-01	5.92E+00	-1.12E+00	5.61E+00	pCi/L

Table L7 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
7.02	MBM 0.2A	Cobalt-60	Dissolved	4.19E+00	8.72E+00	2.08E+00	5.15E+00	-1.41E+00	4.94E+00	pCi/L
7.02	MBM 0.2A	Cesium-137	Residue	0.00E+00	2.90E-01	-3.10E-01	7.50E-01	1.00E-01	7.70E-01	pCi/L
7.02	MBM 0.2A	Cobalt-60	Residue	1.10E-01	3.00E-01	-2.80E-01	6.60E-01	-1.60E-01	8.80E-01	pCi/L
7.02	MBM 0.2A	Gross alpha activity	Total	3.40E-01	9.20E-01	-5.60E+00	2.46E+00	-3.29E+00	3.15E+00	pCi/L
7.02	MBM 0.2A	Gross beta activity	Total	9.90E-01	1.33E+00	1.00E+01	2.87E+00	4.54E+00	4.51E+00	pCi/L
7.02	MBM 0.2A	Strontium-90	Total	4.20E-01	2.63E+00	1.43E+00	1.32E+00	-2.11E+00	1.96E+00	pCi/L
7.02	MBM 0.2A	Tritium	Total	0.00E+00	2.19E+02	1.77E+02	2.56E+02	9.16E+01	2.43E+02	pCi/L
7.02	MBM 0.2B	Particle associated Co-60		-7.58E+00	3.97E+01	5.70E+01	8.83E+01	-1.48E+01	6.44E+01	pCi/G
7.02	MBM 0.2B	Particle associated Cs-137		-1.32E+01	3.64E+01	-4.09E+00	7.97E+01	3.04E+01	6.19E+01	pCi/G
7.02	MBM 0.2B	Cesium-137	Dissolved	-2.68E+00	5.00E+00	9.34E+00	1.16E+01	7.63E+00	1.22E+01	pCi/L
7.02	MBM 0.2B	Cobalt-60	Dissolved	-1.91E+00	4.66E+00	3.93E+00	1.07E+01	-2.60E+00	1.07E+01	pCi/L
7.02	MBM 0.2B	Cesium-137	Residue	-2.30E-01	6.30E-01	-2.00E-02	3.00E-01	1.50E-01	3.10E-01	pCi/L
7.02	MBM 0.2B	Cobalt-60	Residue	-1.30E-01	6.80E-01	2.20E-01	3.40E-01	-7.00E-02	3.20E-01	pCi/L
7.02	MBM 0.2B	Gross alpha activity	Total	4.70E-01	6.60E-01	-1.47E+01	4.65E+00	-3.42E+00	3.13E+00	pCi/L
7.02	MBM 0.2B	Gross beta activity	Total	1.45E+00	1.65E+00	7.83E+00	3.01E+00	1.70E+00	4.55E+00	pCi/L
7.02	MBM 0.2B	Strontium-90	Total	4.55E+00	2.62E+00	1.45E+00	1.19E+00	1.44E+00	1.93E+00	pCi/L
7.02	MBM 0.2B	Tritium	Total	0.00E+00	2.19E+02	1.43E+02	2.56E+02	-1.09E+02	2.43E+02	pCi/L
7.02	MBM 0.2C	Particle associated Co-60		-1.82E+00	2.15E+01	1.77E+02	2.28E+02	4.02E+01	2.23E+02	pCi/G
7.02	MBM 0.2C	Particle associated Cs-137		-1.10E+01	1.97E+01	-6.32E+01	2.15E+02	-2.18E+01	1.76E+02	pCi/G
7.02	MBM 0.2C	Cesium-137	Dissolved	1.22E+01	1.33E+01	2.36E+00	1.22E+01	8.32E+00	1.31E+01	pCi/L
7.02	MBM 0.2C	Cobalt-60	Dissolved	2.53E+00	9.48E+00	1.42E+00	9.83E+00	-2.66E+00	1.03E+01	pCi/L
7.02	MBM 0.2C	Cesium-137	Residue	-1.50E-01	2.80E-01	-2.10E-01	7.30E-01	-7.00E-02	6.00E-01	pCi/L
7.02	MBM 0.2C	Cobalt-60	Residue	-3.00E-02	3.00E-01	6.00E-01	7.80E-01	1.40E-01	7.60E-01	pCi/L
7.02	MBM 0.2C	Gross alpha activity	Total	6.60E-01	9.00E-01	-7.68E+00	2.35E+00	-4.85E+00	3.16E+00	pCi/L
7.02	MBM 0.2C	Gross beta activity	Total	1.94E+00	1.20E+00	6.10E+00	2.98E+00	2.13E+00	4.50E+00	pCi/L

Table L7 (continued).

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
7.02	MBM 0.2C	Strontium-90	Total	5.57E+00	2.28E+00	1.69E+00	1.40E+00	1.46E+00	2.57E+00	pCi/L
7.02	MBM 0.2C	Tritium	Total	0.00E+00	2.15E+02	1.44E+02	2.56E+02	-2.12E+02	2.43E+02	pCi/L
Source: Poplar Creek										
3.04	PCM 0.1B	Particle associated Co-60		4.46E+00	6.68E+01	-5.15E+00	6.60E+01	2.51E+00	6.78E+01	pCi/G
3.04	PCM 0.1B	Particle associated Cs-137		3.93E+00	6.06E+01	-2.07E+01	5.97E+01	1.93E+01	6.16E+01	pCi/G
3.04	PCM 0.1B	Cesium-137	Dissolved	-2.48E+00	1.15E+01	9.42E+00	1.20E+01	1.18E+01	1.24E+01	pCi/L
3.04	PCM 0.1B	Cobalt-60	Dissolved	-3.26E+00	8.82E+00	-5.00E-02	1.13E+01	7.94E+00	1.19E+01	pCi/L
3.04	PCM 0.1B	Cesium-137	Residue	4.00E-02	5.80E-01	-2.10E-01	6.20E-01	2.10E-01	6.60E-01	pCi/L
3.04	PCM 0.1B	Cobalt-60	Residue	4.00E-02	6.40E-01	-5.00E-02	6.90E-01	3.00E-02	7.30E-01	pCi/L
3.04	PCM 0.1B	Gross alpha activity	Total	-5.60E+00	3.01E+00	-8.40E+00	2.41E+00	1.18E+00	2.93E+00	pCi/L
3.04	PCM 0.1B	Gross beta activity	Total	-1.66E+00	3.07E+00	1.26E+01	3.01E+00	-2.67E+00	4.60E+00	pCi/L
3.04	PCM 0.1B	Strontium-90	Total	8.53E+01	1.29E+00	1.31E+00	7.90E-01	8.00E-01	1.53E+00	pCi/L
3.04	PCM 0.1B	Tritium	Total	0.00E+00	2.15E+02	9.19E+02	2.56E+02	8.06E+01	2.53E+02	pCi/L
4.01	CRM 11.8A	Particle associated Co-60		3.32E+01	7.64E+01	2.13E+00	1.55E+01	-1.26E+01	5.60E+01	pCi/G
4.01	CRM 11.8A	Particle associàted Cs-137		.	.	.	.	.	.	pCi/G
4.01	CRM 11.8A	Cesium-137	Dissolved	1.08E+01	1.26E+01	-1.07E+00	5.58E+00	1.47E+00	1.05E+01	pCi/L
4.01	CRM 11.8A	Cobalt-60	Dissolved	-2.49E+00	1.02E+01	-3.70E-01	4.71E+00	1.76E+00	1.09E+01	pCi/L
4.01	CRM 11.8A	Cesium-137	Residue	2.20E-01	6.50E-01	2.30E-01	3.40E-01	-1.10E-01	6.60E-01	pCi/L
4.01	CRM 11.8A	Cobalt-60	Residue	2.50E-01	5.80E-01	4.00E-02	3.20E-01	-1.70E-01	7.50E-01	pCi/L
4.01	CRM 11.8A	Gross alpha activity	Total	1.00E+00	6.70E-01	-9.47E+00	2.53E+00	1.20E-01	3.00E+00	pCi/L
4.01	CRM 11.8A	Gross beta activity	Total	-1.90E+00	1.49E+00	1.27E+01	2.89E+00	9.70E-01	4.49E+00	pCi/L
4.01	CRM 11.8A	Strontium-90	Total	8.90E-01	1.26E+00	8.90E-01	7.90E-01	2.07E+00	1.51E+00	pCi/L
4.01	CRM 11.8A	Tritium	Total	1.05E+02	2.12E+02	4.36E+02	2.56E+02	-6.76E+01	2.53E+02	pCi/L
4.01	CRM 11.8B	Particle associated Co-60		-6.40E-01	3.18E+01	6.29E+00	3.77E+01	-9.15E+01	6.32E+01	pCi/G

Table L7 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
4.01	CRM 11.8B	Particle associated Cs-137		2.81E+01	3.37E+01	-1.28E+01	3.38E+01	1.76E+01	6.41E+01	pCi/G
4.01	CRM 11.8B	Cesium-137	Dissolved	1.33E+01	1.24E+01	9.83E+00	1.28E+01	1.06E+01	1.17E+01	pCi/L
4.01	CRM 11.8B	Cobalt-60	Dissolved	5.54E+00	9.85E+00	1.00E+00	9.64E+00	5.76E+00	1.05E+01	pCi/L
4.01	CRM 11.8B	Cesium-137	Residue	2.60E-01	3.10E-01	-2.30E-01	6.10E-01	2.00E-01	7.40E-01	pCi/L
4.01	CRM 11.8B	Cobalt-60	Residue	-1.00E-02	2.90E-01	1.10E-01	6.90E-01	-1.06E+00	7.30E-01	pCi/L
4.01	CRM 11.8B	Gross alpha activity	Total	2.20E-01	9.70E-01	-1.68E+01	4.93E+00	1.20E+00	4.17E+00	pCi/L
4.01	CRM 11.8B	Gross beta activity	Total	2.95E+00	1.57E+00	1.87E+01	5.91E+00	1.63E+00	3.52E+00	pCi/L
4.01	CRM 11.8B	Strontium-90	Total	0.00E+00	1.79E+00	1.74E+00	9.20E-01	1.80E+00	1.78E+00	pCi/L
4.01	CRM 11.8B	Tritium	Total	2.36E+02	2.14E+02	3.14E+02	2.56E+02	9.81E+01	2.53E+02	pCi/L
4.01	CRM 11.8C	Particle associated Co-60		4.62E+01	9.33E+01	2.52E+01	3.08E+01	-1.33E+01	6.86E+01	pCi/G
4.01	CRM 11.8C	Particle associated Cs-137		-2.52E+01	9.08E+01	4.87E+00	2.81E+01	3.19E+01	6.50E+01	pCi/G
4.01	CRM 11.8C	Cesium-137	Dissolved	6.12E+00	1.13E+01	-8.70E-01	4.64E+00	1.04E+01	1.15E+01	pCi/L
4.01	CRM 11.8C	Cobalt-60	Dissolved	-2.43E+00	9.58E+00	2.74E+00	5.04E+00	-1.22E+00	8.34E+00	pCi/L
4.01	CRM 11.8C	Cesium-137	Residue	-2.00E-01	7.10E-01	1.10E-01	6.50E-01	4.10E-01	8.30E-01	pCi/L
4.01	CRM 11.8C	Cobalt-60	Residue	3.60E-01	7.30E-01	5.80E-01	7.10E-01	-1.70E-01	8.80E-01	pCi/L
4.01	CRM 11.8C	Gross alpha activity	Total	4.60E-01	1.30E+00	-1.03E+01	2.49E+00	2.74E+00	2.94E+00	pCi/L
4.01	CRM 11.8C	Gross beta activity	Total	4.94E+00	2.68E+00	1.86E+01	2.93E+00	-5.13E+00	4.57E+00	pCi/L
4.01	CRM 11.8C	Strontium-90	Total	0.00E+00	1.51E+00	5.60E-01	1.01E+00	1.42E+00	1.49E+00	pCi/L
4.01	CRM 11.8C	Tritium	Total	1.50E+02	2.13E+02	9.05E+01	2.56E+02	5.67E+01	2.53E+02	pCi/L
4.01	CRM 9.0B	Particle associated Co-60		-4.92E+01	6.66E+01	1.72E+01	6.95E+01	2.46E+01	1.75E+02	pCi/G
4.01	CRM 9.0B	Particle associated Cs-137		1.63E+01	6.38E+01	3.85E+00	6.63E+01	1.22E+02	1.71E+02	pCi/G
4.01	CRM 9.0B	Cesium-137	Dissolved	-2.16E+00	4.76E+00	-1.29E+00	9.78E+00	-6.80E-01	1.08E+01	pCi/L
4.01	CRM 9.0B	Cobalt-60	Dissolved	1.60E-01	4.51E+00	-5.00E-02	9.04E+00	7.94E+00	9.95E+00	pCi/L
4.01	CRM 9.0B	Cesium-137	Residue	1.70E-01	6.60E-01	2.00E-02	3.00E-01	5.40E-01	7.50E-01	pCi/L
4.01	CRM 9.0B	Cobalt-60	Residue	-5.10E-01	6.90E-01	8.00E-02	3.20E-01	1.10E-01	7.70E-01	pCi/L

Table L7 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
4.01	CRM 9.0B	Gross alpha activity	Total	7.00E-01	7.40E-01	-7.90E+00	2.35E+00	7.60E-01	2.84E+00	pCi/L
4.01	CRM 9.0B	Gross beta activity	Total	1.38E+00	1.39E+00	7.53E+00	3.09E+00	-3.28E+00	4.75E+00	pCi/L
4.01	CRM 9.0B	Strontium-90	Total	.	.	-3.70E-01	7.50E-01	1.87E+00	1.70E+00	pCi/L
4.01	CRM 9.0B	Tritium	Total	7.67E+01	2.14E+02	4.10E+02	2.56E+02	3.44E+02	2.43E+02	pCi/L
Reference Site										
1	CRM 41.5B	Particle associated Co-60		1.75E+01	5.61E+01	9.67E+00	1.49E+02	-4.67E+01	1.69E+02	pCi/G
1	CRM 41.5B	Particle associated Cs-137		.	.	.	.	.	.	pCi/G
1	CRM 41.5B	Cesium-137	Dissolved	-1.38E+00	1.18E+01	6.23E+00	1.18E+01	8.00E-01	1.16E+01	pCi/L
1	CRM 41.5B	Cobalt-60	Dissolved	-7.60E-01	9.76E+00	-1.37E+00	8.67E+00	-1.00E+01	8.79E+00	pCi/L
1	CRM 41.5B	Cesium-137	Residue	7.00E-02	2.90E-01	1.10E-01	6.10E-01	-1.10E-01	6.70E-01	pCi/L
1	CRM 41.5B	Cobalt-60	Residue	7.00E-02	2.20E-01	5.00E-02	7.70E-01	-2.00E-01	7.10E-01	pCi/L
1	CRM 41.5B	Gross alpha activity	Total	4.20E-01	9.20E-01	-8.15E+00	2.43E+00	4.79E+00	3.08E+00	pCi/L
1	CRM 41.5B	Gross beta activity	Total	1.00E+00	1.33E+00	8.32E+00	2.99E+00	-3.60E+00	4.37E+00	pCi/L
1	CRM 41.5B	Strontium-90	Total	1.40E-01	1.09E+00	8.20E-01	8.90E-01	2.08E+00	1.70E+00	pCi/L
1	CRM 41.5B	Tritium	Total	0.00E+00	2.14E+02	1.31E+02	2.56E+02	-6.10E+01	2.53E+02	pCi/L
1	CRM 43.0B	Particle associated Co-60		5.89E+01	1.04E+02	3.91E+00	4.55E+01	3.62E+01	2.86E+02	pCi/G
1	CRM 43.0B	Particle associated Cs-137		-6.11E+00	8.64E+01	-2.03E+01	4.36E+01	1.44E+01	2.22E+02	pCi/G
1	CRM 43.0B	Cesium-137	Dissolved	2.23E+00	5.17E+00	-1.50E+00	5.24E+00	7.63E+00	1.22E+01	pCi/L
1	CRM 43.0B	Cobalt-60	Dissolved	5.82E+00	4.83E+00	-3.54E+00	4.67E+00	-1.10E-01	9.56E+00	pCi/L
1	CRM 43.0B	Cesium-137	Residue	-4.00E-02	6.20E-01	-1.50E-01	3.20E-01	4.00E-02	6.20E-01	pCi/L
1	CRM 43.0B	Cobalt-60	Residue	4.20E-01	7.50E-01	3.00E-02	3.40E-01	1.00E-01	8.00E-01	pCi/L
1	CRM 43.0B	Gross alpha activity	Total	1.23E+00	8.70E-01	-6.13E+00	2.26E+00	8.00E-02	2.95E+00	pCi/L
1	CRM 43.0B	Gross beta activity	Total	1.62E+00	1.43E+00	7.57E+00	3.20E+00	-3.83E+00	4.56E+00	pCi/L

Table L7 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
1	CRM 43.0B	Strontium-90	Total	3.29E+00	2.49E+00	6.70E-01	7.40E-01	-7.40E-01	1.50E+00	pCi/L
1	CRM 43.0B	Tritium	Total	1.30E+02	2.12E+02	-1.13E+01	2.68E+02	-3.92E+01	2.53E+02	pCi/L
1	CRM 46.0B	Particle associated Co-60		8.29E+01	1.25E+02	-2.42E+01	1.36E+02	6.58E+01	2.21E+02	pCi/G
1	CRM 46.0B	Particle associated Cs-137		5.05E+01	1.22E+02	5.63E+01	1.26E+02	2.64E+01	2.12E+02	pCi/G
1	CRM 46.0B	Cesium-137	Dissolved	-5.30E-01	5.00E+00	7.59E+00	8.78E+00	2.60E-01	1.12E+01	pCi/L
1	CRM 46.0B	Cobalt-60	Dissolved	1.61E+00	4.63E+00	6.87E+00	7.77E+00	7.00E-01	1.05E+01	pCi/L
1	CRM 46.0B	Cesium-137	Residue	2.70E-01	6.60E-01	3.00E-01	6.80E-01	9.00E-02	7.20E-01	pCi/L
1	CRM 46.0B	Cobalt-60	Residue	4.50E-01	6.80E-01	-1.30E-01	7.30E-01	2.20E-01	7.50E-01	pCi/L
1	CRM 46.0B	Gross alpha activity	Total	7.10E-01	6.60E-01	-6.01E+00	2.24E+00	0.00E+00	3.00E+00	pCi/L
1	CRM 46.0B	Gross beta activity	Total	1.89E+00	1.65E+00	1.92E+01	3.23E+00	-1.62E+00	4.54E+00	pCi/L
1	CRM 46.0B	Strontium-90	Total	2.99E+00	2.67E+00	1.18E+00	8.20E-01	1.90E+00	1.65E+00	pCi/L
1	CRM 46.0B	Tritium	Total	.	.	7.47E+01	2.68E+02	3.92E+01	2.53E+02	pCi/L
4.04	CRM 1.0B	Particle associated Co-60		4.21E+00	3.77E+01	1.99E+00	1.38E+02	3.97E+00	1.14E+02	pCi/G
4.04	CRM 1.0B	Particle associated Cs-137		1.34E+01	3.91E+01	5.07E+01	1.37E+02	2.96E+01	1.14E+02	pCi/G
4.04	CRM 1.0B	Cesium-137	Dissolved	3.43E+00	1.09E+01	5.05E+00	1.26E+01	-5.30E-01	6.06E+00	pCi/L
4.04	CRM 1.0B	Cobalt-60	Dissolved	-2.89E+00	9.94E+00	3.11E+00	1.08E+01	4.42E+00	5.08E+00	pCi/L
4.04	CRM 1.0B	Cesium-137	Residue	1.10E-01	3.10E-01	2.90E-01	7.90E-01	1.80E-01	6.80E-01	pCi/L
4.04	CRM 1.0B	Cobalt-60	Residue	3.00E-02	3.00E-01	1.00E-02	8.00E-01	2.00E-02	6.80E-01	pCi/L
4.04	CRM 1.0B	Gross alpha activity	Total	1.40E-01	8.90E-01	-7.07E+00	3.37E+00	-2.20E+00	3.08E+00	pCi/L
4.04	CRM 1.0B	Gross beta activity	Total	2.55E+00	1.20E+00	6.86E+00	4.25E+00	2.75E+00	4.38E+00	pCi/L
4.04	CRM 1.0B	Strontium-90	Total	0.00E+00	2.28E+00	1.56E+00	1.27E+00	1.75E+00	1.79E+00	pCi/L
4.04	CRM 1.0B	Tritium	Total	2.17E+02	2.13E+02	1.38E+02	2.68E+02	1.22E+02	2.53E+02	pCi/L
Source: White Oak Creek										
2.02	CRM 20.2A	Particle associated Co-60		8.16E+00	2.62E+01	-5.62E+01	2.08E+02	7.96E+00	2.15E+02	pCi/G

Table L7 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
2.02	CRM 20.2A	Particle associated Cs-137		.	.	.	.	.	.	pCi/G
2.02	CRM 20.2A	Cesium-137	Dissolved	-2.69E+00	4.69E+00	-2.05E+00	1.19E+01	-3.63E+00	9.79E+00	pCi/L
2.02	CRM 20.2A	Cobalt-60	Dissolved	4.60E-01	4.70E+00	-6.41E+00	8.22E+00	-4.15E+00	8.56E+00	pCi/L
2.02	CRM 20.2A	Cesium-137	Residue	1.10E-01	7.30E-01	4.00E-02	7.30E-01	4.00E-01	7.40E-01	pCi/L
2.02	CRM 20.2A	Cobalt-60	Residue	2.20E-01	7.00E-01	-2.00E-01	7.50E-01	3.00E-02	7.30E-01	pCi/L
2.02	CRM 20.2A	Gross alpha activity	Total	2.92E+00	6.70E-01	-8.34E+00	3.79E+00	-4.14E+00	3.18E+00	pCi/L
2.02	CRM 20.2A	Gross beta activity	Total	1.86E+00	1.49E+00	1.11E+01	3.81E+00	8.68E+00	4.48E+00	pCi/L
2.02	CRM 20.2A	Strontium-90	Total	2.87E+00	2.45E+00	5.28E+00	1.29E+00	3.29E+00	2.42E+00	pCi/L
2.02	CRM 20.2A	Tritium	Total	1.27E+03	2.17E+02	5.76E+03	2.56E+02	1.25E+03	2.43E+02	pCi/L
2.02	CRM 20.2B	Particle associated Co-60		-3.60E-01	1.18E+01	-2.26E+01	9.92E+01	-3.07E+02	2.87E+02	pCi/g
2.02	CRM 20.2B	Particle associated Cs-137		-3.87E+00	1.14E+01	6.58E+01	9.70E+01	5.50E+01	3.01E+02	pCi/g
2.02	CRM 20.2B	Cesium-137	Dissolved	7.57E+00	1.21E+01	3.56E+00	1.08E+01	-2.00E-01	1.05E+01	pCi/L
2.02	CRM 20.2B	Cobalt-60	Dissolved	-3.29E+00	9.75E+00	-3.88E+00	1.00E+01	4.52E+00	1.12E+01	pCi/L
2.02	CRM 20.2B	Cesium-137	Residue	-9.00E-02	2.80E-01	2.20E-01	3.30E-01	1.30E-01	7.20E-01	pCi/L
2.02	CRM 20.2B	Cobalt-60	Residue	-1.00E-02	2.90E-01	-8.00E-02	3.40E-01	-7.40E-01	6.90E-01	pCi/L
2.02	CRM 20.2B	Gross alpha activity	Total	2.00E-02	9.60E-01	-6.90E+00	3.23E+00	-4.97E+00	3.18E+00	pCi/L
2.02	CRM 20.2B	Gross beta activity	Total	2.36E+00	1.56E+00	8.52E+00	4.36E+00	7.15E+00	4.48E+00	pCi/L
2.02	CRM 20.2B	Strontium-90	Total	3.00E-02	2.24E+00	2.68E+00	1.36E+00	3.38E+00	1.60E+00	pCi/L
2.02	CRM 20.2B	Tritium	Total	0.00E+00	2.19E+02	1.89E+03	2.56E+02	9.81E+02	2.43E+02	pCi/L
2.02	CRM 20.2C	Particle associated Co-60		-1.45E+01	3.37E+01	2.56E+01	1.72E+02	6.25E+01	2.85E+02	pCi/g
2.02	CRM 20.2C	Particle associated Cs-137		1.90E-01	3.09E+01	-3.36E+01	1.82E+02	3.36E+01	2.92E+02	pCi/g
2.02	CRM 20.2C	Cesium-137	Dissolved	1.18E+01	1.22E+01	7.70E-01	4.76E+00	-2.58E+00	5.75E+00	pCi/L
2.02	CRM 20.2C	Cobalt-60	Dissolved	-8.10E-01	1.04E+01	3.98E+00	5.11E+00	7.40E-01	4.78E+00	pCi/L
2.02	CRM 20.2C	Cesium-137	Residue	0.00E+00	6.70E-01	-1.30E-01	6.90E-01	9.00E-02	7.60E-01	pCi/L
2.02	CRM 20.2C	Cobalt-60	Residue	-3.20E-01	7.30E-01	1.00E-01	6.50E-01	1.60E-01	7.40E-01	pCi/L

Table L7 (continued)

Subreach	Site	Analyte	Total or Dissolved	Spring Rain	Spring Det. Limit	Summer Rain	Summer Det. Limit	Summer Dry	Summer Det. Limit	Units
2.02	CRM 20.2C	Gross alpha activity	Total	6.70E-01	8.40E-01	-5.80E+00	2.23E+00	-5.00E-01	3.25E+00	pCi/L
2.02	CRM 20.2C	Gross beta activity	Total	1.80E+00	1.42E+00	2.32E+01	6.29E+00	3.71E+00	4.37E+00	pCi/L
2.02	CRM 20.2C	Strontium-90	Total	1.93E+00	2.13E+00	3.29E+00	1.35E+00	1.52E+00	1.73E+00	pCi/L
2.02	CRM 20.2C	Tritium	Total	0.00E+00	2.18E+02	2.94E+03	2.56E+02	9.38E+01	2.43E+02	pCi/L
2.02	WOCM 0.0B	Particle associated Co-60		1.76E+01	3.69E+01	4.37E+01	1.09E+02	-2.15E+01	9.37E+01	pCi/g
2.02	WOCM 0.0B	Particle associated Cs-137		4.11E+02	3.30E+01	1.24E+02	8.94E+01	2.38E+02	6.82E+01	pCi/g
2.02	WOCM 0.0B	Cesium-137	Dissolved	6.40E-01	4.95E+00	5.60E+00	1.12E+01	-2.59E+00	5.24E+00	pCi/L
2.02	WOCM 0.0B	Cobalt-60	Dissolved	-2.70E-01	4.67E+00	4.84E+00	1.10E+01	6.25E+00	4.99E+00	pCi/L
2.02	WOCM 0.0B	Cesium-137	Residue	7.80E+00	6.30E-01	8.00E-01	5.70E-01	1.90E+00	5.50E-01	pCi/L
2.02	WOCM 0.0B	Cobalt-60	Residue	3.30E-01	7.00E-01	2.80E-01	7.00E-01	-1.70E-01	7.50E-01	pCi/L
2.02	WOCM 0.0B	Gross alpha activity	Total	2.67E+01	7.90E-01	-2.70E-01	2.39E+00	8.20E+00	3.24E+00	pCi/L
2.02	WOCM 0.0B	Gross beta activity	Total	1.72E+02	1.40E+00	1.12E+02	2.88E+00	1.44E+02	4.39E+00	pCi/L
2.02	WOCM 0.0B	Strontium-90	Total	6.56E+01	2.28E+00	2.66E+01	8.90E-01	5.10E+01	1.56E+00	pCi/L
2.02	WOCM 0.0B	Tritium	Total	5.20E+04	2.15E+02	6.27E+04	2.56E+02	3.44E+04	2.43E+02	pCi/L
2.03	CRM 19.0B	Particle associated Co-60		5.92E+00	9.03E+00	2.02E+01	6.44E+01	1.09E+02	1.28E+02	pCi/g
2.03	CRM 19.0B	Particle associated Cs-137		3.42E+00	8.68E+00	-6.64E+00	8.21E+01	-1.92E+01	1.20E+02	pCi/g
2.03	CRM 19.0B	Cesium-137	Dissolved	3.00E-02	5.35E+00	6.40E+00	1.20E+01	9.85E+00	1.28E+01	pCi/L
2.03	CRM 19.0B	Cobalt-60	Dissolved	-9.60E-01	4.49E+00	1.52E+00	8.37E+00	1.70E+00	1.03E+01	pCi/L
2.03	CRM 19.0B	Cesium-137	Residue	1.10E-01	2.80E-01	-3.00E-02	3.10E-01	-5.00E-02	3.10E-01	pCi/L
2.03	CRM 19.0B	Cobalt-60	Residue	1.90E-01	2.90E-01	8.00E-02	2.40E-01	2.80E-01	3.30E-01	pCi/L
2.03	CRM 19.0B	Gross alpha activity	Total	4.90E-01	7.40E-01	-7.42E+00	2.25E+00	-3.44E+00	3.18E+00	pCi/L
2.03	CRM 19.0B	Gross beta activity	Total	7.91E+00	1.90E+00	8.40E+00	3.11E+00	3.16E+00	4.47E+00	pCi/L
2.03	CRM 19.0B	Strontium-90	Total	3.10E-01	1.93E+00	2.48E+00	1.52E+00	2.00E+00	1.58E+00	pCi/L
2.03	CRM 19.0B	Tritium	Total	1.56E+02	2.18E+02	3.44E+02	2.56E+02	8.06E+01	2.43E+02	pCi/L

Table L8. Filtered and total methyl mercury and mercury concentrations (ng/L) of sources from biased event sampling

Location	Sampling Date	Filtered Methyl Mercury (ng/L)	Unfiltered Methyl Mercury (ng/L)	Filtered Inorganic Mercury (ng/L)	Unfiltered Inorganic Mercury (ng/L)
		POPLAR CREEK SOURCE			
REACH 3					
PCM 0.1B					
	20APR1994	9.00E-02	1.84E-01	2.84E+00	1.02E+02
	29JUL1994	9.00E-02	1.71E-01	1.40E+00	9.04E+01
	30AUG1994	6.00E-02	9.00E-02	1.72E+00	6.12E+01
REACH 4.01					
CRM 11.8A					
	20APR1994	3.50E-02	4.20E-02	1.79E+00	1.48E+01
	29JUL1994	1.24E-01	1.47E-01	2.71E+00	6.68E+01
	30AUG1994	4.90E-02	6.30E-02	1.72E+00	2.55E+01
CRM 11.8B					
	20APR1994	2.80E-02	3.40E-02	2.15E+00	3.80E+00
	29JUL1994	1.56E-01	2.38E-01	5.68E+00	1.82E+02
	30AUG1994	7.90E-02	8.00E-02	1.88E+00	2.59E+01
CRM 11.8C					
	20APR1994	3.50E-02	3.50E-02	4.83E+00	2.03E+00
	29JUL1994	1.84E-01	3.01E-01	9.32E+00	2.47E+02
	30AUG1994	5.40E-02	1.40E-01	4.24E+00	9.28E+01
CRM 9.0B					
	20APR1994	9.90E-02	9.90E-02	8.47E+00	2.30E+00
	29JUL1994	1.35E-01	1.15E-01	1.84E+00	1.23E+01
	30AUG1994	9.80E-02	1.48E-01	1.72E+00	3.13E+00
		MCCOY BRANCH SOURCE			
REACH 7.01					
MBM 0.4B					
	19APR1994	4.80E-02	1.00E-01	1.92E+00	6.84E+00
	28JUL1994	1.01E-01	1.04E-01	2.74E+00	4.30E+00
	29AUG1994	1.05E-01	1.16E-01	1.39E+00	2.82E+00
REACH 7.02					
MBM 0.2A					
	19APR1994	4.50E-02	3.10E-02	2.55E+00	4.32E+00
	28JUL1994	7.40E-02	8.60E-02	2.24E+00	2.25E+00
	29AUG1994	1.17E-01	1.05E-01	2.10E+00	1.21E+00

Table L8 (continued)

Location	Sampling Date	Filtered Methyl Mercury (ng/L)	Unfiltered Methyl Mercury (ng/L)	Filtered Inorganic Mercury (ng/L)	Unfiltered Inorganic Mercury (ng/L)
MBM 0.2B					
	19APR1994	5.10E-02	3.90E-02	2.54E+00	7.63E+00
	28JUL1994	1.33E-01	7.90E-02	1.93E+00	2.18E+00
	29AUG1994	1.16E-01	5.80E-02	7.38E-01	1.97E+00
MBM 0.2C					
	19APR1994	2.90E-02	3.50E-02	3.29E+00	7.17E+00
	28JUL1994	7.00E-02	9.10E-02	1.78E+00	2.28E+00
	29AUG1994	1.38E-01	1.04E-01	7.43E-01	2.44E+00
REACH 1					
CRM 36.9B					
	19APR1994	2.80E-02	4.70E-02	2.91E+00	4.49E+00
	28JUL1994	5.33E-01	8.50E-02	1.70E+00	1.37E+00
	29AUG1994	1.03E-01	8.10E-02	2.35E+00	2.10E+00
		REFERENCE SOURCES			
REACH 1					
CRM 46.0B					
	20APR1994	3.50E-02	4.40E-02	1.80E+00	4.45E+00
	29JUL1994	1.19E-01	9.20E-02	1.16E+00	3.03E+00
	30AUG1994	5.00E-02	6.80E-02	1.73E+00	1.49E+00
	30AUG1994	6.00E-02	6.00E-02	1.32E+00	2.17E+00
CRM 43.0B					
	20APR1994	3.70E-02	3.60E-02	2.20E+00	4.35E+00
	29JUL1994	1.82E-01	1.06E-01	1.24E+00	2.33E+00
	30AUG1994	5.90E-02	8.00E-02	1.60E+00	1.73E+00
CRM 41.5B					
	20APR1994	2.40E-02	4.30E-02	1.94E+00	2.65E+00
	29JUL1994	7.70E-02	1.07E-01	1.75E+00	2.41E+00
	30AUG1994	4.50E-02	5.40E-02	1.17E+00	1.24E+00
REACH 4.04					
CRM 1.0B					
	20APR1994	3.40E-02	4.60E-02	2.61E+00	1.35E+01
	29JUL1994	1.08E-01	1.19E-01	1.86E+00	7.47E+00
	29JUL1994	1.32E-01	1.47E-01	2.82E+00	9.17E+00
	30AUG1994	1.08E-01	4.00E-02	9.83E+00	1.67E+00

Table L9. Summary statistics for dissolved and total metal concentrations (mg/L) for the contaminant remobilization from sediments study by season

Analyte	Observations.	Detects	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
			Spring/Dissolved					
Aluminum	12	10	7.0E-03	2.9E-02	1.5E-02	1.4E-03	1.8E-02	1.5E-02
Ammonium nitrogen	12	6	5.0E-02	1.9E-01	7.5E-02	1.3E-02	9.8E-02	5.3E-02
Antimony	12	10	1.0E-03	1.2E-02	5.1E-03	1.1E-03	7.1E-03	4.5E-03
Arsenic	12	3	1.0E-03	3.0E-03	1.8E-03	8.1E-05	2.0E-03	1.7E-03
Barium	12	12	2.2E-02	2.5E-02	2.3E-02	3.1E-04	2.4E-02	2.3E-02
Boron	12	8	1.8E-02	1.1E-01	5.1E-02	5.5E-03	6.1E-02	4.5E-02
Calcium	12	12	1.8E+01	2.9E+01	2.6E+01	9.3E-01	2.8E+01	2.7E+01
Chloride	12	12	2.3E+00	1.4E+01	3.9E+00	9.3E-01	5.6E+00	2.9E+00
Chromium	12	6	1.0E-03	4.7E-03	1.8E-03	3.9E-04	2.5E-03	1.0E-03
Copper	12	12	1.2E-03	3.6E-03	2.3E-03	2.0E-04	2.7E-03	2.3E-03
Fluoride	12	4	5.0E-02	1.5E-01	7.0E-02	8.2E-03	8.5E-02	7.0E-02
Iron	12	9	1.3E-02	7.1E-02	4.4E-02	5.8E-03	5.4E-02	4.7E-02
Lead	12	3	1.0E-03	1.7E-03	1.1E-03	9.1E-05	1.3E-03	1.0E-03
Magnesium	12	12	5.4E+00	9.0E+00	7.9E+00	2.9E-01	8.4E+00	8.1E+00
Manganese	12	11	1.0E-03	1.5E-02	5.6E-03	1.2E-03	7.8E-03	4.3E-03
Mercury (BR)	12	1	1.4E-06	8.3E-06	8.3E-06	.	.	8.3E-06
Nickel	12	12	1.3E-03	1.4E-02	4.8E-03	1.2E-03	7.0E-03	3.2E-03
Nitrate/nitrite	12	12	3.6E-01	7.5E-01	5.7E-01	3.5E-02	6.3E-01	5.7E-01
Potassium	12	12	1.2E+00	1.5E+00	1.4E+00	2.5E-02	1.4E+00	1.4E+00
Sodium	12	12	2.6E+00	3.9E+00	3.5E+00	1.0E-01	3.7E+00	3.6E+00
Sulfate	12	12	1.3E+01	1.8E+01	1.7E+01	4.6E-01	1.8E+01	1.8E+01
Zinc	12	12	3.7E-03	7.2E-03	5.5E-03	3.4E-04	6.1E-03	5.5E-03
			Spring/Total					
Aluminum	12	12	4.5E-02	5.8E-01	2.3E-01	4.6E-02	3.1E-01	2.3E-01

Table L9 (continued)

Analyte	Observations.	Detects	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Arsenic	12	4	1.0E-03	3.0E-03	1.5E-03	1.2E-04	1.7E-03	1.3E-03
Barium	12	12	2.4E-02	2.9E-02	2.7E-02	4.7E-04	2.8E-02	2.6E-02
Boron	12	11	1.8E-02	7.6E-02	4.5E-02	4.8E-03	5.4E-02	4.7E-02
Calcium	12	12	1.9E+01	3.5E+01	2.7E+01	1.3E+00	2.9E+01	2.8E+01
Chromium	12	7	1.0E-03	3.1E-03	1.5E-03	1.9E-04	1.9E-03	1.2E-03
Copper	12	12	1.2E-03	6.0E-03	3.1E-03	5.1E-04	4.1E-03	2.5E-03
Iron	12	12	8.2E-02	7.8E-01	3.4E-01	6.2E-02	4.6E-01	3.4E-01
Lead	12	4	1.0E-03	3.0E-03	1.8E-03	1.8E-04	2.1E-03	1.5E-03
Magnesium	12	12	5.5E+00	9.1E+00	7.9E+00	3.0E-01	8.4E+00	8.2E+00
Manganese	12	12	2.5E-02	9.2E-02	6.4E-02	5.8E-03	7.5E-02	6.4E-02
Mercury (BR)	12	8	2.0E-06	6.6E-05	1.9E-05	6.0E-06	3.0E-05	1.1E-05
Nickel	12	12	1.1E-03	4.0E-03	2.5E-03	2.8E-04	3.0E-03	2.6E-03
Potassium	12	12	1.3E+00	1.5E+00	1.4E+00	2.3E-02	1.5E+00	1.4E+00
Sodium	12	12	3.4E+00	5.8E+00	4.3E+00	2.6E-01	4.7E+00	3.9E+00
Vanadium	12	7	1.0E-03	1.6E-03	1.2E-03	4.9E-05	1.2E-03	1.1E-03
Zinc	12	12	3.0E-03	2.2E-02	9.8E-03	2.0E-03	1.3E-02	8.0E-03
			Summer/Dissolved					
Aluminum	11	7	6.0E-03	1.7E-02	1.1E-02	1.0E-03	1.3E-02	9.4E-03
Ammonium nitrogen	12	2	5.0E-02	8.1E-02	5.8E-02	2.8E-03	6.3E-02	5.6E-02
Antimony	11	10	1.0E-03	1.1E-02	5.8E-03	7.1E-04	7.1E-03	5.4E-03
Barium	11	10	1.0E-03	2.8E-02	2.5E-02	6.4E-04	2.6E-02	2.5E-02
Boron	11	6	1.1E-02	7.1E-02	2.5E-02	5.3E-03	3.5E-02	1.6E-02
Calcium	11	10	2.7E-02	2.9E+01	2.7E+01	4.0E-01	2.8E+01	2.8E+01
Chloride	12	12	2.5E+00	3.2E+01	5.3E+00	2.4E+00	9.7E+00	2.9E+00
Chromium	11	8	1.0E-03	8.1E-03	2.4E-03	6.1E-04	3.5E-03	2.0E-03
Copper	11	10	1.0E-03	1.1E-02	4.3E-03	8.0E-04	5.7E-03	3.4E-03

Table L9 (continued)

Analyte	Observations.	Detects	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Fluoride	12	11	5.0E-02	1.1E-01	7.3E-02	4.7E-03	8.2E-02	6.9E-02
Iron	11	5	1.8E-02	2.7E+00	4.1E-01	2.5E-01	8.7E-01	4.0E-02
Magnesium	11	10	9.0E-03	8.1E+00	7.2E+00	2.7E-01	7.7E+00	7.6E+00
Manganese	11	10	1.0E-03	5.7E-02	1.4E-02	5.5E-03	2.4E-02	3.7E-03
Nickel	11	5	1.0E-03	1.3E-02	2.6E-03	1.1E-03	4.5E-03	1.2E-03
Nitrate/nitrite	12	12	3.0E-01	6.4E-01	4.9E-01	3.0E-02	5.4E-01	4.9E-01
Potassium	11	10	1.3E-02	1.4E+00	1.3E+00	2.6E-02	1.4E+00	1.3E+00
Selenium	11	3	1.0E-03	7.5E-03	3.6E-03	4.6E-04	4.4E-03	3.2E-03
Sodium	11	11	2.4E-02	3.4E+00	2.9E+00	2.9E-01	3.4E+00	3.2E+00
Sulfate	12	12	1.3E+01	1.7E+01	1.6E+01	3.4E-01	1.7E+01	1.7E+01
Vanadium	11	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	11	10	2.0E-03	1.1E-02	5.7E-03	1.0E-03	7.6E-03	4.2E-03
			Summer/Total					
Aluminum	12	11	6.0E-03	2.2E-01	1.2E-01	2.1E-02	1.6E-01	1.1E-01
Antimony	12	3	1.0E-03	1.7E-03	1.3E-03	6.0E-05	1.4E-03	1.2E-03
Barium	12	12	2.4E-02	3.0E-02	2.7E-02	6.3E-04	2.8E-02	2.7E-02
Boron	12	4	1.1E-02	3.2E-02	2.2E-02	1.5E-03	2.5E-02	2.0E-02
Calcium	12	12	2.5E+01	3.0E+01	2.8E+01	5.0E-01	2.8E+01	2.8E+01
Chromium	12	9	1.0E-03	2.4E-03	1.7E-03	1.2E-04	1.9E-03	1.6E-03
Copper	12	12	1.4E-03	3.4E-03	2.4E-03	2.1E-04	2.8E-03	2.4E-03
Iron	12	11	1.8E-02	7.9E-01	3.4E-01	8.9E-02	5.0E-01	1.7E-01
Magnesium	12	12	6.2E+00	8.4E+00	7.5E+00	2.6E-01	8.0E+00	7.9E+00
Manganese	12	11	1.0E-03	2.2E-01	8.7E-02	1.4E-02	1.1E-01	7.9E-02
Mercury (BR)	12	5	1.9E-06	3.6E-05	1.0E-05	3.4E-06	1.6E-05	3.6E-06
Nickel	12	4	1.0E-03	1.9E-03	1.3E-03	6.8E-05	1.4E-03	1.2E-03
Potassium	12	12	1.2E+00	1.5E+00	1.3E+00	2.6E-02	1.4E+00	1.4E+00

Table L9 (continued)

Analyte	Observations.	Detects	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Sodium	12	12	2.9E+00	3.4E+00	3.2E+00	3.5E-02	3.3E+00	3.2E+00
Vanadium	12	3	1.0E-03	1.3E-03	1.0E-03	3.4E-05	1.1E-03	1.0E-03
Zinc	12	12	2.0E-03	8.7E-03	4.9E-03	6.8E-04	6.1E-03	4.7E-03

Table L10. Summary statistics for dissolved and total metal concentrations (mg/L) for the contaminant remobilization from sediments study for each site

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
			CRM 1.0/Dissolved					
Aluminum	6	4	6.0E-03	2.9E-02	1.4E-02	3.5E-03	2.1E-02	9.4E-03
Ammonium nitrogen	6	2	5.0E-02	7.5E-02	5.9E-02	4.1E-03	6.7E-02	5.6E-02
Antimony	6	6	1.1E-03	7.5E-03	4.6E-03	8.9E-04	6.4E-03	5.2E-03
Arsenic	6	1	1.0E-03	3.0E-03	2.1E-03	.	.	2.1E-03
Barium	6	6	2.2E-02	2.7E-02	2.5E-02	8.9E-04	2.6E-02	2.4E-02
Boron	6	4	1.1E-02	7.1E-02	4.3E-02	7.2E-03	5.7E-02	3.7E-02
Calcium	6	6	1.8E+01	2.8E+01	2.5E+01	1.7E+00	2.8E+01	2.7E+01
Chloride	6	6	2.3E+00	4.1E+00	3.1E+00	2.5E-01	3.6E+00	2.9E+00
Chromium	6	4	1.0E-03	4.7E-03	2.9E-03	3.8E-04	3.7E-03	2.6E-03
Copper	6	6	1.8E-03	4.5E-03	3.0E-03	3.6E-04	3.8E-03	3.1E-03
Fluoride	6	4	6.0E-02	1.5E-01	7.1E-02	4.9E-03	8.1E-02	7.0E-02
Iron	6	3	1.3E-02	5.7E-01	1.5E-01	9.3E-02	3.4E-01	6.7E-02
Magnesium	6	6	5.4E+00	8.5E+00	7.1E+00	4.6E-01	8.0E+00	7.2E+00
Manganese	6	6	1.8E-03	1.5E-02	4.7E-03	2.1E-03	8.9E-03	2.5E-03
Nickel	6	4	1.0E-03	1.4E-02	3.7E-03	2.1E-03	7.9E-03	1.5E-03
Nitrate/nitrite	6	6	3.0E-01	4.9E-01	4.1E-01	3.3E-02	4.8E-01	4.3E-01
Potassium	6	6	1.2E+00	1.4E+00	1.3E+00	2.6E-02	1.4E+00	1.4E+00
Sodium	6	6	2.6E+00	3.8E+00	3.3E+00	1.6E-01	3.6E+00	3.3E+00
Sulfate	6	6	1.3E+01	1.7E+01	1.5E+01	6.8E-01	1.6E+01	1.6E+01
Zinc	6	6	2.7E-03	1.1E-02	5.5E-03	1.3E-03	8.0E-03	4.3E-03
			CRM 1.0/Total					
Aluminum	6	6	3.4E-02	5.8E-01	2.3E-01	7.9E-02	3.9E-01	2.1E-01
Arsenic	6	1	1.0E-03	3.0E-03	1.5E-03	.	.	1.5E-03
Barium	6	6	2.4E-02	2.9E-02	2.8E-02	8.2E-04	3.0E-02	2.9E-02

Table L10 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Boron	6	4	1.1E-02	5.6E-02	3.1E-02	6.9E-03	4.5E-02	2.3E-02
Calcium	6	6	1.9E+01	2.9E+01	2.5E+01	1.7E+00	2.8E+01	2.6E+01
Chromium	6	4	1.0E-03	2.4E-03	1.6E-03	2.3E-04	2.1E-03	1.4E-03
Copper	6	6	1.4E-03	5.2E-03	3.2E-03	5.0E-04	4.2E-03	3.2E-03
Iron	6	6	7.5E-02	7.9E-01	4.2E-01	1.3E-01	6.7E-01	3.7E-01
Lead	6	1	1.0E-03	1.5E-03	1.5E-03	.	.	1.5E-03
Magnesium	6	6	5.5E+00	8.3E+00	7.0E+00	4.8E-01	8.0E+00	7.1E+00
Manganese	6	6	4.2E-02	8.6E-02	6.7E-02	6.8E-03	8.1E-02	6.8E-02
Mercury (BR)	6	6	1.7E-05	3.6E-05	2.8E-05	3.7E-06	3.5E-05	2.8E-05
Nickel	6	4	1.0E-03	3.2E-03	2.1E-03	3.2E-04	2.7E-03	1.7E-03
Potassium	6	6	1.3E+00	1.5E+00	1.4E+00	2.3E-02	1.4E+00	1.4E+00
Sodium	6	6	3.2E+00	4.9E+00	3.7E+00	2.7E-01	4.2E+00	3.4E+00
Vanadium	6	4	1.0E-03	1.6E-03	1.2E-03	9.5E-05	1.4E-03	1.2E-03
Zinc	6	6	2.7E-03	2.0E-02	8.5E-03	2.5E-03	1.4E-02	7.3E-03
			CRM 41.5/Dissolved					
Aluminum	5	4	7.0E-03	1.6E-02	1.5E-02	3.0E-04	1.6E-02	1.5E-02
Ammonium nitrogen	6	3	5.0E-02	1.3E-01	6.7E-02	1.4E-02	9.5E-02	5.3E-02
Antimony	5	4	1.0E-03	1.1E-02	6.9E-03	1.9E-03	1.1E-02	6.6E-03
Barium	5	5	2.1E-02	2.5E-02	2.3E-02	6.8E-04	2.5E-02	2.4E-02
Boron	5	2	1.1E-02	6.3E-02	4.6E-02	5.5E-03	5.8E-02	4.2E-02
Calcium	5	5	2.5E+01	2.8E+01	2.7E+01	5.9E-01	2.8E+01	2.7E+01
Chloride	6	6	2.7E+00	3.2E+01	9.7E+00	4.8E+00	1.9E+01	3.4E+00
Chromium	5	4	1.0E-03	3.8E-03	1.9E-03	5.6E-04	3.1E-03	1.3E-03
Copper	5	5	1.9E-03	1.1E-02	4.2E-03	1.7E-03	7.8E-03	3.0E-03
Fluoride	6	3	5.0E-02	1.5E-01	6.0E-02	7.5E-03	7.5E-02	5.5E-02
Iron	5	4	1.8E-02	5.1E-01	1.3E-01	9.8E-02	3.4E-01	5.1E-02
Lead	5	2	1.0E-03	1.7E-03	1.1E-03	1.7E-04	1.5E-03	1.0E-03

Table L10 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Magnesium	5	5	6.4E+00	8.8E+00	7.8E+00	4.2E-01	8.7E+00	8.1E+00
Manganese	5	5	7.7E-03	2.7E-02	1.4E-02	3.7E-03	2.1E-02	8.9E-03
Mercury (BR)	6	1	1.4E-06	8.3E-06	8.3E-06	.	.	8.3E-06
Nickel	5	4	1.0E-03	9.3E-03	3.5E-03	1.5E-03	6.8E-03	2.7E-03
Nitrate/nitrite	6	6	5.9E-01	7.4E-01	6.3E-01	2.4E-02	6.8E-01	6.1E-01
Potassium	5	5	1.2E+00	1.5E+00	1.3E+00	5.4E-02	1.5E+00	1.4E+00
Selenium	5	1	1.0E-03	3.2E-03	3.2E-03	.	.	3.2E-03
Sodium	5	5	3.0E+00	3.7E+00	3.4E+00	1.3E-01	3.7E+00	3.5E+00
Sulfate	6	6	1.7E+01	1.8E+01	1.7E+01	2.1E-01	1.8E+01	1.7E+01
Zinc	5	5	4.2E-03	7.2E-03	6.0E-03	6.2E-04	7.3E-03	6.6E-03
			CRM 41.5/Total					
Aluminum	6	6	7.1E-02	3.3E-01	1.8E-01	4.0E-02	2.6E-01	1.6E-01
Arsenic	6	1	1.0E-03	3.0E-03	1.6E-03	.	.	1.6E-03
Barium	6	6	2.4E-02	2.7E-02	2.5E-02	4.5E-04	2.6E-02	2.6E-02
Boron	6	4	1.1E-02	7.6E-02	4.3E-02	9.8E-03	6.3E-02	3.0E-02
Calcium	6	6	2.5E+01	2.9E+01	2.7E+01	7.2E-01	2.9E+01	2.8E+01
Chromium	6	5	1.0E-03	3.1E-03	1.9E-03	3.1E-04	2.5E-03	1.6E-03
Copper	6	6	1.5E-03	6.0E-03	2.8E-03	6.7E-04	4.2E-03	2.6E-03
Iron	6	6	1.3E-01	7.4E-01	3.5E-01	9.8E-02	5.5E-01	2.9E-01
Lead	6	1	1.0E-03	3.0E-03	3.0E-03	.	.	3.0E-03
Magnesium	6	6	6.4E+00	8.5E+00	7.7E+00	3.2E-01	8.4E+00	7.9E+00
Manganese	6	6	6.4E-02	1.2E-01	8.8E-02	7.9E-03	1.0E-01	8.6E-02
Mercury (BR)	6	2	1.9E-06	3.6E-06	3.0E-06	1.5E-07	3.3E-06	2.9E-06
Nickel	6	4	1.0E-03	3.2E-03	2.0E-03	3.0E-04	2.6E-03	1.7E-03
Potassium	6	6	1.2E+00	1.5E+00	1.4E+00	5.5E-02	1.5E+00	1.3E+00
Sodium	6	6	2.9E+00	5.8E+00	3.6E+00	4.3E-01	4.5E+00	3.2E+00
Vanadium	6	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03

Table L10 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Zinc	6	6	2.2E-03	2.2E-02	8.3E-03	3.1E-03	1.4E-02	6.1E-03
			CRM 6.0/Dissolved					
Aluminum	6	4	6.0E-03	1.7E-02	1.2E-02	1.5E-03	1.5E-02	1.0E-02
Antimony	6	6	3.9E-03	9.5E-03	5.7E-03	9.3E-04	7.6E-03	4.7E-03
Arsenic	6	1	1.0E-03	3.0E-03	1.7E-03	.	.	1.7E-03
Barium	6	6	2.2E-02	2.6E-02	2.4E-02	7.2E-04	2.6E-02	2.4E-02
Boron	6	5	1.6E-02	5.0E-02	2.9E-02	6.5E-03	4.2E-02	2.3E-02
Calcium	6	6	2.6E+01	2.9E+01	2.7E+01	5.4E-01	2.8E+01	2.7E+01
Chloride	6	6	2.7E+00	3.2E+00	2.9E+00	7.3E-02	3.0E+00	2.9E+00
Chromium	6	3	1.0E-03	2.6E-03	1.4E-03	2.7E-04	1.9E-03	1.1E-03
Copper	6	6	1.2E-03	3.6E-03	2.4E-03	4.0E-04	3.2E-03	2.2E-03
Fluoride	6	4	5.9E-02	1.5E-01	7.5E-02	1.2E-02	9.9E-02	6.5E-02
Iron	6	4	1.3E-02	5.3E-01	1.3E-01	8.6E-02	3.0E-01	4.0E-02
Magnesium	6	6	6.3E+00	8.6E+00	7.8E+00	3.1E-01	8.4E+00	8.0E+00
Manganese	6	6	1.6E-03	5.8E-03	3.5E-03	6.5E-04	4.8E-03	3.2E-03
Nickel	6	4	1.0E-03	4.5E-03	2.8E-03	5.8E-04	3.9E-03	2.1E-03
Nitrate/nitrite	6	6	4.0E-01	6.9E-01	5.1E-01	4.4E-02	6.0E-01	5.0E-01
Potassium	6	6	1.3E+00	1.4E+00	1.4E+00	2.0E-02	1.4E+00	1.4E+00
Selenium	6	1	1.0E-03	3.3E-03	3.3E-03	.	.	3.3E-03
Sodium	6	6	3.2E+00	3.8E+00	3.4E+00	1.1E-01	3.6E+00	3.3E+00
Sulfate	6	6	1.6E+01	1.8E+01	1.7E+01	3.7E-01	1.8E+01	1.7E+01
Zinc	6	6	2.9E-03	9.4E-03	5.1E-03	9.8E-04	7.1E-03	4.7E-03
			CRM 6.0/Total					
Aluminum	6	6	4.2E-02	4.1E-01	1.5E-01	5.9E-02	2.7E-01	9.3E-02
Antimony	6	2	1.0E-03	1.7E-03	1.6E-03	2.2E-05	1.7E-03	1.6E-03
Arsenic	6	1	1.0E-03	3.0E-03	1.3E-03	.	.	1.3E-03
Barium	6	6	2.5E-02	3.0E-02	2.8E-02	6.3E-04	2.9E-02	2.8E-02

Table L10 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Boron	6	4	1.1E-02	4.7E-02	3.4E-02	3.3E-03	4.1E-02	3.0E-02
Calcium	6	6	2.6E+01	3.0E+01	2.8E+01	8.1E-01	3.0E+01	2.8E+01
Chromium	6	4	1.0E-03	2.1E-03	1.5E-03	2.0E-04	1.9E-03	1.4E-03
Copper	6	6	1.2E-03	5.4E-03	2.4E-03	6.3E-04	3.7E-03	1.9E-03
Iron	6	6	7.1E-02	6.7E-01	3.0E-01	1.1E-01	5.3E-01	1.9E-01
Lead	6	1	1.0E-03	2.8E-03	2.8E-03	.	.	2.8E-03
Magnesium	6	6	6.3E+00	8.6E+00	8.0E+00	3.5E-01	8.7E+00	8.4E+00
Manganese	6	6	2.5E-02	8.0E-02	5.4E-02	7.7E-03	6.9E-02	5.7E-02
Mercury (BR)	6	4	1.3E-05	6.6E-05	3.0E-05	8.0E-06	4.6E-05	2.0E-05
Nickel	6	4	1.0E-03	4.0E-03	1.9E-03	5.3E-04	2.9E-03	1.2E-03
Potassium	6	6	1.3E+00	1.5E+00	1.4E+00	2.6E-02	1.5E+00	1.4E+00
Sodium	6	6	3.2E+00	5.4E+00	3.9E+00	3.5E-01	4.6E+00	3.5E+00
Vanadium	6	3	1.0E-03	1.2E-03	1.2E-03	0.0E+00	1.2E-03	1.2E-03
Zinc	6	6	3.3E-03	1.2E-02	5.8E-03	1.3E-03	8.4E-03	5.0E-03
			MBM 0.2/Dissolved					
Aluminum	6	5	6.0E-03	1.6E-02	1.3E-02	8.0E-04	1.5E-02	1.3E-02
Ammonium nitrogen	6	3	5.0E-02	1.9E-01	9.7E-02	2.1E-02	1.4E-01	7.8E-02
Antimony	6	4	1.0E-03	1.2E-02	5.7E-03	1.3E-03	8.4E-03	4.0E-03
Arsenic	6	1	1.0E-03	3.0E-03	2.2E-03	.	.	2.2E-03
Barium	6	5	1.0E-03	2.8E-02	2.4E-02	9.3E-04	2.6E-02	2.3E-02
Boron	6	3	1.1E-02	1.1E-01	5.0E-02	1.3E-02	7.6E-02	3.7E-02
Calcium	6	5	2.7E-02	2.9E+01	2.7E+01	4.7E-01	2.8E+01	2.7E+01
Chloride	6	6	2.5E+00	3.0E+00	2.8E+00	8.3E-02	2.9E+00	2.9E+00
Chromium	6	3	1.0E-03	8.1E-03	3.1E-03	1.1E-03	5.3E-03	2.0E-03
Copper	6	5	1.0E-03	6.8E-03	3.4E-03	9.0E-04	5.3E-03	2.8E-03
Fluoride	6	4	6.7E-02	1.5E-01	8.2E-02	5.5E-03	9.3E-02	8.5E-02
Iron	6	3	1.3E-02	2.7E+00	4.8E-01	4.9E-01	1.5E+00	4.6E-02

Table L10 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Lead	6	1	1.0E-03	1.7E-03	1.7E-03	.	.	1.7E-03
Magnesium	6	5	9.0E-03	9.0E+00	7.6E+00	4.8E-01	8.6E+00	8.0E+00
Manganese	6	4	1.0E-03	5.7E-02	1.7E-02	9.8E-03	3.7E-02	4.7E-03
Nickel	6	5	1.0E-03	1.3E-02	5.3E-03	2.1E-03	9.5E-03	2.8E-03
Nitrate/nitrite	6	6	4.2E-01	7.5E-01	5.6E-01	4.5E-02	6.5E-01	5.5E-01
Potassium	6	5	1.3E-02	1.4E+00	1.3E+00	4.2E-02	1.4E+00	1.3E+00
Selenium	6	1	1.0E-03	7.5E-03	7.5E-03	.	.	7.5E-03
Sodium	6	6	2.4E-02	3.9E+00	2.9E+00	5.9E-01	4.1E+00	3.3E+00
Sulfate	6	6	1.6E+01	1.8E+01	1.7E+01	3.1E-01	1.8E+01	1.7E+01
Vanadium	6	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	6	5	2.0E-03	1.1E-02	6.1E-03	1.1E-03	8.3E-03	5.5E-03
			MBM 0.2/Total					
Aluminum	6	5	6.0E-03	2.5E-01	1.4E-01	3.8E-02	2.2E-01	1.5E-01
Antimony	6	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Arsenic	6	1	1.0E-03	3.0E-03	2.2E-03	.	.	2.2E-03
Barium	6	6	2.4E-02	3.0E-02	2.6E-02	8.3E-04	2.8E-02	2.6E-02
Boron	6	3	1.1E-02	5.3E-02	3.6E-02	4.9E-03	4.6E-02	2.9E-02
Calcium	6	6	2.6E+01	3.5E+01	3.0E+01	1.3E+00	3.2E+01	2.9E+01
Chromium	6	3	1.0E-03	2.1E-03	1.6E-03	1.1E-04	1.8E-03	1.5E-03
Copper	6	6	1.7E-03	5.0E-03	2.8E-03	5.0E-04	3.8E-03	2.3E-03
Iron	6	5	1.8E-02	7.6E-01	2.9E-01	1.1E-01	5.1E-01	2.2E-01
Lead	6	1	1.0E-03	2.2E-03	2.2E-03	.	.	2.2E-03
Magnesium	6	6	6.4E+00	9.1E+00	8.0E+00	3.7E-01	8.8E+00	8.2E+00
Manganese	6	5	1.0E-03	2.2E-01	9.4E-02	2.7E-02	1.5E-01	7.3E-02
Mercury (BR)	6	1	2.0E-06	7.1E-06	2.0E-06	.	.	2.0E-06
Nickel	6	4	1.0E-03	3.9E-03	1.9E-03	4.8E-04	2.9E-03	1.3E-03
Potassium	6	6	1.3E+00	1.5E+00	1.4E+00	3.7E-02	1.5E+00	1.4E+00

Table L10 (continued)

Analyte	Observations.	Detects	Mininimum	Maximum	Mean	Std. Error	95% UCB	Median
Sodium	6	6	3.1E+00	5.6E+00	3.8E+00	3.8E-01	4.5E+00	3.5E+00
Vanadium	6	2	1.0E-03	1.1E-03	1.0E-03	2.2E-05	1.1E-03	1.0E-03
Zinc	6	6	2.0E-03	1.7E-02	6.9E-03	2.3E-03	1.2E-02	5.0E-03

Table L11. Summary statistics for dissolved and total metal concentrations (mg/L) for the contaminant remobilization from sediments study for each site by season

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
CRM 1.0/Spring/Dissolved								
Aluminum	3	2	7.0E-03	2.9E-02	2.1E-02	4.5E-03	3.4E-02	1.7E-02
Ammonium nitrogen	3	1	5.0E-02	7.5E-02	7.5E-02	.	.	7.5E-02
Antimony	3	3	1.1E-03	5.2E-03	3.8E-03	1.4E-03	7.7E-03	5.1E-03
Arsenic	3	1	1.0E-03	3.0E-03	2.1E-03	.	.	2.1E-03
Barium	3	3	2.2E-02	2.4E-02	2.3E-02	6.3E-04	2.5E-02	2.3E-02
Boron	3	2	1.8E-02	5.2E-02	4.7E-02	2.7E-03	5.5E-02	4.5E-02
Calcium	3	3	1.8E+01	2.8E+01	2.3E+01	3.0E+00	3.1E+01	2.1E+01
Chloride	3	3	2.3E+00	4.1E+00	3.1E+00	5.3E-01	4.6E+00	2.9E+00
Chromium	3	2	1.0E-03	4.7E-03	3.4E-03	7.3E-04	5.6E-03	2.8E-03
Copper	3	3	1.8E-03	2.9E-03	2.5E-03	3.3E-04	3.4E-03	2.7E-03
Fluoride	3	1	7.0E-02	1.5E-01	7.0E-02	.	.	7.0E-02
Iron	3	2	1.3E-02	6.9E-02	6.7E-02	6.4E-04	6.9E-02	6.7E-02
Magnesium	3	3	5.4E+00	8.5E+00	6.9E+00	8.9E-01	9.5E+00	6.9E+00
Manganese	3	3	2.5E-03	1.5E-02	6.7E-03	4.2E-03	1.9E-02	2.5E-03
Nickel	3	3	1.8E-03	1.4E-02	6.1E-03	3.8E-03	1.7E-02	2.9E-03
Nitrate/nitrite	3	3	3.6E-01	4.9E-01	4.4E-01	4.2E-02	5.7E-01	4.8E-01
Potassium	3	3	1.2E+00	1.4E+00	1.3E+00	4.6E-02	1.4E+00	1.3E+00
Sodium	3	3	2.6E+00	3.8E+00	3.3E+00	3.6E-01	4.3E+00	3.4E+00
Sulfate	3	3	1.3E+01	1.6E+01	1.5E+01	8.8E-01	1.7E+01	1.5E+01
Zinc	3	3	3.7E-03	6.4E-03	4.9E-03	8.0E-04	7.2E-03	4.5E-03
CRM 1.0/Spring/Total								
Aluminum	3	3	7.8E-02	5.8E-01	3.1E-01	1.4E-01	7.4E-01	2.9E-01
Arsenic	3	1	1.0E-03	3.0E-03	1.5E-03	.	.	1.5E-03

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Barium	3	3	2.4E-02	2.9E-02	2.7E-02	1.7E-03	3.2E-02	2.9E-02
Boron	3	3	2.5E-02	5.6E-02	4.3E-02	9.1E-03	6.9E-02	4.7E-02
Calcium	3	3	1.9E+01	2.7E+01	2.2E+01	2.5E+00	2.9E+01	2.0E+01
Chromium	3	2	1.0E-03	2.4E-03	1.6E-03	4.6E-04	2.9E-03	1.2E-03
Copper	3	3	2.7E-03	5.2E-03	3.6E-03	7.9E-04	5.9E-03	3.0E-03
Iron	3	3	1.4E-01	7.8E-01	4.4E-01	1.8E-01	9.8E-01	4.1E-01
Lead	3	1	1.0E-03	1.5E-03	1.5E-03	.	.	1.5E-03
Magnesium	3	3	5.5E+00	8.3E+00	6.7E+00	8.3E-01	9.1E+00	6.3E+00
Manganese	3	3	4.2E-02	7.1E-02	5.9E-02	8.9E-03	8.5E-02	6.4E-02
Mercury	3	3	2.1E-05	3.6E-05	3.0E-05	4.9E-06	4.5E-05	3.5E-05
Nickel	3	3	1.5E-03	3.2E-03	2.5E-03	5.1E-04	4.0E-03	2.8E-03
Potassium	3	3	1.3E+00	1.4E+00	1.3E+00	2.5E-02	1.4E+00	1.4E+00
Sodium	3	3	3.5E+00	4.9E+00	4.1E+00	4.2E-01	5.3E+00	3.9E+00
Vanadium	3	3	1.1E-03	1.6E-03	1.3E-03	1.6E-04	1.8E-03	1.3E-03
Zinc	3	3	7.3E-03	2.0E-02	1.2E-02	4.1E-03	2.4E-02	8.8E-03
CRM 1.0/Summer/Dissolved								
Aluminum	3	2	6.0E-03	1.0E-02	9.1E-03	7.5E-04	1.1E-02	8.4E-03
Ammonium nitrogen	3	1	5.0E-02	5.6E-02	5.6E-02	.	.	5.6E-02
Antimony	3	3	3.2E-03	7.5E-03	5.4E-03	1.2E-03	8.9E-03	5.4E-03
Barium	3	3	2.5E-02	2.7E-02	2.6E-02	7.2E-04	2.8E-02	2.7E-02
Boron	3	2	1.1E-02	7.1E-02	4.3E-02	1.6E-02	9.0E-02	3.0E-02
Calcium	3	3	2.6E+01	2.8E+01	2.7E+01	7.0E-01	2.9E+01	2.8E+01
Chloride	3	3	2.8E+00	3.4E+00	3.1E+00	1.8E-01	3.6E+00	3.0E+00
Chromium	3	2	1.0E-03	2.6E-03	2.5E-03	3.8E-05	2.6E-03	2.5E-03
Copper	3	3	3.2E-03	4.5E-03	3.6E-03	4.4E-04	4.9E-03	3.2E-03

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Fluoride	3	3	6.0E-02	8.4E-02	7.1E-02	7.0E-03	9.2E-02	7.0E-02
Iron	3	1	1.8E-02	5.7E-01	5.7E-01	.	.	5.7E-01
Magnesium	3	3	6.3E+00	8.0E+00	7.3E+00	5.0E-01	8.8E+00	7.6E+00
Manganese	3	3	1.8E-03	3.5E-03	2.6E-03	5.0E-04	4.0E-03	2.5E-03
Nickel	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Nitrate/nitrite	3	3	3.0E-01	4.8E-01	3.8E-01	5.2E-02	5.4E-01	3.7E-01
Potassium	3	3	1.3E+00	1.4E+00	1.4E+00	1.8E-02	1.4E+00	1.4E+00
Sodium	3	3	3.3E+00	3.4E+00	3.3E+00	2.9E-02	3.4E+00	3.3E+00
Sulfate	3	3	1.3E+01	1.7E+01	1.5E+01	1.2E+00	1.9E+01	1.6E+01
Zinc	3	3	2.7E-03	1.1E-02	6.1E-03	2.7E-03	1.4E-02	4.1E-03
CRM 1.0/Summer/Total								
Aluminum	3	3	3.4E-02	2.2E-01	1.5E-01	6.0E-02	3.3E-01	2.0E-01
Barium	3	3	2.8E-02	2.9E-02	2.9E-02	2.4E-04	2.9E-02	2.8E-02
Boron	3	1	1.1E-02	2.0E-02	2.0E-02	.	.	2.0E-02
Calcium	3	3	2.5E+01	2.9E+01	2.7E+01	1.3E+00	3.1E+01	2.8E+01
Chromium	3	2	1.0E-03	2.2E-03	1.8E-03	2.3E-04	2.5E-03	1.6E-03
Copper	3	3	1.4E-03	3.4E-03	2.7E-03	6.5E-04	4.6E-03	3.3E-03
Iron	3	3	7.5E-02	7.9E-01	4.0E-01	2.1E-01	1.0E+00	3.2E-01
Magnesium	3	3	6.2E+00	8.1E+00	7.4E+00	6.0E-01	9.1E+00	7.9E+00
Manganese	3	3	5.7E-02	8.6E-02	7.6E-02	9.2E-03	1.0E-01	8.4E-02
Mercury	3	3	1.7E-05	3.6E-05	2.5E-05	6.0E-06	4.2E-05	2.1E-05
Nickel	3	1	1.0E-03	1.9E-03	1.9E-03	.	.	1.9E-03
Potassium	3	3	1.4E+00	1.5E+00	1.4E+00	2.6E-02	1.5E+00	1.4E+00
Sodium	3	3	3.2E+00	3.3E+00	3.3E+00	2.5E-02	3.3E+00	3.3E+00
Vanadium	3	1	1.0E-03	1.3E-03	1.3E-03	.	.	1.3E-03

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Zinc	3	3	2.7E-03	7.3E-03	4.9E-03	1.3E-03	8.8E-03	4.8E-03
CRM 41.5/Spring/Dissolved								
Aluminum	3	3	1.5E-02	1.6E-02	1.6E-02	2.9E-04	1.7E-02	1.6E-02
Ammonium nitrogen	3	3	5.3E-02	1.3E-01	8.0E-02	2.5E-02	1.5E-01	5.8E-02
Antimony	3	2	1.0E-03	1.1E-02	5.7E-03	3.3E-03	1.5E-02	2.9E-03
Barium	3	3	2.2E-02	2.5E-02	2.4E-02	9.3E-04	2.6E-02	2.4E-02
Boron	3	2	1.8E-02	6.3E-02	4.9E-02	8.4E-03	7.3E-02	4.2E-02
Calcium	3	3	2.6E+01	2.8E+01	2.7E+01	5.6E-01	2.9E+01	2.7E+01
Chloride	3	3	2.7E+00	1.4E+01	6.6E+00	3.7E+00	1.7E+01	3.2E+00
Chromium	3	2	1.0E-03	3.8E-03	1.9E-03	1.1E-03	5.0E-03	1.0E-03
Copper	3	3	1.9E-03	3.0E-03	2.3E-03	3.5E-04	3.3E-03	2.0E-03
Fluoride	3	1	5.0E-02	1.5E-01	5.0E-02	.	.	5.0E-02
Iron	3	3	2.0E-02	5.4E-02	4.2E-02	1.1E-02	7.3E-02	5.1E-02
Lead	3	2	1.0E-03	1.7E-03	1.2E-03	2.7E-04	2.0E-03	1.0E-03
Magnesium	3	3	7.4E+00	8.8E+00	8.1E+00	4.1E-01	9.3E+00	8.2E+00
Manganese	3	3	7.7E-03	8.9E-03	8.5E-03	3.8E-04	9.6E-03	8.8E-03
Nickel	3	3	1.3E-03	9.3E-03	4.4E-03	2.5E-03	1.2E-02	2.7E-03
Nitrate/nitrite	3	3	5.9E-01	7.4E-01	6.5E-01	4.7E-02	7.8E-01	6.1E-01
Potassium	3	3	1.4E+00	1.5E+00	1.4E+00	3.7E-02	1.5E+00	1.4E+00
Sodium	3	3	3.5E+00	3.7E+00	3.6E+00	8.1E-02	3.8E+00	3.6E+00
Sulfate	3	3	1.7E+01	1.8E+01	1.8E+01	3.3E-01	1.9E+01	1.8E+01
Zinc	3	3	4.2E-03	7.2E-03	6.2E-03	9.8E-04	9.0E-03	7.1E-03
CRM 41.5/Spring/Total								
Aluminum	3	3	7.1E-02	3.3E-01	2.2E-01	7.7E-02	4.4E-01	2.4E-01
Arsenic	3	1	1.0E-03	3.0E-03	1.6E-03	.	.	1.6E-03

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Barium	3	3	2.6E-02	2.7E-02	2.6E-02	3.2E-04	2.7E-02	2.6E-02
Boron	3	3	2.8E-02	7.6E-02	5.8E-02	1.5E-02	1.0E-01	6.9E-02
Calcium	3	3	2.5E+01	2.9E+01	2.8E+01	1.2E+00	3.1E+01	2.9E+01
Chromium	3	2	1.0E-03	3.1E-03	2.2E-03	5.4E-04	3.7E-03	1.7E-03
Copper	3	3	1.5E-03	6.0E-03	3.3E-03	1.4E-03	7.3E-03	2.3E-03
Iron	3	3	1.3E-01	5.1E-01	3.4E-01	1.1E-01	6.7E-01	3.9E-01
Lead	3	1	1.0E-03	3.0E-03	3.0E-03	.	.	3.0E-03
Magnesium	3	3	7.4E+00	8.5E+00	8.1E+00	3.5E-01	9.1E+00	8.4E+00
Manganese	3	3	6.4E-02	9.2E-02	7.9E-02	8.1E-03	1.0E-01	8.1E-02
Mercury	3	1	2.9E-06	3.4E-06	2.9E-06	.	.	2.9E-06
Nickel	3	3	1.8E-03	3.2E-03	2.5E-03	4.1E-04	3.7E-03	2.4E-03
Potassium	3	3	1.3E+00	1.5E+00	1.4E+00	6.2E-02	1.6E+00	1.5E+00
Sodium	3	3	3.4E+00	5.8E+00	4.2E+00	7.8E-01	6.5E+00	3.4E+00
Vanadium	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	3	3	3.4E-03	2.2E-02	1.2E-02	5.6E-03	2.8E-02	9.7E-03
CRM 41.5/Summer/Dissolved								
Aluminum	2	1	7.0E-03	1.5E-02	1.5E-02	.	.	1.5E-02
Antimony	2	2	6.6E-03	1.1E-02	8.7E-03	2.1E-03	2.2E-02	8.7E-03
Barium	2	2	2.1E-02	2.4E-02	2.3E-02	1.2E-03	3.0E-02	2.3E-02
Calcium	2	2	2.5E+01	2.8E+01	2.7E+01	1.6E+00	3.7E+01	2.7E+01
Chloride	3	3	2.7E+00	3.2E+01	1.3E+01	9.6E+00	4.1E+01	3.6E+00
Chromium	2	2	1.3E-03	2.6E-03	2.0E-03	6.5E-04	6.1E-03	2.0E-03
Copper	2	2	3.4E-03	1.1E-02	7.2E-03	3.8E-03	3.1E-02	7.2E-03
Fluoride	3	2	5.0E-02	8.0E-02	6.6E-02	8.1E-03	9.0E-02	5.9E-02
Iron	2	1	1.8E-02	5.1E-01	5.1E-01	.	.	5.1E-01

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Magnesium	2	2	6.4E+00	8.1E+00	7.3E+00	8.7E-01	1.3E+01	7.3E+00
Manganese	2	2	1.6E-02	2.7E-02	2.1E-02	5.7E-03	5.7E-02	2.1E-02
Nickel	2	1	1.0E-03	2.8E-03	2.8E-03	.	.	2.8E-03
Nitrate/nitrite	3	3	5.9E-01	6.4E-01	6.1E-01	1.5E-02	6.5E-01	6.0E-01
Potassium	2	2	1.2E+00	1.3E+00	1.2E+00	8.0E-02	1.7E+00	1.2E+00
Selenium	2	1	1.0E-03	3.2E-03	3.2E-03	.	.	3.2E-03
Sodium	2	2	3.0E+00	3.2E+00	3.1E+00	7.0E-02	3.5E+00	3.1E+00
Sulfate	3	3	1.7E+01	1.7E+01	1.7E+01	0.0E+00	1.7E+01	1.7E+01
Zinc	2	2	4.8E-03	6.6E-03	5.7E-03	9.0E-04	1.1E-02	5.7E-03
CRM 41.5/Summer/Total								
Aluminum	3	3	1.0E-01	1.9E-01	1.4E-01	2.7E-02	2.2E-01	1.3E-01
Barium	3	3	2.4E-02	2.5E-02	2.5E-02	6.2E-04	2.7E-02	2.5E-02
Boron	3	1	1.1E-02	3.2E-02	3.2E-02	.	.	3.2E-02
Calcium	3	3	2.5E+01	2.9E+01	2.7E+01	1.1E+00	3.0E+01	2.8E+01
Chromium	3	3	1.3E-03	2.4E-03	1.7E-03	3.5E-04	2.7E-03	1.4E-03
Copper	3	3	1.6E-03	2.8E-03	2.4E-03	3.9E-04	3.6E-03	2.8E-03
Iron	3	3	1.5E-01	7.4E-01	3.6E-01	1.9E-01	9.1E-01	2.0E-01
Magnesium	3	3	6.4E+00	8.2E+00	7.4E+00	5.3E-01	8.9E+00	7.7E+00
Manganese	3	3	7.5E-02	1.2E-01	9.8E-02	1.2E-02	1.3E-01	1.0E-01
Mercury	3	1	1.9E-06	3.6E-06	3.6E-06	.	.	3.6E-06
Nickel	3	1	1.0E-03	1.5E-03	1.5E-03	.	.	1.5E-03
Potassium	3	3	1.2E+00	1.3E+00	1.3E+00	4.7E-02	1.4E+00	1.2E+00
Sodium	3	3	2.9E+00	3.1E+00	3.0E+00	5.6E-02	3.2E+00	3.1E+00
Zinc	3	3	2.2E-03	8.7E-03	4.8E-03	2.0E-03	1.1E-02	3.4E-03
CRM 6.0/Spring/Dissolved								

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Aluminum	3	2	7.0E-03	1.5E-02	1.2E-02	1.5E-03	1.7E-02	1.1E-02
Antimony	3	3	3.9E-03	9.5E-03	6.1E-03	1.7E-03	1.1E-02	4.9E-03
Arsenic	3	1	1.0E-03	3.0E-03	1.7E-03	.	.	1.7E-03
Barium	3	3	2.2E-02	2.3E-02	2.3E-02	4.5E-04	2.4E-02	2.3E-02
Boron	3	2	1.8E-02	5.0E-02	4.9E-02	5.0E-04	5.0E-02	4.8E-02
Calcium	3	3	2.6E+01	2.8E+01	2.7E+01	7.8E-01	2.9E+01	2.6E+01
Chloride	3	3	2.7E+00	3.2E+00	2.9E+00	1.5E-01	3.4E+00	2.9E+00
Chromium	3	1	1.0E-03	1.1E-03	1.1E-03	.	.	1.1E-03
Copper	3	3	1.2E-03	3.6E-03	2.3E-03	7.1E-04	4.3E-03	2.0E-03
Fluoride	3	1	7.0E-02	1.5E-01	7.0E-02	.	.	7.0E-02
Iron	3	2	1.3E-02	7.1E-02	5.0E-02	1.2E-02	8.5E-02	4.0E-02
Magnesium	3	3	7.7E+00	8.6E+00	8.1E+00	2.6E-01	8.8E+00	8.0E+00
Manganese	3	3	2.2E-03	5.8E-03	3.6E-03	1.1E-03	6.9E-03	2.8E-03
Nickel	3	3	1.7E-03	4.5E-03	3.5E-03	9.2E-04	6.2E-03	4.4E-03
Nitrate/nitrite	3	3	4.2E-01	6.9E-01	5.6E-01	7.8E-02	7.8E-01	5.6E-01
Potassium	3	3	1.3E+00	1.4E+00	1.3E+00	4.2E-02	1.5E+00	1.4E+00
Sodium	3	3	3.3E+00	3.8E+00	3.6E+00	1.5E-01	4.0E+00	3.7E+00
Sulfate	3	3	1.6E+01	1.8E+01	1.7E+01	6.7E-01	1.9E+01	1.8E+01
Zinc	3	3	4.5E-03	6.0E-03	5.1E-03	4.6E-04	6.4E-03	4.8E-03
CRM 6.0/Spring/Total								
Aluminum	3	3	4.9E-02	4.1E-01	2.2E-01	1.0E-01	5.3E-01	2.1E-01
Arsenic	3	1	1.0E-03	3.0E-03	1.3E-03	.	.	1.3E-03
Barium	3	3	2.5E-02	2.8E-02	2.7E-02	9.7E-04	3.0E-02	2.8E-02
Boron	3	3	3.0E-02	4.7E-02	3.9E-02	4.9E-03	5.3E-02	4.1E-02
Calcium	3	3	2.6E+01	2.9E+01	2.7E+01	1.1E+00	3.1E+01	2.7E+01

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Chromium	3	2	1.0E-03	1.9E-03	1.4E-03	3.1E-04	2.3E-03	1.1E-03
Copper	3	3	1.2E-03	5.4E-03	2.8E-03	1.3E-03	6.6E-03	1.7E-03
Iron	3	3	8.2E-02	6.2E-01	3.4E-01	1.6E-01	7.9E-01	3.1E-01
Lead	3	1	1.0E-03	2.8E-03	2.8E-03	.	.	2.8E-03
Magnesium	3	3	7.9E+00	8.6E+00	8.3E+00	2.1E-01	8.9E+00	8.4E+00
Manganese	3	3	2.5E-02	8.0E-02	5.4E-02	1.6E-02	1.0E-01	5.8E-02
Mercury	3	3	2.0E-05	6.6E-05	4.0E-05	1.4E-05	8.0E-05	3.3E-05
Nickel	3	3	1.1E-03	4.0E-03	2.6E-03	8.4E-04	5.0E-03	2.7E-03
Potassium	3	3	1.3E+00	1.5E+00	1.4E+00	4.7E-02	1.6E+00	1.5E+00
Sodium	3	3	3.6E+00	5.4E+00	4.4E+00	5.4E-01	6.0E+00	4.3E+00
Vanadium	3	2	1.0E-03	1.2E-03	1.2E-03	0.0E+00	1.2E-03	1.2E-03
Zinc	3	3	3.3E-03	1.2E-02	6.8E-03	2.7E-03	1.5E-02	4.9E-03
CRM 6.0/Summer/Dissolved								
Aluminum	3	2	6.0E-03	1.7E-02	1.2E-02	3.1E-03	2.1E-02	9.4E-03
Antimony	3	3	4.1E-03	7.5E-03	5.3E-03	1.1E-03	8.5E-03	4.4E-03
Barium	3	3	2.5E-02	2.6E-02	2.6E-02	4.8E-04	2.7E-02	2.6E-02
Boron	3	3	1.6E-02	2.7E-02	2.1E-02	3.3E-03	3.0E-02	1.9E-02
Calcium	3	3	2.6E+01	2.9E+01	2.8E+01	7.3E-01	3.0E+01	2.8E+01
Chloride	3	3	2.8E+00	3.0E+00	2.9E+00	6.7E-02	3.1E+00	2.8E+00
Chromium	3	2	1.0E-03	2.6E-03	1.7E-03	4.9E-04	3.2E-03	1.3E-03
Copper	3	3	1.8E-03	3.6E-03	2.6E-03	5.3E-04	4.1E-03	2.4E-03
Fluoride	3	3	5.9E-02	1.1E-01	7.6E-02	1.7E-02	1.3E-01	6.0E-02
Iron	3	2	1.8E-02	5.3E-01	2.0E-01	1.9E-01	7.6E-01	4.0E-02
Magnesium	3	3	6.3E+00	8.0E+00	7.5E+00	5.7E-01	9.1E+00	8.0E+00
Manganese	3	3	1.6E-03	4.8E-03	3.4E-03	9.4E-04	6.1E-03	3.7E-03

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Nickel	3	1	1.0E-03	2.6E-03	2.6E-03	.	.	2.6E-03
Nitrate/nitrite	3	3	4.0E-01	5.2E-01	4.6E-01	3.5E-02	5.6E-01	4.7E-01
Potassium	3	3	1.3E+00	1.4E+00	1.4E+00	1.5E-02	1.4E+00	1.4E+00
Selenium	3	1	1.0E-03	3.3E-03	3.3E-03	.	.	3.3E-03
Sodium	3	3	3.2E+00	3.4E+00	3.2E+00	6.1E-02	3.4E+00	3.2E+00
Sulfate	3	3	1.6E+01	1.7E+01	1.7E+01	3.3E-01	1.8E+01	1.7E+01
Zinc	3	3	2.9E-03	9.4E-03	5.1E-03	2.1E-03	1.1E-02	3.0E-03
CRM 6.0/Summer/Total								
Aluminum	3	3	4.2E-02	1.4E-01	7.5E-02	3.1E-02	1.7E-01	4.5E-02
Antimony	3	2	1.0E-03	1.7E-03	1.6E-03	3.8E-05	1.7E-03	1.6E-03
Barium	3	3	2.7E-02	3.0E-02	2.8E-02	8.7E-04	3.1E-02	2.8E-02
Boron	3	1	1.1E-02	2.9E-02	2.9E-02	.	.	2.9E-02
Calcium	3	3	2.6E+01	3.0E+01	2.9E+01	1.3E+00	3.2E+01	2.9E+01
Chromium	3	2	1.0E-03	2.1E-03	1.8E-03	1.5E-04	2.3E-03	1.7E-03
Copper	3	3	1.4E-03	2.5E-03	2.0E-03	3.2E-04	2.9E-03	2.1E-03
Iron	3	3	7.1E-02	6.7E-01	2.7E-01	2.0E-01	8.5E-01	7.6E-02
Magnesium	3	3	6.3E+00	8.4E+00	7.7E+00	6.9E-01	9.7E+00	8.3E+00
Manganese	3	3	4.1E-02	6.4E-02	5.4E-02	6.8E-03	7.3E-02	5.6E-02
Mercury	3	1	1.3E-05	2.0E-05	2.0E-05	.	.	2.0E-05
Nickel	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Potassium	3	3	1.4E+00	1.5E+00	1.4E+00	3.3E-02	1.5E+00	1.4E+00
Sodium	3	3	3.2E+00	3.4E+00	3.3E+00	4.0E-02	3.4E+00	3.3E+00
Vanadium	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	3	3	3.6E-03	5.8E-03	4.8E-03	6.4E-04	6.7E-03	5.0E-03

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
MBM 0.2/Spring/Dissolved								
Aluminum	3	3	1.1E-02	1.5E-02	1.3E-02	1.2E-03	1.7E-02	1.3E-02
Ammonium nitrogen	3	2	5.0E-02	1.9E-01	1.2E-01	4.3E-02	2.4E-01	7.8E-02
Antimony	3	2	1.0E-03	1.2E-02	6.5E-03	2.9E-03	1.5E-02	4.0E-03
Arsenic	3	1	1.0E-03	3.0E-03	2.2E-03	.	.	2.2E-03
Barium	3	3	2.2E-02	2.4E-02	2.3E-02	5.6E-04	2.4E-02	2.3E-02
Boron	3	2	1.8E-02	1.1E-01	6.6E-02	2.4E-02	1.4E-01	4.6E-02
Calcium	3	3	2.6E+01	2.9E+01	2.8E+01	7.7E-01	3.0E+01	2.8E+01
Chloride	3	3	2.8E+00	3.0E+00	2.9E+00	5.8E-02	3.1E+00	2.9E+00
Chromium	3	1	1.0E-03	2.2E-03	2.2E-03	.	.	2.2E-03
Copper	3	3	1.5E-03	2.9E-03	2.3E-03	4.3E-04	3.6E-03	2.6E-03
Fluoride	3	1	9.0E-02	1.5E-01	9.0E-02	.	.	9.0E-02
Iron	3	2	1.3E-02	4.9E-02	4.7E-02	1.0E-03	5.0E-02	4.6E-02
Lead	3	1	1.0E-03	1.7E-03	1.7E-03	.	.	1.7E-03
Magnesium	3	3	8.1E+00	9.0E+00	8.5E+00	3.0E-01	9.3E+00	8.3E+00
Manganese	3	2	1.0E-03	7.7E-03	3.6E-03	2.3E-03	1.0E-02	1.6E-03
Nickel	3	3	1.3E-03	1.1E-02	5.2E-03	2.9E-03	1.4E-02	3.5E-03
Nitrate/nitrite	3	3	5.3E-01	7.5E-01	6.2E-01	6.7E-02	8.1E-01	5.8E-01
Potassium	3	3	1.2E+00	1.4E+00	1.3E+00	7.2E-02	1.6E+00	1.4E+00
Sodium	3	3	3.5E+00	3.9E+00	3.7E+00	1.4E-01	4.1E+00	3.6E+00
Sulfate	3	3	1.7E+01	1.8E+01	1.8E+01	3.3E-01	1.9E+01	1.8E+01
Zinc	3	3	4.9E-03	6.5E-03	5.8E-03	4.7E-04	7.2E-03	6.0E-03
MBM 0.2/Spring/Total								
Aluminum	3	3	4.5E-02	2.5E-01	1.6E-01	6.1E-02	3.4E-01	2.0E-01
Arsenic	3	1	1.0E-03	3.0E-03	2.2E-03	.	.	2.2E-03

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Barium	3	3	2.6E-02	2.8E-02	2.7E-02	6.5E-04	2.8E-02	2.6E-02
Boron	3	2	1.8E-02	5.3E-02	4.9E-02	2.2E-03	5.5E-02	4.7E-02
Calcium	3	3	2.9E+01	3.5E+01	3.2E+01	1.8E+00	3.7E+01	3.0E+01
Chromium	3	1	1.0E-03	1.6E-03	1.6E-03	.	.	1.6E-03
Copper	3	3	1.7E-03	5.0E-03	2.9E-03	1.1E-03	6.0E-03	2.0E-03
Iron	3	3	9.7E-02	3.6E-01	2.5E-01	8.1E-02	4.9E-01	3.0E-01
Lead	3	1	1.0E-03	2.2E-03	2.2E-03	.	.	2.2E-03
Magnesium	3	3	8.1E+00	9.1E+00	8.5E+00	3.2E-01	9.4E+00	8.2E+00
Manganese	3	3	4.9E-02	9.0E-02	6.5E-02	1.3E-02	1.0E-01	5.5E-02
Mercury	3	1	2.0E-06	5.8E-06	2.0E-06	.	.	2.0E-06
Nickel	3	3	1.2E-03	3.9E-03	2.5E-03	7.8E-04	4.8E-03	2.5E-03
Potassium	3	3	1.4E+00	1.5E+00	1.4E+00	2.2E-02	1.5E+00	1.4E+00
Sodium	3	3	3.7E+00	5.6E+00	4.4E+00	6.1E-01	6.1E+00	3.8E+00
Vanadium	3	1	1.0E-03	1.1E-03	1.1E-03	.	.	1.1E-03
Zinc	3	3	3.0E-03	1.7E-02	8.6E-03	4.5E-03	2.2E-02	5.4E-03
MBM 0.2/Summer/Dissolved								
Aluminum	3	2	6.0E-03	1.6E-02	1.3E-02	1.2E-03	1.7E-02	1.2E-02
Ammonium nitrogen	3	1	5.0E-02	8.1E-02	8.1E-02	.	.	8.1E-02
Antimony	3	2	1.0E-03	7.0E-03	4.9E-03	1.2E-03	8.3E-03	3.9E-03
Barium	3	2	1.0E-03	2.8E-02	2.6E-02	8.9E-04	2.9E-02	2.5E-02
Boron	3	1	1.1E-02	3.7E-02	3.7E-02	.	.	3.7E-02
Calcium	3	2	2.7E-02	2.8E+01	2.7E+01	5.8E-01	2.9E+01	2.7E+01
Chloride	3	3	2.5E+00	2.9E+00	2.7E+00	1.3E-01	3.0E+00	2.6E+00
Chromium	3	2	1.0E-03	8.1E-03	4.0E-03	2.3E-03	1.1E-02	2.0E-03
Copper	3	2	1.0E-03	6.8E-03	5.9E-03	5.2E-04	7.4E-03	5.4E-03

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Fluoride	3	3	6.7E-02	9.0E-02	7.9E-02	6.7E-03	9.8E-02	8.0E-02
Iron	3	1	1.8E-02	2.7E+00	2.7E+00	.	.	2.7E+00
Magnesium	3	2	9.0E-03	8.0E+00	6.8E+00	6.8E-01	8.8E+00	6.2E+00
Manganese	3	2	1.0E-03	5.7E-02	4.1E-02	9.1E-03	6.7E-02	3.3E-02
Nickel	3	2	1.0E-03	1.3E-02	5.6E-03	4.0E-03	1.7E-02	2.1E-03
Nitrate/nitrite	3	3	4.2E-01	5.7E-01	4.9E-01	4.3E-02	6.2E-01	4.9E-01
Potassium	3	2	1.3E-02	1.3E+00	1.3E+00	2.1E-02	1.3E+00	1.2E+00
Selenium	3	1	1.0E-03	7.5E-03	7.5E-03	.	.	7.5E-03
Sodium	3	3	2.4E-02	3.1E+00	2.1E+00	1.0E+00	5.1E+00	3.1E+00
Sulfate	3	3	1.6E+01	1.7E+01	1.7E+01	3.3E-01	1.8E+01	1.7E+01
Vanadium	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Zinc	3	2	2.0E-03	1.1E-02	6.4E-03	2.6E-03	1.4E-02	4.2E-03
MBM 0.2/Summer/Total								
Aluminum	3	2	6.0E-03	2.2E-01	1.3E-01	4.7E-02	2.7E-01	9.3E-02
Antimony	3	1	1.0E-03	1.2E-03	1.2E-03	.	.	1.2E-03
Barium	3	3	2.4E-02	3.0E-02	2.6E-02	1.7E-03	3.2E-02	2.6E-02
Boron	3	1	1.1E-02	2.9E-02	2.9E-02	.	.	2.9E-02
Calcium	3	3	2.6E+01	2.8E+01	2.7E+01	5.6E-01	2.9E+01	2.8E+01
Chromium	3	2	1.0E-03	2.1E-03	1.7E-03	2.3E-04	2.4E-03	1.5E-03
Copper	3	3	2.2E-03	3.3E-03	2.6E-03	3.5E-04	3.6E-03	2.3E-03
Iron	3	2	1.8E-02	7.6E-01	3.4E-01	2.4E-01	1.0E+00	1.3E-01
Magnesium	3	3	6.4E+00	8.4E+00	7.6E+00	6.2E-01	9.4E+00	8.0E+00
Manganese	3	2	1.0E-03	2.2E-01	1.4E-01	4.2E-02	2.7E-01	1.1E-01
Nickel	3	1	1.0E-03	1.4E-03	1.4E-03	.	.	1.4E-03
Potassium	3	3	1.3E+00	1.5E+00	1.3E+00	5.8E-02	1.5E+00	1.3E+00

Table L11 (continued)

Analyte	Obs.	Detects	Min.	Max.	Mean	Std. Error	95% UCB	Median
Sodium	3	3	3.1E+00	3.3E+00	3.2E+00	4.6E-02	3.3E+00	3.2E+00
Vanadium	3	1	1.0E-03	1.0E-03	1.0E-03	.	.	1.0E-03
Zinc	3	3	2.0E-03	8.7E-03	5.1E-03	1.9E-03	1.1E-02	4.7E-03

Table L12. Differences between seasons for unfiltered and filtered metals (mg/L) for the contaminant remobilization study

Analyte	Filtered or Whole	Season	Number of Obs.	Number of Det.	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Aluminum	FLTR	spring	12	10	0.0070	0.0286	0.0149	0.00	0.0175	0.0150
Aluminum	FLTR	summer	11	7	0.0060	0.0174	0.0111	0.00	0.0130	0.0094
Aluminum	WHOL	spring	12	12	0.0451	0.5760	0.2290	0.05	0.3121	0.2260
Aluminum	WHOL	summer	12	11	0.0060	0.2230	0.1203	0.02	0.1584	0.1137
Antimony	FLTR	spring	12	10	0.0010	0.0115	0.0052	0.00	0.0071	0.0045
Antimony	FLTR	summer	11	10	0.0010	0.0108	0.0058	0.00	0.0071	0.0054
Antimony	WHOL	spring	12	0	0.0010	0.0010	.	.	.	.
Antimony	WHOL	summer	12	3	0.0010	0.0017	0.0013	0.00	0.0014	0.0012
Copper	FLTR	spring	12	12	0.0012	0.0036	0.0023	0.00	0.0027	0.0023
Copper	FLTR	summer	11	10	0.0010	0.0109	0.0043	0.00	0.0057	0.0034
Copper	WHOL	spring	12	12	0.0012	0.0060	0.0031	0.00	0.0041	0.0025
Copper	WHOL	summer	12	12	0.0014	0.0034	0.0024	0.00	0.0028	0.0024
Iron	FLTR	spring	12	9	0.0130	0.0707	0.0437	0.01	0.0542	0.0472
Iron	FLTR	summer	11	5	0.0180	2.6500	0.4128	0.25	0.8651	0.0397
Iron	WHOL	spring	12	12	0.0817	0.7770	0.3436	0.06	0.4557	0.3355
Iron	WHOL	summer	12	11	0.0180	0.7940	0.3375	0.09	0.4967	0.1732
Manganese	FLTR	spring	12	11	0.0010	0.0152	0.0056	0.00	0.0078	0.0043
Manganese	FLTR	summer	11	10	0.0010	0.0566	0.0138	0.01	0.0237	0.0037
Manganese	WHOL	spring	12	12	0.0252	0.0919	0.0642	0.01	0.0746	0.0639
Manganese	WHOL	summer	12	11	0.0010	0.2150	0.0869	0.01	0.1116	0.0794
Mercury	FLTR	spring	24	13	0.0000	0.0013	0.0001	0.00	0.0002	0.0000
Mercury	FLTR	summer	23	7	0.0000	0.0002	0.0000	0.00	0.0000	0.0000
Mercury	WHOL	spring	24	12	0.0000	0.0002	0.0000	0.00	0.0000	0.0000
Mercury	WHOL	summer	24	9	0.0000	0.0002	0.0000	0.00	0.0000	0.0000

Table L12 (continued)

Analyte	Filtered or Whole	Season	Number of Obs.	Number of Det.	Minimum	Maximum	Mean	Standard Error	95% UCB	Median
Methyl Mercury	FLTR	spring	12	12	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
Methyl Mercury	FLTR	summer	12	12	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
Methyl Mercury	WHOL	spring	12	12	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
Methyl Mercury	WHOL	summer	12	12	0.0000	0.0000	0.0000	0.00	0.0000	0.0000
Nickel	FLTR	spring	12	12	0.0013	0.0136	0.0048	0.00	0.0070	0.0032
Nickel	FLTR	summer	11	5	0.0010	0.0125	0.0026	0.00	0.0045	0.0012
Nickel	WHOL	spring	12	12	0.0011	0.0040	0.0025	0.00	0.0030	0.0026
Nickel	WHOL	summer	12	4	0.0010	0.0019	0.0013	0.00	0.0014	0.0012
Zinc	FLTR	spring	12	12	0.0037	0.0072	0.0055	0.00	0.0061	0.0055
Zinc	FLTR	summer	11	10	0.0020	0.0114	0.0057	0.00	0.0076	0.0042
Zinc	WHOL	spring	12	12	0.0030	0.0223	0.0098	0.00	0.0133	0.0080
Zinc	WHOL	summer	12	12	0.0020	0.0087	0.0049	0.00	0.0061	0.0047
Hardness	WHOL	spring	12	12	75.3231	125.9622	102.3497	4.14	109.7788	104.7260
Hardness	WHOL	summer	12	12	90.1133	110.8912	101.2331	2.03	104.8712	104.1510

Table L13. Metals summary statistics (mg/L) by reach for the contaminant remobilization from sediments study

Analyte	Filtered or Whole	Sub reach	No. of Obs.	No. of Det.	Min.	Max.	Mean	S.E.	95% UCB	Median
Aluminum	FLTR	1	5	4	7.00E-03	1.64E-02	1.55E-02	0	1.61E-02	1.54E-02
Aluminum	FLTR	4.02	6	4	6.00E-03	1.74E-02	1.18E-02	0	1.48E-02	1.01E-02
Aluminum	FLTR	4.04	6	4	6.00E-03	2.86E-02	1.35E-02	0	2.05E-02	9.42E-03
Aluminum	FLTR	7.02	6	5	6.00E-03	1.55E-02	1.31E-02	0	1.47E-02	1.28E-02
Aluminum	WHOL	1	6	6	7.06E-02	3.31E-01	1.77E-01	0.04	2.58E-01	1.59E-01
Aluminum	WHOL	4.02	6	6	4.19E-02	4.09E-01	1.48E-01	0.06	2.67E-01	9.29E-02
Aluminum	WHOL	4.04	6	6	3.44E-02	5.76E-01	2.34E-01	0.08	3.92E-01	2.12E-01
Aluminum	WHOL	7.02	6	5	6.00E-03	2.50E-01	1.41E-01	0.04	2.18E-01	1.46E-01
Antimony	FLTR	1	5	4	1.00E-03	1.14E-02	6.93E-03	0	1.10E-02	6.60E-03
Antimony	FLTR	4.02	6	6	3.90E-03	9.50E-03	5.72E-03	0	7.59E-03	4.65E-03
Antimony	FLTR	4.04	6	6	1.10E-03	7.46E-03	4.58E-03	0	6.37E-03	5.15E-03
Antimony	FLTR	7.02	6	4	1.00E-03	1.15E-02	5.69E-03	0	8.37E-03	3.95E-03
Antimony	WHOL	1	6	0	1.00E-03	1.00E-03	.		.	.
Antimony	WHOL	4.02	6	2	1.00E-03	1.70E-03	1.62E-03	0	1.66E-03	1.60E-03
Antimony	WHOL	4.04	6	0	1.00E-03	1.00E-03	.		.	.
Antimony	WHOL	7.02	6	1	1.00E-03	1.20E-03	1.20E-03		.	1.20E-03
Copper	FLTR	1	5	5	1.90E-03	1.09E-02	4.24E-03	0	7.84E-03	3.00E-03
Copper	FLTR	4.02	6	6	1.20E-03	3.60E-03	2.44E-03	0	3.25E-03	2.21E-03
Copper	FLTR	4.04	6	6	1.80E-03	4.52E-03	3.05E-03	0	3.78E-03	3.05E-03
Copper	FLTR	7.02	6	5	1.00E-03	6.75E-03	3.44E-03	0	5.25E-03	2.75E-03
Copper	WHOL	1	6	6	1.50E-03	6.00E-03	2.84E-03	0	4.19E-03	2.55E-03
Copper	WHOL	4.02	6	6	1.20E-03	5.40E-03	2.38E-03	0	3.66E-03	1.90E-03
Copper	WHOL	4.04	6	6	1.40E-03	5.20E-03	3.17E-03	0	4.18E-03	3.15E-03
Copper	WHOL	7.02	6	6	1.70E-03	5.00E-03	2.75E-03	0	3.76E-03	2.25E-03
Iron	FLTR	1	5	4	1.80E-02	5.11E-01	1.31E-01	0.1	3.41E-01	5.05E-02

Table L13 (continued)

Analyte	Filtered or Whole	Sub reach	No. of Obs.	No. of Det.	Min.	Max.	Mean	S.E.	95% UCB	Median
Iron	FLTR	4.02	6	4	1.30E-02	5.34E-01	1.27E-01	0.09	3.00E-01	4.00E-02
Iron	FLTR	4.04	6	3	1.30E-02	5.68E-01	1.51E-01	0.09	3.38E-01	6.69E-02
Iron	FLTR	7.02	6	3	1.30E-02	2.65E+00	4.80E-01	0.49	1.46E+00	4.58E-02
Iron	WHOL	1	6	6	1.28E-01	7.36E-01	3.51E-01	0.1	5.48E-01	2.92E-01
Iron	WHOL	4.02	6	6	7.13E-02	6.66E-01	3.03E-01	0.11	5.31E-01	1.95E-01
Iron	WHOL	4.04	6	6	7.51E-02	7.94E-01	4.20E-01	0.13	6.73E-01	3.65E-01
Iron	WHOL	7.02	6	5	1.80E-02	7.59E-01	2.92E-01	0.11	5.06E-01	2.19E-01
Manganese	FLTR	1	5	5	7.70E-03	2.71E-02	1.37E-02	0	2.14E-02	8.88E-03
Manganese	FLTR	4.02	6	6	1.60E-03	5.80E-03	3.48E-03	0	4.80E-03	3.24E-03
Manganese	FLTR	4.04	6	6	1.80E-03	1.52E-02	4.66E-03	0	8.93E-03	2.50E-03
Manganese	FLTR	7.02	6	4	1.00E-03	5.66E-02	1.70E-02	0.01	3.68E-02	4.65E-03
Manganese	WHOL	1	6	6	6.39E-02	1.18E-01	8.85E-02	0.01	1.04E-01	8.64E-02
Manganese	WHOL	4.02	6	6	2.52E-02	8.00E-02	5.39E-02	0.01	6.95E-02	5.70E-02
Manganese	WHOL	4.04	6	6	4.18E-02	8.63E-02	6.74E-02	0.01	8.12E-02	6.76E-02
Manganese	WHOL	7.02	6	5	1.00E-03	2.15E-01	9.40E-02	0.03	1.47E-01	7.26E-02
Mercury	FLTR	1	6	4	1.44E-06	8.28E-06	2.85E-06	0	5.20E-06	1.56E-06
Mercury	FLTR	4.02	6	4	1.84E-06	4.34E-06	2.66E-06	0	3.75E-06	1.85E-06
Mercury	FLTR	4.04	6	5	1.54E-06	5.16E-06	3.23E-06	0	4.58E-06	3.06E-06
Mercury	FLTR	7.02	6	6	1.35E-06	5.83E-06	2.79E-06	0	4.27E-06	2.14E-06
Mercury	WHOL	1	6	4	1.91E-06	3.60E-06	2.77E-06	0	3.45E-06	2.88E-06
Mercury	WHOL	4.02	6	6	1.31E-05	6.61E-05	2.82E-05	0	4.44E-05	1.97E-05
Mercury	WHOL	4.04	6	6	1.67E-05	3.64E-05	2.75E-05	0	3.49E-05	2.79E-05
Mercury	WHOL	7.02	6	5	2.01E-06	7.09E-06	4.18E-06	0	5.88E-06	4.09E-06
Methyl Mercury	FLTR	1	6	6	1.80E-08	1.03E-07	5.78E-08	0	8.16E-08	5.50E-08
Methyl Mercury	FLTR	4.02	6	6	4.30E-08	9.60E-08	7.00E-08	0	8.82E-08	6.65E-08
Methyl Mercury	FLTR	4.04	6	6	3.20E-08	1.30E-07	6.57E-08	0	9.40E-08	5.65E-08

Table L13 (continued)

Analyte	Filtered or Whole	Sub reach	No. of Obs.	No. of Det.	Min.	Max.	Mean	S.E.	95% UCB	Median
Methyl Mercury	FLTR	7.02	6	6	3.00E-08	7.10E-08	4.95E-08	0	6.26E-08	4.65E-08
Methyl Mercury	WHOL	1	6	6	3.70E-08	1.43E-07	6.97E-08	0	1.01E-07	5.90E-08
Methyl Mercury	WHOL	4.02	6	6	5.60E-08	1.66E-07	1.00E-07	0	1.34E-07	9.40E-08
Methyl Mercury	WHOL	4.04	6	6	6.40E-08	1.40E-07	1.04E-07	0	1.29E-07	1.07E-07
Methyl Mercury	WHOL	7.02	6	6	3.20E-08	9.40E-08	5.66E-08	0	7.67E-08	5.28E-08
Nickel	FLTR	1	5	4	1.00E-03	9.33E-03	3.49E-03	0	6.78E-03	2.70E-03
Nickel	FLTR	4.02	6	4	1.00E-03	4.50E-03	2.77E-03	0	3.94E-03	2.15E-03
Nickel	FLTR	4.04	6	4	1.00E-03	1.36E-02	3.65E-03	0	7.92E-03	1.50E-03
Nickel	FLTR	7.02	6	5	1.00E-03	1.25E-02	5.25E-03	0	9.49E-03	2.80E-03
Nickel	WHOL	1	6	4	1.00E-03	3.20E-03	1.98E-03	0	2.58E-03	1.65E-03
Nickel	WHOL	4.02	6	4	1.00E-03	4.00E-03	1.87E-03	0	2.93E-03	1.15E-03
Nickel	WHOL	4.04	6	4	1.00E-03	3.20E-03	2.06E-03	0	2.70E-03	1.70E-03
Nickel	WHOL	7.02	6	4	1.00E-03	3.90E-03	1.89E-03	0	2.85E-03	1.28E-03
Zinc	FLTR	1	5	5	4.22E-03	7.20E-03	5.98E-03	0	7.30E-03	6.60E-03
Zinc	FLTR	4.02	6	6	2.91E-03	9.40E-03	5.10E-03	0	7.08E-03	4.65E-03
Zinc	FLTR	4.04	6	6	2.70E-03	1.14E-02	5.46E-03	0	8.04E-03	4.30E-03
Zinc	FLTR	7.02	6	5	2.00E-03	1.10E-02	6.12E-03	0	8.28E-03	5.45E-03
Zinc	WHOL	1	6	6	2.17E-03	2.23E-02	8.28E-03	0	1.45E-02	6.05E-03
Zinc	WHOL	4.02	6	6	3.30E-03	1.21E-02	5.78E-03	0	8.44E-03	4.95E-03
Zinc	WHOL	4.04	6	6	2.70E-03	2.02E-02	8.51E-03	0	1.35E-02	7.30E-03
Zinc	WHOL	7.02	6	6	2.00E-03	1.74E-02	6.86E-03	0	1.15E-02	5.03E-03

Table L14. All organic analytes detected (mg/L) for the contaminant remobilization from sediments study

Reach	River Mile		Season	Analyte	Process	Result
1	CRM	41.5	summer	Bis(2-ethylhexyl)phthalate	Filtered	2.70E-02
4.02	CRM	6	spring	Bis(2-ethylhexyl)phthalate	Filtered	1.00E-03
4.04	CRM	1	summer	Bis(2-ethylhexyl)phthalate	Filtered	3.00E-02
7.02	MBM	0.2	summer	Bis(2-ethylhexyl)phthalate	Total	6.00E-03
1	CRM	41.5	spring	Di-n-butylphthalate	Filtered	1.00E-03
4.02	CRM	6	summer	Di-n-butylphthalate	Filtered	1.00E-03
7.02	MBM	0.2	spring	Di-n-butylphthalate	Filtered	1.00E-03
1	CRM	41.5	spring	Di-n-butylphthalate	Total	1.00E-03
7.02	MBM	0.2	summer	Di-n-butylphthalate	Total	4.00E-03
7.02	MBM	0.2	spring	alpha-BHC	Filtered	1.80E-05
7.02	MBM	0.2	spring	alpha-BHC	Total	1.30E-05

Table L15. Radionuclide water data for the contaminant remobilization study by reach, site, and season

Reach	Site	Season	Analyte	Process	Obs.	Detects	Max.	Min.	Mean	Median	Std. Error	Units
1	CRM 41.5	spring	Cesium-137	Cart. Filter	3	1	4.26E+00	-1.44E+00	0.00E+00	0.00E+00	.	PCI/L
1	CRM 41.5	summer	Cesium-137	Cart. Filter	3	2	-6.00E-01	-2.71E+00	0.00E+00	0.00E+00	0.00E+00	pCi/L
4.02	CRM 6.0	spring	Cesium-137	Cart. Filter	3	2	6.13E+00	-1.22E+00	1.00E-02	8.00E-03	1.00E-02	pCi/L
4.02	CRM 6.0	summer	Cesium-137	Cart. Filter	3	2	-1.53E+00	-3.12E+00	0.00E+00	0.00E+00	0.00E+00	pCi/L
4.04	CRM 1.0	spring	Cesium-137	Cart. Filter	4	2	1.12E+01	-1.12E+00	3.80E-01	3.78E-01	3.80E-01	pCi/L
4.04	CRM 1.0	summer	Cesium-137	Cart. Filter	4	0	9.14E+00	0.00E+00	.	.	.	pCi/L
7.02	MBM 0.2	spring	Cesium-137	Cart. Filter	3	1	1.29E+01	-2.94E+00	0.00E+00	0.00E+00	.	pCi/L
7.02	MBM 0.2	summer	Cesium-137	Cart. Filter	4	1	7.56E+00	-2.00E+00	0.00E+00	0.00E+00	.	pCi/L
1	CRM 41.5	spring	Cesium-137	Cart. Filter	3	0	2.40E-01	5.00E-02	.	.	.	pCi/L
1	CRM 41.5	summer	Cesium-137	Cart. Filter	3	0	1.30E-01	-4.00E-02	.	.	.	pCi/L
4.02	CRM 6.0	spring	Cesium-137	Cart. Filter	3	0	2.10E-01	-6.00E-02	.	.	.	pCi/L
4.02	CRM 6.0	summer	Cesium-137	Cart. Filter	3	0	2.00E-01	3.00E-02	.	.	.	pCi/L
4.04	CRM 1.0	spring	Cesium-137	Cart. Filter	5	0	2.70E-01	-1.30E-01	.	.	.	pCi/L
4.04	CRM 1.0	summer	Cesium-137	Cart. Filter	4	1	2.10E-01	-9.00E-02	2.10E-01	2.12E-01	.	pCi/L
7.02	MBM 0.2	spring	Cesium-137	Cart. Filter	3	0	1.00E-01	-4.80E-01	.	.	.	pCi/L
7.02	MBM 0.2	summer	Cesium-137	Cart. Filter	4	0	-2.00E-02	-2.90E-01	.	.	.	pCi/L
1	CRM 41.5	spring	Cobalt-60	Cart. Filter	3	0	4.94E+00	7.30E-01	.	.	.	pCi/L
1	CRM 41.5	summer	Cobalt-60	Cart. Filter	3	0	7.60E-01	-6.81E+00	.	.	.	pCi/L
4.02	CRM 6.0	spring	Cobalt-60	Cart. Filter	3	0	1.12E+00	1.60E-01	.	.	.	pCi/L
4.02	CRM 6.0	summer	Cobalt-60	Cart. Filter	3	0	5.15E+00	2.00E-01	.	.	.	pCi/L
4.04	CRM 1.0	spring	Cobalt-60	Cart. Filter	4	0	1.11E+00	-3.60E+00	.	.	.	pCi/L
4.04	CRM 1.0	summer	Cobalt-60	Cart. Filter	4	0	4.80E+00	-1.08E+00	.	.	.	pCi/L
7.02	MBM 0.2	spring	Cobalt-60	Cart. Filter	3	0	5.99E+00	-4.24E+00	.	.	.	pCi/L
7.02	MBM 0.2	summer	Cobalt-60	Cart. Filter	4	0	5.44E+00	-2.05E+00	.	.	.	pCi/L
1	CRM 41.5	spring	Cobalt-60	Cart. Filter	3	0	1.50E-01	-3.30E-01	.	.	.	pCi/L
1	CRM 41.5	summer	Cobalt-60	Cart. Filter	3	0	-4.00E-02	-1.10E-01	.	.	.	pCi/L
4.02	CRM 6.0	spring	Cobalt-60	Cart. Filter	3	0	1.20E-01	-7.00E-02	.	.	.	pCi/L

Table L15 (continued)

Reach	Site	Season	Analyte	Process	Obs.	Detects	Max.	Min.	Mean	Median	Std. Error	Units
4.02	CRM 6.0	summer	Cobalt-60	Cart. Filter	3	0	-1.30E-01	-3.90E-01	.	.	.	pCi/L
4.04	CRM 1.0	spring	Cobalt-60	Cart. Filter	5	0	4.60E-01	-3.20E-01	.	.	.	pCi/L
4.04	CRM 1.0	summer	Cobalt-60	Cart. Filter	4	0	2.40E-01	-2.10E-01	.	.	.	pCi/L
7.02	MBM 0.2	spring	Cobalt-60	Cart. Filter	3	0	2.00E-02	-2.20E-01	.	.	.	pCi/L
7.02	MBM 0.2	summer	Cobalt-60	Cart. Filter	4	0	1.10E-01	-5.70E-01	.	.	.	pCi/L
1	CRM 41.5	spring	Gross alpha activity		3	1	1.97E+00	4.20E-01	1.97E+00	1.97E+00	.	pCi/L
1	CRM 41.5	summer	Gross alpha activity		3	0	6.60E-01	-8.43E+00	.	.	.	pCi/L
4.02	CRM 6.0	spring	Gross alpha activity		3	2	1.21E+00	6.80E-01	9.70E-01	8.50E-01	1.40E-01	pCi/L
4.02	CRM 6.0	summer	Gross alpha activity		3	1	1.76E+00	-1.08E+01	0.00E+00	0.00E+00	.	pCi/L
4.04	CRM 1.0	spring	Gross alpha activity		4	0	8.60E-01	1.70E-01	.	.	.	pCi/L
4.04	CRM 1.0	summer	Gross alpha activity		3	0	2.75E+00	-1.29E+01	.	.	.	pCi/L
7.02	MBM 0.2	spring	Gross alpha activity		3	1	1.08E+00	2.90E-01	1.08E+00	1.08E+00	.	pCi/L
7.02	MBM 0.2	summer	Gross alpha activity		4	0	4.20E-01	-8.22E+00	.	.	.	pCi/L
1	CRM 41.5	spring	Gross alpha activity		3	2	5.79E+00	2.08E+00	4.74E+00	4.22E+00	6.00E-01	pCi/L
1	CRM 41.5	summer	Gross alpha activity		3	3	1.34E+01	4.82E+00	8.91E+00	8.51E+00	2.48E+00	pCi/L
4.02	CRM 6.0	spring	Gross alpha activity		3	2	5.53E+00	1.84E+00	4.86E+00	4.53E+00	3.80E-01	pCi/L
4.02	CRM 6.0	summer	Gross alpha activity		3	2	7.74E+00	3.80E-01	6.91E+00	6.49E+00	4.80E-01	pCi/L
4.04	CRM 1.0	spring	Gross alpha activity		4	2	2.88E+00	1.61E+00	2.46E+00	2.32E+00	1.70E-01	pCi/L
4.04	CRM 1.0	summer	Gross alpha activity		3	2	8.95E+00	9.90E-01	6.35E+00	5.05E+00	1.50E+00	pCi/L
7.02	MBM 0.2	spring	Gross alpha activity		3	2	6.26E+00	-2.80E-01	3.57E+00	2.22E+00	1.55E+00	pCi/L
7.02	MBM 0.2	summer	Gross alpha activity		4	4	8.14E+00	3.15E+00	6.07E+00	6.50E+00	1.09E+00	pCi/L
1	CRM 41.5	spring	Particle associated Co-60	Cart. Filter	3	0	8.81E+00	-3.98E+01	.	.	.	pCi/g
1	CRM 41.5	summer	Particle associated Co-60	Cart. Filter	3	0	-3.75E+00	-2.98E+01	.	.	.	pCi/g
4.02	CRM 6.0	spring	Particle associated Co-60	Cart. Filter	3	0	1.27E+01	-1.92E+01	.	.	.	pCi/g
4.02	CRM 6.0	summer	Particle associated Co-60	Cart. Filter	3	0	-1.80E+01	-6.55E+01	.	.	.	pCi/g
4.04	CRM 1.0	spring	Particle associated Co-60	Cart. Filter	3	0	5.30E+01	9.42E+00	.	.	.	pCi/g
4.04	CRM 1.0	summer	Particle associated Co-60	Cart. Filter	3	0	3.29E+01	0.00E+00	.	.	.	pCi/g

Table L15 (continued)

Reach	Site	Season	Analyte	Process	Obs.	Detects	Max.	Min.	Mean	Median	Std. Error	Units
7.02	MBM 0.2	spring	Particle associated Co-60	Cart. Filter	3	0	4.03E+00	-2.52E+01	.	.	.	pCi/g
7.02	MBM 0.2	summer	Particle associated Co-60	Cart. Filter	3	0	3.24E+01	-2.61E+00	.	.	.	pCi/g
1	CRM 41.5	spring	Particle associated Cs-137	Cart. Filter	3	0	2.86E+01	3.06E+00	.	.	.	pCi/g
1	CRM 41.5	summer	Particle associated Cs-137	Cart. Filter	3	0	3.55E+01	-6.18E+00	.	.	.	pCi/g
4.02	CRM 6.0	spring	Particle associated Cs-137	Cart. Filter	3	0	5.59E+01	-6.27E+00	.	.	.	pCi/g
4.02	CRM 6.0	summer	Particle associated Cs-137	Cart. Filter	3	0	1.44E+01	4.78E+00	.	.	.	pCi/g
4.04	CRM 1.0	spring	Particle associated Cs-137	Cart. Filter	3	0	2.54E+01	4.43E+00	.	.	.	pCi/g
4.04	CRM 1.0	summer	Particle associated Cs-137	Cart. Filter	3	0	1.16E+01	-6.12E+00	.	.	.	pCi/g
7.02	MBM 0.2	spring	Particle associated Cs-137	Cart. Filter	3	0	1.70E+01	-5.76E+01	.	.	.	pCi/g
7.02	MBM 0.2	summer	Particle associated Cs-137	Cart. Filter	3	0	-6.59E+00	-3.98E+01	.	.	.	pCi/g
1	CRM 41.5	spring	Strontium-90		3	0	2.47E+00	4.90E-01	.	.	.	pCi/L
1	CRM 41.5	summer	Strontium-90		3	0	7.90E-01	0.00E+00	.	.	.	pCi/L
4.02	CRM 6.0	spring	Strontium-90		3	0	1.99E+00	0.00E+00	.	.	.	pCi/L
4.02	CRM 6.0	summer	Strontium-90		3	1	8.16E+00	-1.40E-01	8.16E+00	8.16E+00	.	pCi/L
4.04	CRM 1.0	spring	Strontium-90		4	1	1.22E+01	0.00E+00	1.22E+01	1.22E+01	.	pCi/L
4.04	CRM 1.0	summer	Strontium-90		3	0	1.30E-01	0.00E+00	.	.	.	pCi/L
7.02	MBM 0.2	spring	Strontium-90		3	0	1.80E+00	0.00E+00	.	.	.	pCi/L
7.02	MBM 0.2	summer	Strontium-90		3	1	1.07E+00	4.70E-01	1.07E+00	1.07E+00	.	pCi/L
1	CRM 41.5	spring	Tritium		3	0	4.87E+01	0.00E+00	.	.	.	pCi/L
1	CRM 41.5	summer	Tritium		3	0	7.24E+01	-1.48E+02	.	.	.	pCi/L
4.02	CRM 6.0	spring	Tritium		3	3	9.52E+02	2.93E+02	7.17E+02	9.06E+02	2.12E+02	pCi/L
4.02	CRM 6.0	summer	Tritium		3	1	3.44E+02	-1.03E+02	3.44E+02	3.44E+02	.	pCi/L
4.04	CRM 1.0	spring	Tritium		4	3	3.46E+02	1.57E+02	2.53E+02	2.28E+02	3.45E+01	pCi/L
4.04	CRM 1.0	summer	Tritium		3	3	2.43E+02	-1.53E+02	8.11E+01	0.00E+00	8.11E+01	pCi/L
7.02	MBM 0.2	spring	Tritium		3	0	3.52E+01	0.00E+00	.	.	.	pCi/L
7.02	MBM 0.2	summer	Tritium		4	0	2.88E+01	-1.91E+02	.	.	.	pCi/L

Table L16. Fathead minnow survival in the Clinch River and Poplar Creek

Test Date	Site ID[a]	Survival				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
4/22-29/93	Control	100.0	0.0	100	100	NA	NA	17.6	NA
	PCM 1.0	100.0	0.0	100	100	0.0	NA	17.6	NA
	PCM 2.9	97.5	5.0	90	100	-2.5	NA	14.7	NA
	PCM 4.3	90.0	0.0	90	90	-10.0	NA	5.9	NA
	PCM 5.1	80.0	18.3	60	100	-20.0	NA	-5.9	NA
	PCM 11.3	85.0	12.9	70	100	-15.0	NA	NA	NA
	CRM 9.0	100.0	0.0	100	100	0.0	NA	NA	NA
7/22-29/93	Control	90.0	14.1	70	100	NA	9.1	12.5	-10.0
	PCM 1.0	67.5	17.1	50	90	-25.0	-18.2	-15.6	NA
	PCM 2.9	72.5	15.0	60	90	-19.4	-12.1	-9.4	NA
	PCM 4.3	65.0	10.0	60	80	-27.8	-21.2	-18.8	NA
	PCM 5.1	80.0	0.0	80	80	-11.1	-3.0	0.0	NA
	PCM 6.0	82.5	9.6	70	90	-8.33	NA	3.1	NA
	PCM 11.3	80.0	21.6	50	100	-11.1	-3.0	NA	NA
	CRM 9.0	90.0	8.2	80	100	0.0	NA	NA	-10.0
	CRM 19.0	95.0	5.8	90	100	5.6	NA	NA	-5.0
	CRM 22.0	100.0	0.0	100	100	11.1	NA	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]Reference site
NA = Not Applicable

Table L16 (continued)

Test Date	Site ID[a]	Survival				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
10/21-28/93	Control	87.5	12.6	70	100	NA	34.6	25.0	0.0
	PCM 1.0	60.0	14.1	50	80	-31.4	-7.7	-14.3	NA
	PCM 2.9	62.5	9.6	50	70	-28.6	-3.8	-10.7	NA
	PCM 4.3	87.5	9.6	80	100	0.0	34.6	25.0	NA
	PCM 5.1	65.0	12.9	50	80	-25.7	0.0	-7.1	NA
	PCM 6.0	65.0	17.3	40	80	-25.7	NA	-7.1	NA
	PCM 11.3	70.0	24.5	50	100	-20.0	7.7	NA	NA
	CRM 9.0	82.5	5.0	80	90	-5.7	NA	NA	-5.7
	CRM 19.0	77.5	26.3	40	100	-11.4	NA	NA	-11.4
	CRM 22.0	87.5	5.0	80	90	0.0	NA	NA	NA
1/25-2/1/94	Control	100.0	0.0	100	100	NA	60.0	21.2	2.6
	PCM 1.0	75.0	28.9	50	100	-25.0	20.0	-9.1	NA
	PCM 2.9	82.5	17.1	60	100	-17.5	32.0	0.0	NA
	PCM 4.3	75.0	31.1	30	100	-25.0	20.0	-9.1	NA
	PCM 5.1	77.5	26.3	40	100	-22.5	24.0	-6.1	NA
	PCM 6.0	62.5	27.5	30	90	-37.5	NA	-24.2	NA
	PCM 11.3	82.5	28.7	40	100	-17.5	32.0	NA	NA
	CRM 9.0	95.0	5.8	90	100	-5.0	NA	NA	-2.6

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]Reference site
NA = Not Applicable

Table L16 (continued)

Test Date	Site ID[a]	Survival				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	CRM 19.0	95.0	5.8	90	100	-5.0	NA	NA	-2.6
	CRM 22.0	97.5	5.0	90	100	-2.5	NA	NA	NA
4/14-21/94	Control	97.5	5.0	90	100	NA	69.6	25.8	18.2
	PCM 1.0	45.0	17.3	20	60	-53.8	-21.7	-41.9	NA
	PCM 2.9	52.5	17.1	30	70	-46.2	-8.7	-32.3	NA
	PCM 4.3	42.5	9.6	30	50	-56.4	-26.1	-45.2	NA
	PCM 5.1	52.5	33.0	20	90	-46.2	-8.7	-32.3	NA
	PCM 6.0	57.5	15.0	40	70	-41.0	NA	-25.8	NA
	PCM 11.3	77.5	26.3	40	100	-20.5	34.8	NA	NA
	CRM 9.0	45.0	30.0	30	90	-53.8	NA	NA	-45.5
	CRM 19.0	75.0	5.8	70	80	-23.1	NA	NA	-9.1
	CRM 22.0	82.5	12.6	70	100	-15.4	NA	NA	NA
7/21-28/94	Control	80.0	14.1	60	90	NA	-17.9	-8.6	14.3
	PCM 1.0	90.0	11.5	80	100	12.5	-7.7	2.9	NA
	PCM 2.9	92.5	5.0	90	100	15.6	-5.1	5.7	NA
	PCM 4.3	90.0	8.2	80	100	12.5	-7.7	2.9	NA
	PCM 5.1	82.5	15.0	60	90	3.1	-15.4	-5.7	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]Reference site
NA = Not Applicable

Table L16 (continued)

Test Date	Site ID[a]	Survival				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	PCM 6.0	97.5	5.0	90	100	21.9	NA	11.4	NA
	PCM 11.3	87.5	5.0	80	90	9.4	-10.3	NA	NA
	CRM 9.0	72.5	23.6	40	90	-9.4	NA	NA	3.6
	CRM 19.0	95.0	5.8	90	100	18.8	NA	NA	35.7
	CRM 22.0	70.0	24.5	50	100	-12.5	NA	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]Reference site
NA = Not Applicable

Table L17. Fathead minnow survival in McCoy Branch and Walker Branch

Test Date	Site ID[a]	Survival				Percent Difference	
		Mean	SD	Min.	Max.	Control	WBM 0.4[b]
6/2–9/94	Control	92.5	5.0	90	100	NA	-2.6
	MBM 0.2	92.5	5.0	90	100	0.0	-2.6
	MBM 0.4	92.5	5.0	90	100	0.0	-2.6
	WBM 0.4	95.0	10.0	80	100	2.7	NA
8/11–18/94	Control	95.0	5.8	90	100	NA	8.6
	MBM 0.2	75.0	23.8	40	90	-21.1	-14.3
	MBM 0.4	97.5	5.0	90	100	2.6	11.4
	WBM 0.4	87.5	9.6	80	100	-7.9	NA

[a]MBM = McCoy Branch Mile; WBM = Walker Branch mile
[b]Reference site
NA = Not Applicable

Table L18. Fathead minnow growth (per surviving larvae) in the Clinch River and Poplar Creek

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
4/22-29/93	Control	0.42	0.06	0.35	0.47	NA	NA	10.53	NA
	PCM 1.0	0.40	0.02	0.37	0.43	-4.76	NA	5.26	NA
	PCM 2.9	0.41	0.04	0.36	0.45	-2.38	NA	7.89	NA
	PCM 4.3	0.39	0.02	0.36	0.41	-7.14	NA	2.63	NA
	PCM 5.1	0.43	0.04	0.38	0.48	2.38	NA	13.16	NA
	PCM 11.3	0.38	0.04	0.34	0.42	-9.52	NA	NA	NA
	CRM 9.0	0.38	0.03	0.34	0.41	-9.52	NA	NA	NA
7/22-29/93	Control	0.33	0.07	0.28	0.43	NA	6.45	3.13	-8.33
	PCM 1.0	0.42	0.10	0.31	0.55	27.27	35.48	31.25	NA
	PCM 2.9	0.37	0.06	0.33	0.45	12.12	19.35	15.63	NA
	PCM 4.3	0.36	0.08	0.25	0.43	9.09	16.13	12.50	NA
	PCM 5.1	0.38	0.04	0.32	0.41	15.15	22.58	18.75	NA
	PCM 6.0	0.31	0.05	0.25	0.37	-6.06	NA	-3.12	NA
	PCM 11.3	0.32	0.09	0.19	0.41	-3.03	3.23	NA	NA
	CRM 9.0	0.30	0.06	0.21	0.36	-9.09	NA	NA	-16.67
	CRM 19.0	0.34	0.02	0.31	0.35	3.03	NA	NA	-5.56
	CRM 22.0	0.36	0.05	0.31	0.41	9.09	NA	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile.
[b] Reference site
NA = Not Applicable

Table L18 (continued)

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
10/21-28/93	Control	0.39	0.06	0.33	0.47	NA	-30.36	-27.78	-25.00
	PCM 1.0	0.39	0.08	0.33	0.51	0.00	-30.36	-27.78	NA
	PCM 2.9	0.51	0.10	0.39	0.63	30.77	-8.93	-5.56	NA
	PCM 4.3	0.46	0.05	0.39	0.51	17.95	-17.86	-14.81	NA
	PCM 5.1	0.42	0.09	0.29	0.49	7.69	-25.00	-22.22	NA
	PCM 6.0	0.56	0.12	0.41	0.66	43.59	NA	3.70	NA
	PCM 11.3	0.54	0.11	0.38	0.64	38.46	-3.57	NA	NA
	CRM 9.0	0.51	0.09	0.43	0.64	30.77	NA	NA	-1.92
	CRM 19.0	0.54	0.03	0.51	0.58	38.46	NA	NA	3.85
	CRM 22.0	0.52	0.02	0.48	0.53	33.33	NA	NA	NA
1/25-2/1/94	Control	0.41	0.05	0.35	0.46	NA	-25.45	-8.89	-10.87
	PCM 1.0	0.56	0.07	0.48	0.64	36.59	1.82	24.44	NA
	PCM 2.9	0.54	0.06	0.49	0.62	31.71	-1.82	20.00	NA
	PCM 4.3	0.56	0.09	0.46	0.67	36.59	1.82	24.44	NA
	PCM 5.1	0.48	0.12	0.38	0.65	17.07	-12.73	6.67	NA
	PCM 6.0	0.55	0.12	0.46	0.72	34.15	NA	22.22	NA
	PCM 11.3	0.45	0.04	0.40	0.50	9.76	-18.18	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile.
[b] Reference site
NA = Not Applicable

Table L18 (continued)

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	CRM 9.0	0.49	0.02	0.46	0.51	19.51	NA	NA	6.52
	CRM 19.0	0.49	0.10	0.42	0.64	19.51	NA	NA	6.52
	CRM 22.0	0.46	0.06	0.38	0.53	12.20	NA	NA	NA
4/14-21/94	Control	0.23	0.04	0.17	0.26	NA	-20.69	-14.81	-28.13
	PCM 1.0	0.28	0.05	0.20	0.32	21.74	-3.45	3.70	NA
	PCM 2.9	0.33	0.09	0.24	0.42	43.48	13.79	22.22	NA
	PCM 4.3	0.31	0.05	0.27	0.37	34.78	6.90	14.81	NA
	PCM 5.1	0.31	0.04	0.26	0.34	34.78	6.90	14.81	NA
	PCM 6.0	0.29	0.05	0.22	0.33	26.09	NA	7.41	NA
	PCM 11.3	0.27	0.09	0.19	0.39	17.39	-6.90	NA	NA
	CRM 9.0	0.39	0.04	0.34	0.44	69.57	NA	NA	21.88
	CRM 19.0	0.30	0.03	0.26	0.34	30.43	NA	NA	-6.25
	CRM 22.0	0.32	0.07	0.27	0.42	39.13	NA	NA	NA
7/21-28/94	Control	0.55	0.08	0.44	0.63	NA	-14.06	-12.70	1.85
	PCM 1.0	0.60	0.04	0.57	0.66	9.09	-6.25	-4.76	NA
	PCM 2.9	0.64	0.10	0.56	0.78	16.36	0.00	1.59	NA
	PCM 4.3	0.52	0.12	0.38	0.65	-5.45	-18.75	-17.46	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile.
[b] Reference site
NA = Not Applicable

Table L18 (continued)

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference			
		Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	PCM 5.1	0.60	0.06	0.53	0.66	9.09	-6.25	-4.76	NA
	PCM 6.0	0.64	0.08	0.53	0.70	16.36	NA	1.59	NA
	PCM 11.3	0.63	0.17	0.49	0.83	14.55	-1.56	NA	NA
	CRM 9.0	0.64	0.06	0.59	0.73	16.36	NA	NA	18.52
	CRM 19.0	0.57	0.05	0.52	0.62	3.64	NA	NA	5.56
	CRM 22.0	0.54	0.16	0.31	0.69	-1.82	NA	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile.
[b] Reference site
NA = Not Applicable

Table L19. Fathead minnow growth (per surviving larvae) in McCoy Branch and Walker Branch

Test Date	Site ID[a]	Growth (weight in mg)				Percent Difference	
		Mean	SD	Min.	Max.	Control	WBM 0.4[b]
6/2–9/94	Control	0.43	0.06	0.36	0.48	NA	-18.87
	MBM 0.2	0.55	0.10	0.45	0.69	27.91	3.77
	MBM 0.4	0.57	0.05	0.51	0.64	32.56	7.55
	WBM 0.4	0.53	0.05	0.47	0.59	23.26	NA
8/11–18/94	Control	0.48	0.10	0.39	0.57	NA	-15.79
	MBM 0.2	0.46	0.18	0.19	0.57	-4.17	-19.30
	MBM 0.4	0.52	0.05	0.46	0.58	8.33	-8.77
	WBM 0.4	0.57	0.04	0.52	0.61	18.75	NA

[a]MBM = McCoy Branch Mile; WBM = Walker Branch Mile.
[b]Reference site
NA = Not Applicable

Table L20. *Ceriodaphnia dubia* reproduction per surviving female in the Clinch River and Poplar Creek

Test date	Site ID[a]	Percent survival	Reproduction				Percent difference			
			Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
4/22-29/93	Control	90	27.1	6.8	14	37	NA	NA	3.0	NA
	PCM 1.0	100	26.8	4.7	21	38	-1.1	NA	1.9	NA
	PCM 2.9	80	26.5	9.5	7	37	-2.2	NA	0.8	NA
	PCM 4.3	90	30.6	7.0	20	42	12.9	NA	16.4	NA
	PCM 5.1	100	27.7	6.7	13	38	2.2	NA	5.3	NA
	PCM 11.3	100	26.3	7.5	17	40	-3.0	NA	NA	NA
	CRM 9.0	100	30.1	3.3	27	36	11.1	NA	NA	NA
7/22-29/93	Control	80	28.4	4.9	21	34	NA	-18.9	-7.8	-12.1
	PCM 1.0	100	31.7	6.1	21	43	11.6	-9.4	2.9	NA
	PCM 2.9	90	33.8	3.9	28	40	19.0	-3.4	9.7	NA
	PCM 4.3	80	33.3	5.3	27	44	17.3	-4.9	8.1	NA
	PCM 5.1	100	31.0	11.8	0	41	9.2	-11.4	0.7	NA
	PCM 6.0	100	35.0	4.3	27	42	23.2	NA	13.6	NA
	PCM 11.3	100	30.8	6.4	14	38	8.5	-12.0	NA	NA
	CRM 9.0	100	35.3	6.7	20	44	24.3	NA	NA	9.3

[a]PCM = Poplar Creek mile; CRM = Clinch River mile.
[b]Reference site
NA = Not Applicable

Table L20. (continued)

Test date	Site ID[a]	Percent survival	Reproduction				Percent difference			
			Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	CRM 19.0	100	28.4	9.8	10	38	0.0	NA	NA	-12.7
	CRM 22.0	100	32.3	6.5	19	42	13.7	NA	NA	NA
10/21-28/93	Control	100	29.4	1.6	27	32	NA	-10.1	-10.4	-8.1
	PCM 1.0	100	39.0	5.9	32	52	32.7	19.3	18.9	NA
	PCM 2.9	100	35.3	6.1	30	51	20.1	8.0	7.6	NA
	PCM 4.3	100	31.6	4.8	25	42	7.5	-3.4	-3.7	NA
	PCM 5.1	100	33.0	3.3	28	38	12.2	0.9	0.6	NA
	PCM 6.0	100	32.7	2.9	29	39	11.2	NA	-0.3	NA
	PCM 11.3	100	32.8	4.8	27	41	11.6	0.3	NA	NA
	CRM 9.0	100	31.2	4.2	22	36	6.1	NA	NA	-2.5
	CRM 19.0	100	31.2	3.2	25	35	6.1	NA	NA	-2.5
	CRM 22.0	90	32.0	4.8	27	40	8.8	NA	NA	NA
1/25-2/1/94	Control	100	18.4	3.4	13	25	NA	15.0	53.3	21.1
	PCM 1.0	100	18.6	3.6	12	25	1.1	16.3	55.0	NA
	PCM 2.9	90	17.3	4.0	9	21	-6.0	8.1	44.2	NA
	PCM 4.3	90	13.3	3.8	6	18	-27.7	-16.9	10.8	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile.
[b]Reference site
NA = Not Applicable

Table L20. (continued)

Test date	Site ID[a]	Percent survival	Reproduction				Percent difference			
			Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
	PCM 5.1	100	15.4	2.1	13	19	-16.3	-3.8	28.3	NA
	PCM 6.0	100	16.0	2.7	10	19	-13.0	NA	33.3	NA
	PCM 11.3	90	12.0	4.7	4	18	-34.8	-25.0	NA	NA
	CRM 9.0	100	18.2	1.8	16	21	-1.1	NA	NA	19.7
	CRM 19.0	100	17.3	1.4	15	20	-6.0	NA	NA	13.8
	CRM 22.0	100	15.2	4.2	5	19	-17.4	NA	NA	NA
4/14-21/94	Control	100	18.7	3.2	16	26	NA	-15.4	11.3	3.9
	PCM 1.0	100	20.8	4.8	10	26	11.2	-5.9	23.8	NA
	PCM 2.9	100	20.7	2.6	18	27	10.7	-6.3	23.2	NA
	PCM 4.3	100	20.8	4.6	11	27	11.2	-5.9	23.8	NA
	PCM 5.1	100	22.6	3.4	18	31	20.9	2.3	34.5	NA
	PCM 6.0	100	22.1	3.0	17	26	18.2	NA	31.6	NA
	PCM 11.3	100	16.8	7.5	1	25	-10.2	-24.0	NA	NA
	CRM 9.0	90	16.6	4.7	9	23	-11.2	NA	NA	-7.8
	CRM 19.0	100	18.4	5.6	9	26	-1.6	NA	NA	2.2
	CRM 22.0	100	18.0	4.9	8	23	-3.7	NA	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile.
[b]Reference site
NA = Not Applicable

Table L20. (continued)

Test date	Site ID[a]	Percent survival	Reproduction				Percent difference			
			Mean	SD	Min.	Max.	Control	PCM 6.0[b]	PCM 11.3[b]	CRM 22.0[b]
7/21-28/94	Control	90	24.4	5.8	14	36	NA	-12.9	-15.9	7.0
	PCM 1.0	100	28.1	3.4	23	33	15.2	0.4	-3.1	NA
	PCM 2.9	90	25.3	2.1	23	29	3.7	-9.6	-12.8	NA
	PCM 4.3	100	28.9	2.6	25	34	18.4	3.2	-0.3	NA
	PCM 5.1	100	28.0	6.8	13	36	14.8	0.0	-3.5	NA
	PCM 6.0	100	28.0	3.9	22	35	14.8	NA	-3.5	NA
	PCM 11.3	90	29.0	5.5	20	37	18.9	3.6	NA	NA
	CRM 9.0	100	24.2	8.4	9	39	-0.8	NA	NA	6.1
	CRM 19.0	100	21.8	6.7	4	28	-10.7	NA	NA	-4.4
	CRM 22.0	80	22.8	6.2	11	31	-6.6	NA	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile.
[b]Reference site
NA = Not Applicable

Table L21. *Ceriodaphnia dubia* reproduction per surviving female in McCoy Branch and Walker Branch

Test date	Site ID[a]	Percent survival	Reproduction				Percent difference	
			Mean	SD	Min.	Max.	Control	WBM 0.4[b]
6/2-8/94	Control	100	20.5	2.4	16	23	NA	-30.5
	MBM 0.2	90	26.4	5.0	19	34	28.8	-10.5
	MBM 0.4	100	24.9	2.8	20	30	21.5	-15.6
	WMB 0.4	100	29.5	3.3	26	35	43.9	NA
8/11-17/94	Control	100	20.3	4.6	13	28	NA	-13.3
	MBM 0.2	100	24.6	4.8	17	31	21.2	5.1
	MBM 0.4	100	9.7	4.0	3	16	-52.2	-58.6
	WBM 0.4	100	23.4	4.4	15	30	15.3	NA

[a]MBM = McCoy Branch Mile; WBM = Walker Branch Mile.
[b]Reference site.
NA = Not Applicable

Table L22. Results of quarterly medaka embryo-larval tests of surface water from the Clinch River and Poplar Creek conducted for the CR-ERP between July 1993 and July 1994[a, b]

Date	Site[c]	Survival			Hatch			Developmental abnormalities		
		Percent survival	Decrease from control (%)	Decrease from reference (%)	Percent hatch	Decrease from control (%)	Decrease from reference (%)	Percent normal[d]	Decrease from control (%)	Decrease from reference (%)
7/21/93	Control	91	-	-	91	-	-	82	-	-
	CRM 22.0	96	-5	-	96	-5	-	100	-22	-
	CRM 19.0	86	5	10	81	11	16	81	1	19*
	CRM 9.0	100	-10	-4	87	4	9	87	-6	13*
	PCM 11.3	4	96*	-	4	96*	-	79	4	-
	PCM 6.0	5	95*	-25	5	95*	-25	67	18	15
	PCM 5.1	0	100*	100	0	100*	100	83	-1	-5
	PCM 4.3	4	96*	0	4	96*	0	57	30*	28
	PCM 2.9	9	90*	-125	9	90*	-125	74	10	6
	PCM 1.0	76	16	-1800	76	16	-1800	76	7	4

[a]n = 21-25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River mile; PCM = Poplar Creek mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table L22 (continued)

Date	Site[c]	Survival			Hatch			Developmental abnormalities		
		Percent survival	Decrease from control (%)	Decrease from reference (%)	Percent hatch	Decrease from control (%)	Decrease from reference (%)	Percent normal[d]	Decrease from control (%)	Decrease from reference (%)
	CRM 22.0	92	-11	-	92	-24	-	100	-27	-
	CRM 19.0	88	-6	4	88	-19	4	84	-6	16*
	CRM 9.0	83	0	10	78	-5	15	91	-15	9
	PCM 11.3	40	52*	-	40	46*	-	72	9	-
	PCM 6.0	8	90*	80*	8	89*	80*	37	53*	49*
	PCM 5.1	20	76*	50	20	73*	50	52	34*	28
	PCM 4.3	8	90*	80*	13	82*	68*	46	42*	36*
	PCM 2.9	20	76*	50	24	68*	40	76	4	-6
	PCM 1.0	13	84*	68*	13	82*	68*	58	27	19
1/25/94	Control	92	-	-	92	-	-	87	-	-
	CRM 22.0	92	-1050	-	83	-538	-	96	-10	-

[a]n = 21–25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River mile; PCM = Poplar Creek mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table L22 (continued)

Date	Site[c]	Survival			Hatch			Developmental abnormalities		
		Percent survival	Decrease from control (%)	Decrease from reference (%)	Percent hatch	Decrease from control (%)	Decrease from reference (%)	Percent normal[d]	Decrease from control (%)	Decrease from reference (%)
	CRM 19.0	100	-1150	-9	92	-608	-11	96	-10	0
	CRM 9.0	88	-1000	4	79	-508	5	87	0	9
	PCM 11.3	100	-1150	-	92	-608	-	96	-10	-
	PCM 6.0	96	-1100	4	79	-508	14	96	-10	0
	PCM 5.1	92	-1050	8	76	-485	17	84	3	12
	PCM 4.3	83	-938	17*	83	-538	10	67	23*	30*
	PCM 2.9	63	-688	37*	63	32*	32*	58	33*	40*
	PCM 1.0	36	61*	64*	40	57*	57*	48	45*	50*
4/14/94	Control	96	-	-	64	-	-	100	-	-
	CRM 22.0	92	0	-	92	-21	-	96	4	-
	CRM 19.0	80	17*	13	80	-5	13	92	8	4

[a]n = 21–25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River mile; PCM = Poplar Creek mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table L22 (continued)

Date	Site[c]	Survival			Hatch			Developmental abnormalities		
		Percent survival	Decrease from control (%)	Decrease from reference (%)	Percent hatch	Decrease from control (%)	Decrease from reference (%)	Percent normal[d]	Decrease from control (%)	Decrease from reference (%)
	CRM 9.0	92	0	0	92	-21	0	100	0	-4
	PCM 11.3	92	0	-	92	-21	-	100	0	-
	PCM 6.0	84	9	9	84	-11	9	96	4	4
	PCM 5.1	92	0	0	92	-21	0	96	4	4
	PCM 4.3	84	9	9	88	-16	4	92	8	8
	PCM 2.9	92	0	0	92	-21	0	100	0	0
	PCM 1.0	84	9	9	88	-16	4	96	4	4
7/21/94	Control	96	-	-	84	-	-	92	-	-
	CRM 22.0	36	63*	-	44	48*	-	68	26*	-
	CRM 19.0	16	83*	56	24	71*	45	68	26*	0
	CRM 9.0	79	18*	-119	83	10	-89	96	-4	-41

[a]n = 21–25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River mile; PCM = Poplar Creek mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table L22 (continued)

Date	Site[c]	Survival			Hatch			Developmental abnormalities		
		Percent survival	Decrease from control (%)	Decrease from reference (%)	Percent hatch	Decrease from control (%)	Decrease from reference (%)	Percent normal[d]	Decrease from control (%)	Decrease from reference (%)
	PCM 11.3	71	26*	-	79	14	-	75	18	-
	PCM 6.0	84	9	-18	84	9	-6	84	9	-12
	PCM 5.1	52	46*	27	52	38*	34*	72	22*	4
	PCM 4.3	40	58*	44*	40	52*	49*	64	30*	15
	PCM 2.9	16	83*	77*	16	81*	80*	56	39*	25
	PCM 1.0	12	88*	83*	12	86*	85*	80	13	-7

[a]n = 21–25 individually incubated embryos per site per test
[b]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or the appropriate reference site (CRM 22.0 for Clinch River sites, PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River mile; PCM = Poplar Creek mile
[d]Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table L23. Results of medaka embryo-larval tests of surface water from the Clinch River and Poplar Creek conducted for the K-25 Site Biological Monitoring and Abatement Program (BMAP) during October 1994 and January 1995[a,b]

		Survival			Hatch			Developmental abnormalities		
Date	Site[c]	Percent survival	Decrease from control (%)	Decrease from reference (%)	Percent hatch	Decrease from control (%)	Decrease from reference (%)	Percent normal[d]	Decrease from control (%)	Decrease from reference (%)
10/13/94	Control	96	--	--	83	--	--	96	--	--
	CRM 9.0	100	-4	--	96	??	--	100	-4	--
	PCM 11.3	32	67*	--	32	61*	--	56	42*	--
	PCM 5.1	13	86*	59	13	84*	??	21	78*	63*
	PCM 4.3	24	75*	25	24	71*	??	12	88*	79*
	PCM 2.9	24	75*	25	28	66*	??	8	92*	86*
	PCM 1.0	12	88*	63*	12	86*	63*	20	79*	64*
1/19/95	Control	85	--	--	85	--	--	85	--	--
	CRM 9.0	80	6	--	80	??	--	85	0	--
	PCM 11.3	90	-6	--	95	??	--	90	-6	--
	PCM 5.1	53	38*	41*	58	32*	39*	47	45*	48*
	PCM 4.3	50	41*	44*	50	41*	47*	35	59*	61*
	PCM 2.9	42	51*	53*	42	51*	56*	53	38*	41*
	PCM 1.0	25	71*	72*	30	65*	68*	10	88*	89*

[a]n=23-25 individually incubated embryos per site for 10/94 test; 19-20 embryos per site for 1/95 test
[b]Asterisks signify a significant difference in percent survival, hatch, or normal development between a site and a control or appropriate reference site (PCM 11.3 for Poplar Creek sites)
[c]CRM = Clinch River mile; PCM = Poplar Creek mile

Table L24. Results of medaka embryo-larval tests of surface water from McCoy Branch and Walker Branch conducted for the CR-ERP during June 1994 and August 1994[a,b]

Date	Site[c]	Survival			Hatch			Developmental abnormalities		
		Percent survival	Decrease from control (%)	Decrease from reference (%)	Percent hatch	Decrease from control (%)	Decrease from reference (%)	Percent normal[d]	Decrease from control (%)	Decrease from reference (%)
6/2/94	Control	100	-	-	88	-	-	92	-	-
	WBM 0.4	88	12*	-	88	0	-	96	9	-
	MBM 0.4	96	4	-9	96	-9	-9	96	9	0
	MBM 0.2	96	4	-9	100	-14	-14	96	9	0
8/11/94	Control	92	-	-	56	-	-	100	-	-
	WBM 0.4	100	-9	-	100	-79	-	100	0	-
	MBM 0.4	92	0	8	92	-64	8	98	4	4
	MBM 0.2	84	9	16*	88	-57	12*	96	8	8

[a] n = 24-25 individually incubated embryos per site per test.
[b] Asterisks signify a significant difference in % survival, hatch, or normal development between a site and either the control or the reference site (WBM 0.4)
[c] MBM = McCoy Branch mile; WBM = Walker Branch mile
[d] Percent of embryos that did not exhibit any obvious developmental abnormalities (other than delayed hatching) during the course of a test

Table L25. Comparison of medaka and redbreast sunfish embryo-larval test of surface water from selected sites on the Clinch River and Poplar Creek.[a, b, c]

		Survival		Hatch		Developmental abnormalities[e]	
Species	Site[d]	Percent survival	Decrease from reference (%)	Percent hatch	Decrease from reference (%)	Percent normal	Decrease from reference (%)
Medaka	CRM 22.0	80		85		90	-
	CRM 9.0	85	-6	85	0	80	11
	PCM 11.3	70		75		95	-
	PCM 6.0	45	36	50	33	70	26*
	PCM 4.3	11	84*	11	85*	50	47*
	PCM 1.0	11	84*	11	85*	42	56*
Sunfish	CRM 22.0	91		91		96	-
(Pair 1)	CRM 9.0	83	9	100	-10	92	4
	PCM 11.3	96		100		91	-
	PCM 6.0	80	17*	96	4	96	-6
	PCM 4.3	36	63*	96	4	84	8
	PCM 1.0	50	48*	100	0	92	-1
Sunfish	CRM 22.0	87		96		91	-
(Pair 2)	CRM 9.0	92	-6	100	-4	84	8
	PCM 11.3	96		100		91	-
	PCM 6.0	92	4	96	4	92	-1
	PCM 4.3	57	41*	100	0	95	-4
	PCM 1.0	88	8	100	0	100	-10
Sunfish	CRM 22.0	79		96		96	-
(Pair 3)	CRM 9.0	88	-11	96	0	100	4
	PCM 11.3	96		96		96	-
	PCM 6.0	78	19*	96	0	91	5
	PCM 4.3	63	34*	96	0	92	4
	PCM 1.0	72	25*	100	-4	96	0

[a]Test initiated 7/28/94
[b]n = 18-20 embryos per site per test for medaka; n = 21-25 embryos per site per redbreast sunfish pairing.
[c]Asterisks signify a significant difference in % survival, hatch, or incidence of developmental abnormalities between a site and either the control or appropriate reference site (PCM 11.3 for Poplar Creek sites)
[d]CRM = Clinch River Mile; PCM = Poplar Creek Mile
[e]Percent of embryos not exhibiting any developmental abnormality (other than delayed hatching) during the course of

Table L26. Summary of individual survival statistics for Largemouth Bass embryo-larval tests of surface water from the Clinch River and Poplar Creek conducted for the CR-ERP during April 1994[a,b]

	Pair 1			Pair 2			Pair 3			Pair 4			Pair 5		
Site[c]	%	Control	Ref	%	Control	Ref	%	Control	Ref	%	Control	Ref	%	Control	Ref
Control	90			88			80			86			94		
CRM 22.0	85	6		92	-5		94	-18		94	-9		92	2	
CRM 19.0	88	2	-4	98	-11	-7	96	-20	-2	94	-9	0	94	0	-2
CRM 9.0	76	16*	11	96	-9	-4	96	-20	-2	96	-12	-2	78	17*	15*
TRM 547	90	0	-6	94	-7	-2	90	-13	4	92	-7	2	88	6	4
PCM 11.3	90	0		94	-7		90	-13		80	7		72	23*	
PCM 6.0	88	2	2	96	-9	-2	88	-10	2	62	28*	23*	64	32*	11
PCM 5.1	74	18*	18*	98	-11	-4	84	-5	7	64	26*	20*	90	4	-25
PCM 4.3	86	4	4	96	-9	-2	92	-15	-2	66	23*	18	94	0	-31
PCM 2.9	94	-4	-4	96	-9	-2	88	-10	2	72	16*	10	82	13*	-14
PCM 1.0	94	-4	-4	98	-11	-4	96	-20	-7	76	12	5	90	4	-25

[a]Test initiated 4/21/94; expressed as percent decrease from control or appropriate reference (PCM 11.3 for Poplar Creek sites, CRM 22.0 for Clinch River and Tenness River sites) in the % survival of an initial 50 embryos per site per each of five different largemouth bass pairings; eggs were fertilized in vitrowith sperm derived from testes minced in a saline solution

[b]Asterisks signify a significant difference in % survival between a site and the control or appropriate reference site

[c]CRM = Clinch River mile, TRM = Tennessee River mile, and PCM = Poplar Creek mile

Table L27. Summary of developmental abnormality statistics for largemouth bass embryo-larval tests of surface water from the Clinch River and Poplar Creek conducted for the CR-ERP during April 1994 [a,b]

	Pair 1			Pair 2			Pair 3			Pair 4			Pair 5		
Site[c]	%[d]	Control	Ref	%[d]	Control	Ref	%[d]	Control	Ref	%[d]	Control	Ref	%[d]	Control	Ref
Control	94	--	--	78	--	--	95	--	--	92	--	--	100	--	--
CRM 22.0	96	-2	--	98	-26	--	96	-1	--	90	2	--	96	4	--
CRM 19.0	92	2	4	100	-28	-2	98	-3	-2	100	-9	-11	96	4	0
CRM 9.0	96	-2	0	98	-26	0	94	1	2	94	-2	-4	89	11*	7
TRM 547	98	-4	-2	94	-20	4	96	-1	0	96	-4	-7	88	12*	8
PCM 11.3	100	-6	--	96	-23	--	98	-3	--	88	4	--	92	8*	--
PCM 6.0	100	-6	0	100	-28	-4	96	-1	0	96	-4	-9	90	10*	2
PCM 5.1	92	2	8*	96	-23	0	98	-3	-2	88	4	0	92	8*	0
PCM 4.3	98	-4	2	86	-10	10*	90	5	6	92	0	-4	90	10*	2
PCM 2.9	94	0	6*	96	-23	0	96	-1	0	96	-4	-9	86	14*	6
PCM 1.0	98	-4	2	96	-23	0	100	-5	-4	86	6	2	90	10*	2

[a]Test initiated 4/21/94; expressed as percent decrease from control or appropriate reference (PCM 11.3 for Poplar Creek sites, CRM 22.0 for Clinch River and Tennessee River sites) in the % normal embryos of an initial 50 embryos per site per each of five different largemouth bass pairings; eggs were fertilized in vitro with sperm derived from testes minced in a saline solution

[b]Asterisks signify a significant difference in % normal between a site and the control or appropriate reference site

[c]CRM = Clinch River mile, TRM = Tennessee River mile, and PCM = Poplar Creek mile

[d]Percent of embryos that did not exhibit any obvious developmental abnormality (other than delayed hatching) during the course of the test

Table L28. Concentrations of selected analytes in surface water (µg/L) and sediment (mg/kg) at areas near potential contaminant sources [a]

Sample location[b]	Possible contaminant sources[c]	Copper		Arsenic		Mercury		Manganese		Aroclor 1254	Aroclor 1260	Total Chlordane
		Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Sediment		
CRM 50.1 - Oak Ridge Marina	Contaminated fill material	35*	25.5*	1*	5.5*	0.2*	0.11*	39*	3900*	25	25	26
CRM 47.9 - Bull Run Steam Plant	Plant operations	40	48	1	6.3	0.2	0.10	65	4300	45	100	25
CRM 41 - Upper Scarboro Creek	Kerr Hollow (Y-12 Plant)	20	24	1	6.4	0.2	0.2	60	1900	25	51.5	16.5
CRM 41 - Lower Scarboro Creek	CARL	10	37	1	1.6	0.2	0.12	31	3300	25	25	10
CRM 37.5 - Lower McCoy Branch	Rogers Quarry (Y-12 Plant)	10	39	1	23	0.2	0.1	26	5300	25	25	10
CRM 33.2 - Walker Branch	Reference site	10	30	1	6.5	0.2	0.49	18	1900	25	25	10
CRM 31.8 - Bearden Creek	ORNL WAGs	10*	30	1*	6.8	0.2*	0.1*	11*	3400	25	25	10
CRM 27.1 - unnamed embayment	ORNL WAGs and SWMUs	10	41	1	12	0.2	0.1	6	3100	25	25	10

[a]Asterisks indicate an average of two samples; otherwise, values are for single samples. The values listed for surface water are unfiltered (total) concentrations.
[b]CRM = Clinch River mile.
[c]CARL = Comparative Animal Research Laboratory; ORNL = Oak Ridge National Laboratory; WAG = Waste Area Grouping; SWMU = Solid Waste Management Unit.

Appendix M

SEDIMENT CHARACTERIZATION–SUPPORTING STUDIES

Table M1. ***Hyalella azteca*** **survival in the Poplar Creek and Clinch River test sites**

Test Date	Site ID[a]	Percent survival					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
7/21 - 8/2, 1993	PCM 1.0	53.75	19.31	4	35	80	-39.44	NA
	PCM 2.9	55.00	26.77	4	25	90	-38.03	NA
	PCM 4.3	42.50	13.23	4	25	55	-52.11	NA
	PCM 5.1	92.50	5.00	4	85	95	4.23	NA
	PCM 6.0	88.75	4.79	4	85	95	NA	NA
	CRM 9.0	88.75	4.79	4	85	95	NA	7.58
	CRM 19.0	65.00	27.08	4	25	85	NA	-21.21
	CRM 22.0	82.50	9.57	4	75	95	NA	NA
8/24 - 9/5,1993	PCM 1.0	93.75	4.79	4	90	100	0.00	NA
	PCM 2.9	93.75	4.79	4	90	100	0.00	NA
	PCM 4.3	95.00	4.08	4	90	100	1.33	NA
	PCM 5.1	100.00	0.00	4	100	100	6.67	NA
	PCM 6.0	93.75	4.79	4	90	100	NA	NA
	CRM 9.0	96.25	7.50	4	85	100	NA	2.67
	CRM 19.0	95.00	4.08	4	90	100	NA	1.33
	CRM 22.0	93.75	2.50	4	90	95	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
NA = Not Applicable.

Table M1 (continued)

Test Date	Site ID[a]	Percent survival					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
11/2-11/16,1993	PCM 1.0	90.00	10.80	4	75	100	-1.37	NA
	PCM 2.9	93.75	7.50	4	85	100	2.74	NA
	PCM 4.3	91.67	2.89	3	90	95	0.46	NA
	PCM 5.1	96.25	4.79	4	90	100	5.48	NA
	PCM 6.0	91.25	8.54	4	80	100	NA	NA
	CRM 9.0	75.00	18.03	3	55	90	NA	-20.00
	CRM 19.0	85.00	7.07	4	80	95	NA	-9.33
	CRM 22.0	93.75	2.50	4	90	95	NA	NA
2/22 - 3/7,1994	PCM 1.0	75.00	37.19	4	20	100	-4.76	NA
	PCM 2.9	97.50	5.00	4	90	100	23.81	NA
	PCM 4.3	70.00	20.41	4	55	100	-11.11	NA
	PCM 5.1	38.75	46.97	4	0	95	-50.79	NA
	PCM 6.0	78.75	32.76	4	30	100	NA	NA
	CRM 9.0	58.75	40.29	4	15	100	NA	-36.49
	CRM 19.0	73.75	42.70	4	10	100	NA	-20.27
	CRM 21.2	92.50	6.46	4	85	100	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
NA = Not Applicable.

Table M1 (continued)

Test Date	Site ID[a]	Percent survival					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
5/10 - 5/23,1994	PCM 1.0	87.50	9.57	4	80	100	-2.78	NA
	PCM 2.9	60.00	29.72	4	25	95	-33.33	NA
	PCM 4.3	87.50	8.66	4	75	95	-2.78	NA
	PCM 5.1	80.00	5.00	3	75	85	-11.11	NA
	PCM 6.0	90.00	4.08	4	85	95.	NA	NA
	CRM 9.0	96.25	7.50	4	85	100	NA	6.94
	CRM 19.0	90.00	8.66	3	80	95	NA	0.00
	CRM 21.5	90.00	5.00	3	85	95	NA	NA
7/10 - 7/26,1994	PCM 1.0	82.50	6.46	4	75	90	0.00	NA
	PCM 2.9	91.25	7.50	4	85	100	10.61	NA
	PCM 4.3	92.50	6.46	4	85	100	12.12	NA
	PCM 5.1	95.00	5.77	4	90	100	15.15	NA
	PCM 6.0	82.50	12.58	4	65	95	NA	NA
	CRM 9.0	78.75	36.14	4	25	100	NA	-10.00
	CRM 19.0	67.50	32.79	4	20	95	NA	-22.86
	CRM 20.5	87.50	15.55	4	65	100	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
NA = Not Applicable.

Table M1 (continued)

Test Date	Site ID[a]	Percent survival					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
9/13 - 9/23, 1994	PCM 1.0	73.75	6.29	4	65	80	-9.23	NA
	PCM 2.9	78.75	7.50	4	75	90	-3.08	NA
	PCM 4.3	83.75	4.79	4	80	90	3.08	NA
	PCM 5.1	75.00	17.80	4	55	90	-7.69	NA
	PCM 6.0	81.25	8.54	4	70	90	NA	NA
	CRM 9.0	12.50	10.41	4	0	25	NA	-44.44
	CRM 19.0	28.75	34.49	4	0	75	NA	27.78
	CRM 20.5	22.50	35.71	4	0	75	NA	NA
12/5-12/15, 1995 Confirmatory Test	PCM 0.5	70.00	34.64	4	20	100	-9.68	NA
	PCM 4.0	85.00	12.91	4	70	100	9.68	NA
	PCM 4.5	77.50	22.17	4	50	100	0.00	NA
	PCM 6.0	77.50	32.02	4	30	100	NA	NA
	Lab Control	90.00	14.14	4	70	100	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2 and 20.5 were used.
NA = Not Applicable.
[c]Laboratory formulated control sediment (batch no. LFS1295). Used to evaluate test acceptability.

Table M2. *Hyalella azteca* survival in the McCoy Branch and Walker Branch embayment sites

Test date	Site ID[a]	Percent survival					Percent difference from reference
		Mean	SD	*n*	Min.	Max.	
6/7 - 6/21, 1994	MBM 0.2	93.75	4.79	4	90	100	7.14
	MBM 0.4	91.25	6.29	4	85	100	4.29
	WBM 0.6[b]	87.50	6.45	4	80	95	NA
8/15 - 8/28, 1994	MBM 0.2	82.50	19.36	4	55	100	24.53
	MBM 0.4	70.00	27.39	4	30	90	5.67
	WBM 0.4[b]	66.25	24.28	4	30	80	NA

[a]MBM = McCoy Branch embayment mile; WBM = Walker Branch embayment mile; Control = a water-only treatment.
[b]The reference site for McCoy Branch was either Walker Branch embayment site WBM 0.6 or WBM 0.4, as shown.
NA = Not Applicable.

Table M3. *Anodonta imbecillis* (freshwater mussel) survival in the Poplar Creek and Clinch River test sites

Test date	Site ID[a]	Percent survival					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
7/21 - 8/2, 1993	PCM 1.0	87.50	15.00	4	70.00	100.00	7.69	NA
	PCM 2.9	90.00	8.17	4	80.00	100.00	10.77	NA
	PCM 4.3	91.94	9.14	4	77.78	100.00	13.23	NA
	PCM 5.1	91.94	9.14	4	77.78	100.00	13.23	NA
	PCM 6.0	81.11	9.72	4	66.67	90.00	NA	NA
	CRM 9.0	79.45	7.14	4	70.00	90.00	NA	7.07
	CRM 19.0	55.00	40.41	4	0.00	90.00	NA	-25.93
	CRM 22.0	74.17	11.64	4	60.00	90.00	NA	NA
8/24 - 9/5, 1993	PCM 1.0	85.00	17.32	4	60.00	100.00	9.68	NA
	PCM 2.9	82.50	9.57	4	70.00	90.00	6.45	NA
	PCM 4.3	55.00	12.91	4	40.00	70.00	-29.03	NA
	PCM 5.1	77.50	12.58	4	60.00	90.00	0.00	NA
	PCM 6.0	77.50	15.00	4	60.00	90.00	NA	NA
	CRM 9.0	52.50	41.13	4	0.00	90.00	NA	-8.70
	CRM 19.0	80.00	8.17	4	70.00	90.00	NA	39.13
	CRM 22.0	57.50	40.31	4	0.00	90.00	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
NA = Not Applicable.

Table M3 (continued)

Test date	Site ID[a]	Percent survival					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
9/13 - 9/23, 1994	PCM 1.0	79.72	18.57	4	50.00	100.00	-12.37	NA
	PCM 2.9	95.00	8.67	4	80.00	100.00	4.43	NA
	PCM 4.3	64.70	26.67	4	33.33	100.00	-28.88	NA
	PCM 5.1	97.50	4.33	4	90.00	100.00	7.14	NA
	PCM 6.0	90.97	10.28	4	75.00	100.00	NA	NA
	CRM 9.0	85.42	14.88	4	66.67	100.00	NA	-10.09
	CRM 19.0	51.25	28.80	4	20.00	80.00	NA	-46.05
	CRM 20.5	95.00	5.00	4	90.00	100.00	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
NA = Not Applicable.

Table M4. *Ceriodaphnia dubia* (pore water) survival in the Poplar Creek and Clinch River test sites

Test date	Site ID[a]	Percent survival					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
8/24 - 9/5, 1993	Control	90.00	10.00	4	80	100	-10.00	NA
	PCM 1.0	100.00	0.00	4	100	100	0.00	NA
	PCM 2.9	100.00	0.00	4	100	100	0.00	NA
	PCM 4.3	100.00	0.00	4	100	100	0.00	NA
	PCM 5.1	100.00	0.00	4	100	100	0.00	NA
	PCM 6.0	100.00	0.00	4	100	100	NA	NA
	CRM 9.0	95.00	8.66	4	80	100	NA	NA
	CRM 19.0	100.00	0.00	4	100	100	NA	NA
	CRM 22.0[c]	NA	NA	NA	NA	NA	NA	NA
11/2 - 11/16, 1993	Control	100.00	0.00	4	100	100	4.35	0.00
	PCM 1.0	95.83	7.22	4	83.33	100.00	0.00	NA
	PCM 2.9	91.67	14.43	4	66.67	100.00	-4.35	NA
	PCM 4.3	100.00	0.00	4	100.00	100.00	4.35	NA
	PCM 5.1	95.83	7.22	4	83.33	100.00	0.00	NA
	PCM 6.0	95.83	7.22	4	83.33	100.00	NA	NA
	CRM 9.0	91.67	8.33	4	83.33	100.00	NA	8.33
	CRM 19.0	100.00	0.00	4	100.00	100.00	NA	0.00
	CRM 22.0	100.00	0.00	4	100.00	100.00	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; Control = a water-only treatment (control treatment was not run on 11/2 - 11/16, 1993).
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
[c]This site was not tested; insufficient volume of pore water was collected.
NA = Not Applicable.

Table M4 (continued)

Test date	Site ID[a]	Percent survival					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
2/22 - 3/7, 1994	Control	100.00	0.00	4	100.00	100.00	4.38	9.09
	PCM 1.0	95.83	7.22	4	83.33	100.00	0.00	NA
	PCM 2.9	87.50	13.82	4	66.67	100.00	-8.70	NA
	PCM 4.3	83.33	11.79	4	66.67	100.00	-13.04	NA
	PCM 5.1	91.67	8.33	4	83.33	100.00	-4.35	NA
	PCM 6.0	95.83	7.22	4	83.33	100.00	NA	NA
	CRM 9.0	100.00	0.00	4	100.00	100.00	NA	9.09
	CRM 19.0	95.83	7.22	4	83.33	100.00	NA	4.55
	CRM 22.0	91.67	14.43	4	66.67	100.00	NA	NA
5/10 - 5/23, 1994	Control	100.00	0.00	4	100.00	100.00	0.00	0.00
	PCM 1.0	100.00	0.00	4	100.00	100.00	0.00	NA
	PCM 2.9	100.00	0.00	4	100.00	100.00	0.00	NA
	PCM 4.3	79.17	13.82	4	66.67	100.00	-20.83	NA
	PCM 5.1	95.83	7.22	4	83.33	100.00	-4.17	NA
	PCM 6.0	100.00	0.00	4	100.00	100.00	NA	NA
	CRM 9.0	91.67	8.33	4	83.33	100.00	NA	-8.33
	CRM 19.0	100.00	0.00	4	100.00	100.00	NA	0.00
	CRM 21.2	100.00	0.00	4	100.00	100.00	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; Control = a water-only treatment (control treatment was not run on 11/2 - 11/16, 1993).
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
[c]This site was not tested; insufficient volume of pore water was collected.
NA = Not Applicable.

Table M4 (continued)

Test date	Site ID[a]	Percent survival					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
7/10 - 7/26, 1994	Control	100.00	0.00	4	100.00	100.00	0.00	0.00
	PCM 1.0	100.00	0.00	4	100.00	100.00	0.00	NA
	PCM 2.9	100.00	0.00	4	100.00	100.00	0.00	NA
	PCM 4.3	100.00	0.00	4	100.00	100.00	0.00	NA
	PCM 5.1	100.00	0.00	4	100.00	100.00	0.00	NA
	PCM 6.0	100.00	0.00	4	100.00	100.00	NA	NA
	CRM 9.0	NA	NA	0	NA	NA	NA	NA
	CRM 19.0	NA	NA	0	NA	NA	NA	NA
	CRM 21.5	100.00	0.00	4	100.00	100.00	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; Control = a water-only treatment (control treatment was not run on 11/2 - 11/16, 1993).
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
[c]This site was not tested; insufficient volume of pore water was collected.
NA = Not Applicable.

Table M5. *Ceriodaphnia dubia* (pore water) survival in the McCoy Branch and Walker Branch embayment sites

Test date	Site ID[a]	Percent survival					Percent difference from reference
		Mean	SD	*n*	Min.	Max.	
6/7 - 6/21, 1994	Control	100.00	0.00	4	100	100	0.00
	MBM 0.2	100.00	0.00	4	100	100	0.00
	MBM 0.4	91.67	14.43	4	66.67	100	-8.33
	WBM 0.6[b]	100.00	0.00	4	100	100	NA
8/15 - 8/28, 1994	Control	100.00	0.00	4	100	100	4.35
	MBM 0.2	100.00	0.00	4	100	100	4.35
	MBM 0.4	87.50	13.82	4	66.67	100	-8.69
	WBM 0.4[b]	95.83	7.22	4	83.33	100	NA

[a]MBM = McCoy Branch Embayment mile; WBM = Walker Branch Embayment mile; Control = a water-only treatment.
[b]The reference site for McCoy Branch was either Walker Branch Embayment site WBM 0.6 or WBM 0.4, as shown.
NA = Not Applicable.

Table M6. *Daphnia magna* survival in the Poplar Creek and Clinch River test sites

Test date	Site ID[a]	Mean percent survival	Percent difference	
			PCM Ref.[b]	CRM Ref.[b]
7/21 - 8/2, 1993	Control	90	-10.00	-10.00
	PCM 1.0	80	-20.00	NA
	PCM 2.9	90	-10.00	NA
	PCM 4.3	90	-10.00	NA
	PCM 5.1	100	0.00	NA
	PCM 6.0	100	NA	NA
	CRM 9.0	100	NA	0.00
	CRM 19.0	70	NA	-30.00
	CRM 22.0	100	NA	NA
8/24 - 9/5, 1993	Control	100	11.11	0.00
	PCM 1.0	80	-11.11	NA
	PCM 2.9	90	0.00	NA
	PCM 4.3	100	11.11	NA
	PCM 5.1	90	0.00	NA
	PCM 6.0	90	NA	NA
	CRM 9.0	100	NA	0.00
	CRM 19.0	100	NA	0.00
	CRM 22.0	100	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; Control = a water-only treatment.
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2 and 20.5 were used.
[c]A water-only control treatment was not run during this test period.
NA = Not Applicable.

Table M6 (continued)

Test date	Site ID[a]	Mean percent survival	Percent difference PCM Ref.[b]	Percent difference CRM Ref.[b]
11/2 - 11/16, 1993[c]	Control	NA	NA	NA
	PCM 1.0	100	0.00	NA
	PCM 2.9	100	0.00	NA
	PCM 4.3	100	0.00	NA
	PCM 5.1	100	0.00	NA
	PCM 6.0	100	NA	NA
	CRM 9.0	100	NA	0.00
	CRM 19.0	100	NA	0.00
	CRM 22.0	100	NA	NA
2/22 - 3/7, 1994	Control	90	-10.00	-10.00
	PCM 1.0	90	-10.00	NA
	PCM 2.9	100	0.00	NA
	PCM 4.3	90	-10.00	NA
	PCM 5.1	90	-10.00	NA
	PCM 6.0	100	NA	NA
	CRM 9.0	80	NA	-20.00
	CRM 19.0	90	NA	10.00
	CRM 21.2	100	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; Control = a water-only treatment.
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2 and 20.5 were used.
[c]A water-only control treatment was not run during this test period.
NA = Not Applicable.

Table M6 (continued)

Test date	Site ID[a]	Mean percent survival	Percent difference PCM Ref.[b]	Percent difference CRM Ref.[b]
5/10 - 5/23, 1994	Control	100	25.00	11.11
	PCM 1.0	70	-12.50	NA
	PCM 2.9	90	12.50	NA
	PCM 4.3	90	12.50	NA
	PCM 5.1	100	25.00	NA
	PCM 6.0	80	NA	NA
	CRM 9.0	90	NA	0.00
	CRM 19.0	60	NA	-33.33
	CRM 21.5	90	NA	NA
7/10 - 7/26, 1994	Control	100	42.86	11.11
	PCM 1.0	40	-42.86	NA
	PCM 2.9	90	28.57	NA
	PCM 4.3	100	42.86	NA
	PCM 5.1	100	42.86	NA
	PCM 6.0	70	NA	NA
	CRM 9.0	80	NA	-11.11
	CRM 19.0	100	NA	11.11
	CRM 20.5	90	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; Control = a water-only treatment.
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2 and 20.5 were used.
[c]A water-only control treatment was not run during this test period.
NA = Not Applicable.

Table M7. *Daphnia magna* survival in the McCoy Branch and Walker Branch embayment sites

Test date	Site ID[a]	Mean percent survival	Percent difference from reference
6/7 - 6/21, 1994	Control	100	12.50
	MBM 0.2	90	1.25
	MBM 0.4	100	12.50
	WBM 0.6[b]	88.89[c]	NA
8/15 - 8/28, 1994	Control	60	-14.29
	MBM 0.2	90	28.57
	MBM 0.4	70	0.00
	WBM 0.4[b]	70	NA

[a]MBM = McCoy Branch Embayment mile; WBM = Walker Branch Embayment mile; Control = a water-only treatment.
[b]The reference site for McCoy Branch was either Walker Branch Embayment site WBM 0.6 or WBM 0.4, as shown.
[c]One replicate was lost due to technician error. Survival was calculated as 8 of the 9 remaining replicates, or 88.89%.
NA = Not Applicable.

Table M8. *Daphnia magna* reproduction in the Poplar Creek and Clinch River test sites

Test date	Site ID[a]	Reproduction: offspring per surviving female					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
7/21 - 8/2, 1993	Control	90.56	25.33	9	42	132	435.86	192.13
	PCM 1.0	33.25	4.63	8	26	42	96.75	NA
	PCM 2.9	50.67	14.17	9	31	76	199.80	NA
	PCM 4.3	34.33	11.32	9	16	53	103.16	NA
	PCM 5.1	34.10	5.36	10	24	41	101.78	NA
	PCM 6.0	16.90	5.50	10	10	30	NA	NA
	CRM 9.0	40.20	14.03	10	28	79	NA	29.68
	CRM 19.0	30.14	6.85	7	22	41	NA	-2.76
	CRM 22.0	31.00	6.56	10	21	39	NA	NA
8/24 - 9/5, 1993	Control	104.50	12.15	10	90	124	148.16	195.20
	PCM 1.0	43.25	10.92	8	21	53	2.70	NA
	PCM 2.9	45.89	10.44	9	24	60	8.97	NA
	PCM 4.3	38.50	10.74	10	21	52	-8.58	NA
	PCM 5.1	39.89	14.22	9	9	58	-5.28	NA
	PCM 6.0	42.11	11.13	9	26	56	NA	NA
	CRM 9.0	47.30	6.71	10	34	56	NA	33.62
	CRM 19.0	38.10	13.52	17	17	63	NA	7.63
	CRM 22.0	35.40	10.26	10	22	55	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; Control = a water-only treatment.
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
[c]A water-only control treatment was not run during this test period.
NA = Not Applicable.

Table M8 (continued)

Test date	Site ID[a]	Reproduction: offspring per surviving female					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
11/2 - 11/16, 1993[c]	Control	NA	NA	NA	NA	NA	NA	NA
	PCM 1.0	24.10	5.36	10	18	36	-17.75	NA
	PCM 2.9	26.70	5.39	10	15	36	-8.87	NA
	PCM 4.3	24.00	3.63	10	19	28	-18.09	NA
	PCM 5.1	28.20	5.72	10	18	40	-3.75	NA
	PCM 6.0	29.30	4.90	10	19	37	NA	NA
	CRM 9.0	42.10	9.80	10	20	62	NA	144.77
	CRM 19.0	43.10	9.99	10	29	60	NA	150.58
	CRM 22.0	17.20	3.74	10	9	23	NA	NA
2/22 - 3/7, 1994	Control	51.89	12.34	9	35	72	90.07	74.13
	PCM 1.0	15.33	5.33	9	8	28	-43.83	NA
	PCM 2.9	22.60	9.22	10	12	45	-17.22	NA
	PCM 4.3	17.22	6.25	9	9	27	-36.91	NA
	PCM 5.1	16.00	9.82	9	9	42	-41.39	NA
	PCM 6.0	27.30	11.95	10	12	51	NA	NA
	CRM 9.0	18.50	6.84	8	9	33	NA	-37.92
	CRM 19.0	21.22	3.49	9	17	28	NA	-28.78
	CRM 21.2	29.80	8.57	10	18	49	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; Control = a water-only treatment.
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
[c]A water-only control treatment was not run during this test period.
NA = Not Applicable.

Table M8 (continued)

Test date	Site ID[a]	Reproduction: offspring per surviving female					Percent difference	
		Mean	SD	*n*	Min.	Max.	PCM Ref.[b]	CRM Ref.[b]
5/10 - 5/23, 1994	Control	47.00	9.15	10	35	67	178.44	159.53
	PCM 1.0	9.57	4.27	7	4	15	-43.28	NA
	PCM 2.9	26.11	12.31	9	13	55	54.73	NA
	PCM 4.3	16.56	9.33	9	7	35	-1.89	NA
	PCM 5.1	17.60	6.30	10	13	31	4.30	NA
	PCM 6.0	16.88	7.91	8	12	37	NA	NA
	CRM 9.0	9.00	1.56	9	8	12	NA	-50.31
	CRM 19.0	16.83	11.26	6	0	34	NA	-7.06
	CRM 21.5	18.11	4.93	9	11	26	NA	NA
7/10 - 7/26, 1994	Control	44.00	12.62	10	22	62	185.16	122.45
	PCM 1.0	20.00	3.46	4	18	26	29.63	NA
	PCM 2.9	13.67	1.94	9	11	16	-11.42	NA
	PCM 4.3	18.00	2.10	10	15	23	16.67	NA
	PCM 5.1	14.30	3.98	10	5	19	-7.31	NA
	PCM 6.0	15.43	2.92	7	11	21	NA	NA
	CRM 9.0	16.00	7.07	8	6	31	NA	-19.10
	CRM 19.0	18.90	2.62	10	15	24	NA	-4.44
	CRM 20.5	19.78	3.64	9	14	25	NA	NA

[a]PCM = Poplar Creek mile; CRM = Clinch River mile; Control = a water-only treatment.
[b]The reference site for Poplar Creek was PCM 6.0; the reference site for Clinch River varied: CRM 22.0, 21.5, 21.2, and 20.5 were used.
[c]A water-only control treatment was not run during this test period.
NA = Not Applicable.

Table M9. *Daphnia magna* reproduction in the McCoy Branch and Walker Branch embayment sites

Test date	Site ID[a]	Reproduction: offspring per surviving female					Percent difference from reference
		Mean	SD	*n*	Min.	Max.	
6/7 - 6/21, 1994	Control	33.00	5.16	10	24	41	144.44
	MBM 0.2	12.67	2.67	9	8	19	-6.17
	MBM 0.4	14.90	2.26	10	10	18	10.37
	WBM 0.6[b]	13.50	2.65	8	10	17	NA
8/15 - 8/28, 1994	Control	83.83	20.45	6	71	129	93.65
	MBM 0.2	42.44	26.36	9	22	115	1.94
	MBM 0.4	59.14	27.63	7	34	119	36.63
	WBM 0.4[b]	43.29	16.76	7	22	72	NA

[a]MBM = McCoy Branch Embayment mile; WBM = Walker Branch Embayment mile; Control = a water-only treatment.
[b]The reference site for McCoy Branch was either Walker Branch Embayment site WBM 0.6 or WBM 0.4, as shown.
*Indicates sites in which survival differed from reference site survival by greater than or equal to 20%.
†Indicates sites in which survival was significantly different from the reference site ($\alpha = 0.05$; Tukey's test).
NA = Not Applicable.

Appendix N

BIOTA CHARACTERIZATION–SUPPORTING STUDIES

Table N1. Mean ± SE (N) concentrations (ppm, wet wt) of elements and Aroclor 1260[a] from homogenized fish[b] collected from great blue heron colonies located on[c] and off[d] the Oak Ridge Reservation (ORR)

	On ORR	Off ORR	P[e]
Mercury	0.06±0.02 (13)	0.02±0.00 (15)	0.030
Arsenic	0.30±0.05 (13)	0.23±0.03 (15)	0.238
Chromium	1.52±0.54 (12)	0.37±0.08 (15)	0.030
Aroclor 1260	0.20±0.04 (13)	0.15±0.03 (15)	0.269

[a]All congener concentrations were <20 ppb.
[b]Various fish species collected from active nest or stomachs of collected great blue heron chicks.
[c]Includes the K25 and Melton Hill colonies.
[d]Includes the Long Island and Looney Island colonies.
[e]T-test P value.

Table N2. Metal[a] concentrations (ppm, wet wt) detected in great blue heron eggs from colonies located on[b] and off[c] the Oak Ridge Reservation during 1992–1994

	On ORR	Off ORR	P[d]
Mercury			
Mean	0.17	0.12	0.009
SE	0.02	0.02	
Min	0.04	0.04	
Max	0.31	0.29	
N	24	34	
Chromium			
Mean	0.18	0.11	0.046
SE	0.03	0.01	
Min	0.05	0.06	
Max	0.84	0.21	
N	25	26	

[a]Arsenic was quantified in one egg at a concentration below the contract required detection limit.
[b]Includes K-25 colony.
[c]Includes Long Island and Looney Island colonies.
[d]T-test P value.

Table N3. Metal concentrations (Mean ±SE) detected in tissues collected from great blue heron chicks from colonies located on[a] (N=38) and off[b] (N=35) the Oak Ridge Reservation (ORR) during 1992–1994

	On ORR	Off ORR	P[c]
Mercury			
Feather	1.71±0.21	0.91±0.08	0.001
Liver	0.24±0.03	0.16±0.02	0.028
Muscle	0.08±0.01	0.09±0.02	0.655
Chromium			
Feather	0.96±0.17	1.16±0.19	0.429
Liver	1.49±0.48	1.26±0.49	0.739
Muscle	1.86±0.56	2.84±0.81	0.322
Arsenic			
Feather	0.10±0.01	0.10±0.01	0.977
Liver	0.13±0.03	0.12±0.02	0.771
Muscle	0.15±0.05	0.15±0.04	0.938

[a]Includes K25 and Melton Hill colonies.
[b]Includes Long Island and Looney Island colonies.
[c]T-test P value.

Table N4. Mean ± SE (N) Aroclor 1260 and congener concentrations[a] (ppm, wet wt) in great blue heron eggs collected from colonies located on[b] and off[c] the Oak Ridge Reservation (ORR)

	On ORR	Off ORR	p[d]
Aroclor 1260	1.68±0.48 (24)	0.27±0.08 (34)	0.008
CB 81	0.13±0.04 (16)	0.08±0.02 (26)	0.365
CB 99	0.09±0.03 (16)	0.02±0.01 (26)	0.030
CB 101	0.04±0.02 (16)	0.00±0.00 (26)	0.018
CB 118	0.17±0.04 (16)	0.08±0.02 (26)	0.062
CB 123	0.11±0.04 (16)	0.01±0.00 (26)	0.015
CB 138	0.29±0.05 (16)	0.14±0.03 (26)	0.025
CB 146	0.09±0.03 (16)	0.03±0.01 (26)	0.036
CB 149	0.09±0.05 (8)	0.03±0.01 (14)	0.288
CB 153	0.37±0.07 (16)	0.16±0.04 (26)	0.019
CB 158	0.04±0.02 (16)	0.06±0.02 (26)	0.128
CB 167	0.05±0.01 (16)	0.01±0.00 (26)	0.008
CB 170	0.09±0.02 (16)	0.04±0.01 (26)	0.012
CB 180	0.27±0.06 (16)	0.11±0.02 (26)	0.021
CB 183	0.06±0.01 (16)	0.02±0.00 (26)	0.020
CB 194	0.04±0.01 (16)	0.02±0.00 (26)	0.076
CB 196	0.07±0.02 (16)	0.03±0.01 (26)	0.059

[a]Concentrations of CBs 66, 76, 77, 95, 105, 110, 114, 126, 128, 132, 151, 156, 171, and 201 were <30 ppb and are not included.
[b]Includes the K25 colony.
[c]Includes the Long Island and Looney Island colonies.
[d]T-test P value.

Table N5. Mean ± SE (N) Aroclor 1260 and congener concentrations (ppm, wet wt) in abdominal fat from great blue heron chicks collected from colonies located on[a] and off[b] the Oak Ridge Reservation (ORR)

	On ORR	Off ORR	P[c]
Aroclor 1260	48.63±11.71 (16)	15.70±2.64 (24)	0.014
CB 66	1.21±0.75 (16)	0.23±0.03 (24)	0.210
CB 76	0.78±0.55 (16)	0.12±0.02 (24)	0.250
CB 77	0.27± 0.10 (16)	0.20±0.04 (24)	0.556
CB 81	1.54±0.44 (16)	1.28±0.30 (24)	0.761
CB 95	0.84±0.54 (16)	0.14±0.04 (24)	0.216
CB 99	2.70±1.36 (16)	0.56±0.15 (24)	0.138
CB 101	2.65±1.37 (16)	0.47±0.15 (24)	0.134
CB 105	0.73±0.36 (16)	0.13±0.02 (24)	0.115
CB 110	2.40±1.16 (16)	0.49±0.10 (24)	0.122
CB 114	0.07±0.04 (16)	0.00±0.00 (24)	0.999
CB 118	1.95±0.82 (16)	0.79±0.11 (24)	0.182
CB 123	2.53±1.09 (16)	0.63±0.11 (24)	0.102
CB 126	0.54±0.13 (16)	0.33±0.08 (24)	0.195
CB 128	0.95±0.37 (16)	0.19±0.02 (24)	0.058
CB 132	0.76±0.41 (16)	0.14±0.02 (24)	0.146
CB 138	5.13±1.44 (16)	1.70±0.23 (24)	0.032
CB 146	1.70±0.37 (16)	0.75±0.11 (24)	0.024
CB 149	2.76±0.54 (7)	1.04±0.24 (12)	0.018
CB 151	0.98±0.35 (16)	0.33±0.06 (24)	0.084
CB 153	6.24±1.35 (16)	2.47±0.45 (24)	0.016
CB 156	0.31±0.09 (16)	0.12±0.02 (24)	0.043
CB 158	0.19±0.14 (16)	0.21±0.08 (24)	0.905
CB 167	0.86±0.30 (16)	0.29±0.04 (24)	0.078
CB 170	1.57±0.34 (16)	0.54±0.07 (24)	0.010
CB 171	0.22±0.09 (16)	0.17±0.05 (24)	0.621
CB 180	4.27±0.95 (16)	1.37±0.25 (24)	0.009
CB 183	0.88±0.25 (16)	0.35±0.05 (24)	0.054
CB 194	0.63±0.12 (16)	0.38±0.05 (31)	0.078
CB 196	0.93±0.21 (16)	0.37±0.06 (24)	0.018
CB 201	0.53±0.11 (16)	0.22±0.03 (24)	0.012

[a]Includes the K-25 colony.
[b]Includes the Long Island and Looney Island colonies.
[c]T-test P value.

Table N6. Mean ± SE (N) Aroclor 1260 and congener concentrations[a] (ppm, wet wt) in liver tissue from great blue heron chicks collected from colonies located on[b] and off[c] the Oak Ridge Reservation (ORR)

	On ORR	Off ORR	P[d]
Aroclor 1260	0.77±0.23 (18)	0.23±0.03 (22)	0.029
CB 110	0.06±0.02 (18)	0.02±0.00 (22)	0.050
CB 118	0.05±0.02 (18)	0.01±0.00 (22)	0.049
CB 138	0.07±0.03 (18)	0.02±0.00 (22)	0.077
CB 149	0.06±0.03 (8)	0.02±0.00 (10)	0.209
CB 151	0.04±0.02 (18)	0.01±0.00 (22)	0.048
CB 153	0.10±0.03 (18)	0.03±0.00 (22)	0.017
CB 180	0.07±0.02 (18)	0.02±0.00 (22)	0.021

[a]Concentrations of CBs 66, 76, 77, 95, 99, 101, 105, 114, 123, 126, 128, 132, 146, 156, 158, 167, 170, 171, 183, 194, 196, and 201 were <30 ppb and are not included.
[b]Includes the K-25 colony.
[c]Includes the Long Island and Looney Island colonies.
[d]T-test P value.

Table N7. Mean ± SE (N) Aroclor 1260 and congener concentrations[a] (ppm, wet wt) in muscle tissue from great blue heron chicks collected from colonies located on[b] and off[c] the Oak Ridge Reservation (ORR)

	On ORR	Off ORR	P[d]
Aroclor 1260	1.05±0.25 (18)	0.35±0.08 (24)	0.015
CB 81	0.04±0.01 (18)	0.04±0.02 (24)	0.795
CB 110	0.06±0.02 (18)	0.01±0.00 (24)	0.027
CB 118	0.06±0.01 (18)	0.02±0.01 (24)	0.015
CB 138	0.09±0.02 (18)	0.04±0.01 (24)	0.033
CB 149	0.09±0.03 (8)	0.03±0.01 (12)	0.086
CB 153	0.16±0.03 (18)	0.05±0.01 (24)	0.009
CB 180	0.10±0.02 (18)	0.03±0.01 (24)	0.008

[a]Concentrations of CBs 66, 76, 77, 95, 99, 101, 105, 114, 123, 126, 128, 132, 146, 151, 156, 167, 170, 171, 183, 194, 196, and 201 were <30 ppb and are not included.
[b]Includes the K-25 colony.
[c]Includes the Long Island and Looney Island colonies.
[d]T-test P value, based on lipid adjusted concentrations.

Table N8. Reproductive, physiological, and biomarker measurements [Mean ± SE (N)] in great blue heron from colonies located on[a] and off[b] the Oak Ridge Reservation (ORR) during 1992–1994

	On ORR	Off ORR
Mean eggs/nest	3.5±0.2 (26)	3.2±0.2 (27)
Egg shell thickness (mm)	0.427±0.01 (33)	0.410±0.01 (34)
Egg weight (g)[c]	69.16±0.97 (33)	66.36±0.97 (34)
Mean chicks/nest	2.7±0.1 (55)	2.7±0.2 (30)
Chick weight/length ratio	2.06±0.05 (38)	2.12±0.06 (35)
Liver somatic index	4.50±0.16 (38)	4.64±0.23 (35)
Liver EROD activity[d]	31.9±2.7 (12)	41.3±3.2 (12)
DNA double-strandedness (F)[e]	73±0.03 (26)	84±0.02 (27)
Hematocrit	32±0.8 (38)	31±0.7 (26)

[a]Includes K-25 and Melton Hill colonies.
[b]Includes Long Island and Looney Island colonies.
[c]Means significantly different (T-test, P = 0.048).
[d]1994 data; ethoxyresorufin-o-deethylase activity (pmole/mq protein/min); means significantly different (T-test, P=0.033).
[e]Means signficantly different (T-test, P = 0.006), F = fraction of double-stranded DNA.

Table N9. Percent by weight of the most common fish species collected from the Oak Ridge Reservation (ORR) and Clinch River above Melton Hill Dam

Common name	ORR %	Weight Kg	Clinch River %	Weight Kg
Sucker	17	280	3	12
Carp	20	330	24	97
Catfish	15	248	13	53
Shad	7	116	6	24
Buffalo	17	280	42	170
Other species	24	396	12	49
Totals	100	1,650	100	405

Table N10. Mean mercury concentrations (ppm, wet wt) in homogenized fish[a] collected on the Oak Ridge Reservation[b] (ORR), Clinch River above ORR[c], and from the ocean[d] and diets fed to mink

	N[e]	Mean[f]	SE	Min	Max
Location					
On ORR	10	0.35[a]	0.03	0.17	0.43
Clinch River	10	0.07[b]	0.00	0.05	0.09
Ocean	10	0.03[c]	0.00	0.02	0.04
Diet					
A[g]	10	0.02[a]	0.00	0.02	0.03
B[h]	10	0.05[b]	0.00	0.04	0.06
C[i]	10	0.09[c]	0.00	0.08	0.11
D[j]	10	0.15[d]	0.01	0.12	0.18
E[k]	10	0.22[e]	0.01	0.16	0.24

[a]Various fish species.
[b]Poplar Creek between East Fork Poplar Creek and confluence with the Clinch River.
[c]Above Melton Hill Dam near Bull Run Power Plant.
[d]Mackerel purchased from commercial supplier.
[e]Number of aliquots analyzed.
[f]Means followed by different letters are significantly different, $P<0.05$.
[g]75% ocean fish, 25% ranch mink diet.
[h]75% fish collected from the Clinch River above ORR, 25% ranch mink diet.
[i]25% fish collected from Poplar Creek on ORR, 50% ocean fish, 25% ranch mink diet.
[j]50% fish collected from Poplar Creek on ORR, 25% ocean fish, 25% ranch mink diet.
[k]75% fish collected from Poplar Creek on ORR, 25% ranch mink diet.

Table N11. Mean[a] ± SE lipid adjusted Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in homogenized fish[b] collected on the Oak Ridge Reservation[c] (ORR), Clinch River above ORR[d], and from the ocean[e]

	Ocean	Clinch River	ORR
CB 77	0.022[a]±0.000 (10)	0.039[b]±0.001 (10)	0.190[c]±0.004 (10)
CB 81	0.053[a]±0.001 (10)	0.592[b]±0.062 (10)	1.419[c]±0.262 (9)
CB 99	0.022[a]±0.000 (10)	0.076[b]±0.011 (10)	0.894[c]±0.015 (10)
CB 101	0.022[a]±0.000 (10)	0.142[b]±0.022 (10)	0.609[c]±0.010 (10)
CB 118	0.022[a]±0.000 (10)	0.468[ab]±0.219 (10)	1.150[b]±0.030 (9)
CB 123	0.022[a]±0.000 (10)	0.039[ab]±0.001 (10)	0.051[b]±0.010 (10)
CB 126	0.022[a]±0.000 (10)	0.039[b]±0.001 (10)	0.041[b]±0.001 (10)
CB 128	0.022[a]±0.000 (10)	0.178[b]±0.003 (10)	0.636[c]±0.012 (10)
CB 138	0.022[a]±0.000 (10)	0.706[b]±0.014 (10)	1.611[c]±0.052 (9)
CB 146	0.022[a]±0.000 (10)	0.388[b]±0.007 (10)	0.822[c]±0.023 (10)
CB 151	0.039[a]±0.002 (10)	0.496[b]±0.008 (10)	1.731[c]±0.048 (10)
CB 153	0.074[a]±0.002 (10)	2.813[b]±0.082 (10)	4.733[c]±0.123 (9)
CB 156	0.022[a]±0.000 (10)	0.039[b]±0.001 (10)	0.078[b]±0.037 (10)
CB 167	0.022[a]±0.000 (10)	0.044[b]±0.003 (10)	0.193[c]±0.003 (10)
CB 170	0.022[a]±0.000 (10)	0.455[b]±0.010 (10)	1.315[c]±0.025 (10)
CB 171	0.022[a]±0.000 (10)	0.039[b]±0.001 (10)	0.041[b]±0.001 (10)
CB 180	0.022[a]±0.000 (10)	3.021[b]±0.099 (10)	3.592[c]±0.088 (10)
CB 183	0.022[a]±0.000 (10)	0.690[b]±0.012 (10)	1.000[c]±0.016 (10)
CB 189	0.022[a]±0.000 (10)	0.039[b]±0.001 (10)	0.041[b]±0.001 (10)
CB 194	0.022[a]±0.000 (10)	0.376[b]±0.009 (10)	0.430[c]±0.006 (10)
CB 195	0.022[a]±0.000 (10)	0.042[b]±0.002 (10)	0.043[b]±0.002 (10)
CB 196	0.022[a]±0.000 (10)	0.570[b]±0.014 (10)	1.660[c]±0.041 (10)
CB 201	0.022[a]±0.000 (10)	0.486[b]±0.009 (10)	0.605[c]±0.008 (10)
Aroclor 1260	0.379[a]±0.008 (10)	21.917[b]±0.681 (10)	28.997[c]±0.659 (10)

[a]Means with different superscripts are significantly different, $P<0.05$.
[b]Various fish species.
[c]Poplar Creek between East Fork Poplar Creek and confluence with the Clinch River.
[d]Above Melton Hill Dam near Bull Run Power Plant.
[e]Mackerel purchased from commercial supplier.
NOTE: Superscript letters within table do not correlate to the above footnotes; please refer to footnote *a*.

Table N12. Mean ± SE lipid adjusted Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in mink diets[a] (n=10/diet)

	Diet A	Diet B	Diet C	Diet D	Diet E
CB 77	0.025±0.000	0.037±0.001	0.046±0.003	0.102±0.002	0.116±0.005
CB 81	0.027±0.002	0.337±0.051	0.507±0.011	0.873±0.022	1.158±0.033
CB 99	0.025±0.000	0.037±0.001	0.276±0.011	0.531±0.014	0.520±0.013
CB 101	0.031±0.004	0.239±0.032	0.288±0.009	0.585±0.012	0.396±0.020
CB 118	0.025±0.000	0.117±0.010	0.192±0.007	0.405±0.007	0.668±0.021
CB 123	0.025±0.000	0.037±0.001	0.212±0.008	0.446±0.008	0.076±0.003
CB 126	0.025±0.000	0.037±0.001	0.027±0.001	0.038±0.003	0.033±0.001
CB 128	0.025±0.000	0.085±0.003	0.104±0.004	0.228±0.005	0.351±0.013
CB 138	0.080±0.002	0.791±0.087	0.331±0.011	0.690±0.009	1.048±0.020
CB 146	0.025±0.000	0.037±0.001	0.141±0.006	0.335±0.007	0.501±0.015
CB 151	0.025±0.000	0.314±0.010	0.254±0.009	0.555±0.009	1.058±0.039
CB 153	0.025±0.000	1.862±0.025	0.766±0.029	1.772±0.026	3.126±0.056
CB 156	0.025±0.000	0.139±0.013	0.065±0.002	0.094±0.015	0.033±0.001
CB 167	0.025±0.000	0.037±0.001	0.027±0.001	0.061±0.003	0.103±0.004
CB 170	0.025±0.000	1.847±0.964	0.154±0.007	0.346±0.008	0.798±0.016
CB 171	0.025±0.000	0.037±0.001	0.061±0.002	0.127±0.003	0.033±0.001
CB 180	0.025±0.000	1.011±0.266	0.507±0.019	1.091±0.018	2.292±0.040
CB 183	0.025±0.000	0.276±0.053	0.170±0.006	0.355±0.007	0.573±0.019
CB 189	0.025±0.000	0.037±0.001	0.027±0.001	0.031±0.000	0.033±0.001
CB 194	0.025±0.000	0.058±0.022	0.072±0.008	0.149±0.020	0.245±0.009
CB 195	0.025±0.000	0.039±0.003	0.027±0.001	0.033±0.002	0.033±0.001
CB 196	0.025±0.000	1.081±0.084	0.184±0.008	0.415±0.008	1.071±0.024
CB 201	0.025±0.000	0.230±0.034	0.060±0.002	0.131±0.003	0.338±0.010
Aroclor 1260	0.169±0.002	11.440±0.327	4.697±0.174	10.405±0.250	20.670±0.458

[a]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table N13. Mercury concentration (ppm, wet wt) in tissues from female mink fed (n=8/diet) various diets[1] and their 6-week-old kits

		Diet A	Diet B	Diet C	Diet D	Diet E
Adult female mink						
Liver Hg	Mean[2]	0.41[a]	0.61[a]	1.06[a]	1.93[b]	3.67[c]
	SE	0.07	0.06	0.10	0.15	0.32
	Range	0.17-0.8	0.47-0.87	0.74-1.49	1.26-2.47	2.52-5.20
Kidney Hg	Mean	0.84[a]	1.25[ab]	2.22[bc]	3.47[cd]	4.35[d]
	SE	0.13	0.18	0.35	0.52	0.34
	Range	0.25-1.46	0.53-1.96	1.24-4.22	2.38-7.00	3.33-6.25
Hair Hg	Mean	3.79[a]	7.43[b]	7.71[b]	13.44[c]	19.03[d]
	SE	0.26	0.55	0.63	0.79	0.57
	Range	2.20-4.61	5.05-9.70	4.38-9.62	10.2-15.6	16.8-21.4
Kits						
Carcass	Mean	0.02[a]	0.03[a]	0.05[a]		0.20[b]
	SE	0.004	0.003	0.003		0.02
	Range	0.01-0.05	0.02-0.05	0.04-0.06		0.10-0.30
	N	9	9	8		9
Kidney Hg	Mean	0.03[a]	0.03[a]	0.06[a]		0.19[b]
	SE	0.001	0.003	0.003		0.02
	Range	0.02-0.04	0.02-0.04	0.05-0.07		0.11-0.31
	N	9	9	8		9

[1]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.
[2]Means with different superscripts are significantly different, $P<0.05$.

Table N14. Mean ± SE lipid adjusted Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in liver tissue from female mink (n = 8/diet) for various diets[1]

	Diet A	Diet B	Diet C	Diet D	Diet E
CB 77	0.048±0.016	0.081±0.010	0.033±0.004	0.095±0.040	0.028±0.005
CB 81	0.048±0.016	0.054±0.010	0.033±0.004	0.095±0.040	0.197±0.117
CB 99	0.048±0.016	0.117±0.014	0.420±0.061	0.962±0.123	0.823±0.215
CB 101	0.048±0.016	0.053±0.011	0.033±0.004	0.145±0.019	0.154±0.015
CB 118	0.141±0.008	0.590±0.040	1.066±0.153	2.157±0.406	1.656±0.332
CB 123	0.048±0.016	0.041±0.006	0.033±0.004	0.095±0.040	1.598±0.228
CB 126	0.048±0.016	0.224±0.023	0.033±0.004	0.095±0.040	1.703±0.251
CB 128	0.048±0.016	0.174±0.023	0.151±0.024	0.353±0.054	0.691±0.097
CB 138	0.136±0.023	2.063±0.479	2.083±0.224	4.816±0.915	5.649±0.465
CB 146	0.059±0.015	0.627±0.051	0.545±0.055	1.188±0.113	0.604±0.111
CB 153	0.206±0.020	5.075±0.445	3.858±0.365	8.063±1.195	7.242±1.658
CB 156	0.048±0.016	0.228±0.074	0.193±0.037	0.480±0.102	0.648±0.102
CB 167	0.048±0.016	0.125±0.013	0.166±0.020	0.244±0.077	0.776±0.100
CB 170	0.057±0.015	2.249±0.219	0.774±0.144	1.971±0.444	1.878±0.194
CB 171	0.048±0.016	0.041±0.006	0.093±0.013	0.217±0.027	0.774±0.065
CB 180	0.131±0.015	6.576±0.772	3.117±0.390	6.980±1.296	7.752±0.815
CB 183	0.048±0.016	0.412±0.032	0.229±0.024	0.479±0.097	0.527±0.086
CB 189	0.048±0.016	0.044±0.007	0.042±0.007	0.137±0.038	0.106±0.013
CB 194	0.050±0.016	1.887±0.208	0.803±0.086	1.795±0.202	1.218±0.174
CB 195	0.048±0.016	0.041±0.006	0.192±0.018	0.457±0.035	0.115±0.015
CB 196	0.068±0.015	2.998±0.302	0.033±0.004	0.095±0.040	1.863±0.985
CB 201	0.048±0.016	2.085±0.261	0.245±0.084	1.448±0.459	2.794±0.356
Aroclor 1260	0.344±0.132	0.270±0.039	0.230±0.021	0.723±0.329	79.486±8.112

[1]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table N15. Mean ± SE Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in fat tissue from female mink (n=8/diet) fed various diets[1]

	Diet A	Diet B	Diet C	Diet D	Diet E
CB 77	0.011±0.005	0.035±0.006	0.046±0.006	0.083±0.019	0.138±0.011
CB 81	0.120±0.042	0.339±0.061	0.280±0.052	0.429±0.023	0.696±0.078
CB 99	0.050±0.018	0.169±0.029	0.786±0.168	1.447±0.265	1.708±0.272
CB 101	0.016±0.006	0.098±0.020	0.107±0.018	0.263±0.029	0.311±0.037
CB 118	0.163±0.066	0.464±0.089	1.461±0.276	2.943±0.388	3.175±0.299
CB 123	0.130±0.036	0.458±0.088	0.033±0.006	0.063±0.006	2.375±0.330
CB 126	0.064±0.029	1.171±0.212	0.196±0.032	0.481±0.035	1.511±0.160
CB 128	0.033±0.020	0.299±0.048	0.352±0.059	0.781±0.080	1.210±0.097
CB 138	0.267±0.135	2.800±0.609	3.464±0.638	9.543±1.036	9.925±0.833
CB 146	0.041±0.015	0.500±0.104	0.600±0.097	1.421±0.111	1.771±0.179
CB 153	0.405±0.230	5.538±1.069	5.195±0.988	15.714±1.686	15.375±1.349
CB 156	0.009±0.003	0.469±0.084	0.409±0.073	0.914±0.086	1.188±0.077
CB 167	0.040±0.019	0.350±0.055	0.621±0.109	1.347±0.126	1.500±0.125
CB 170	0.093±0.051	2.278±0.471	0.800±0.157	2.043±0.238	3.013±0.168
CB 171	0.035±0.017	0.521±0.093	0.488±0.086	1.083±0.100	1.393±0.084
CB 180	0.290±0.188	7.175±1.544	5.264±1.034	14.571±1.325	14.750±1.161
CB 183	0.019±0.012	0.559±0.102	0.368±0.069	0.899±0.073	1.114±0.143
CB 189	0.005±0.001	0.090±0.019	0.041±0.006	0.130±0.015	0.186±0.018
CB 194	0.060±0.035	2.103±0.475	0.918±0.174	2.386±0.201	2.688±0.351
CB 195	0.011±0.007	0.419±0.078	0.033±0.006	0.063±0.006	0.133±0.021
CB 196	0.021±0.014	0.778±0.163	0.426±0.091	1.064±0.105	1.645±0.295
CB 201	0.031±0.019	0.889±0.151	0.477±0.080	1.226±0.101	1.813±0.178
Aroclor 1260	3.169±1.849	61.250±12.560	0.261±0.044	105.86±11.26	128.63±7.73

[1]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table N16. Mean[1] ± SE Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in liver tissue from 6-week-old mink kits from dams fed diets of fish collected from various sources[2]

	Diet A	Diet B	Diet C	Diet E
CB 77	0.003±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 81	0.004±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.007±0.001 (9)
CB 99	0.003^{a}±0.000 (9)	0.006^{a}±0.001 (9)	0.016^{a}±0.005 (8)	0.049^{b}±0.012 (9)
CB 101	0.004±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 118	0.012^{a}±0.001 (9)	0.012^{a}±0.002 (9)	0.068^{b}±0.014 (8)	0.138^{c}±0.025 (9)
CB 123	0.008±0.001 (9)	0.007±0.000 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 126	0.003^{a}±0.000 (9)	0.007^{a}±0.001 (9)	0.007^{a}±0.001 (8)	0.014^{b}±0.003 (9)
CB 128	0.003^{a}±0.000 (9)	0.006^{a}±0.001 (9)	0.020^{a}±0.005 (8)	0.092^{b}±0.034 (9)
CB 138	0.015^{a}±0.002 (9)	0.058^{a}±0.011 (9)	0.141^{a}±0.033 (8)	0.547^{b}±0.200 (9)
CB 146	0.004^{a}±0.000 (9)	0.011^{a}±0.002 (9)	0.033^{a}±0.006 (8)	0.143^{b}±0.042 (9)
CB 151	0.004±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 153	0.011^{a}±0.002 (9)	0.065^{a}±0.010 (9)	0.157^{a}±0.039 (8)	0.509^{b}±0.137 (9)
CB 156	0.003±0.000 (9)	0.008±0.001 (9)	0.009±0.001 (8)	0.006±0.001 (9)
CB 167	0.004^{a}±0.000 (9)	0.007^{a}±0.001 (9)	0.009^{a}±0.002 (8)	0.028^{b}±0.007 (9)
CB 170	0.004^{a}±0.000 (9)	0.054^{a}±0.009 (9)	0.078^{b}±0.014 (8)	0.294^{b}±0.118 (9)
CB 171	0.003±0.000 (9)	0.008±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 180	0.006^{a}±0.001 (9)	0.109^{a}±0.018 (9)	0.194^{b}±0.040 (8)	0.629^{b}±0.235 (9)
CB 183	0.004^{a}±0.000 (9)	0.007^{a}±0.000 (9)	0.013^{a}±0.004 (8)	0.035^{b}±0.009 (9)
CB 189	0.003±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.008±0.002 (9)
CB 194	0.004^{a}±0.000 (9)	0.019^{a}±0.003 (9)	0.041^{b}±0.008 (8)	0.146^{b}±0.055 (9)
CB 195	0.003±0.000 (9)	0.006±0.001 (9)	0.007±0.001 (8)	0.006±0.001 (9)
CB 196	0.004^{a}±0.000 (9)	0.052^{a}±0.011 (9)	0.084^{b}±0.015 (8)	0.319^{b}±0.128 (9)
CB 201	0.003^{a}±0.000 (9)	0.014^{a}±0.002 (9)	0.027^{a}±0.005 (8)	0.142^{b}±0.032 (9)
Aroclor 1260	0.099±0.016 (9)	0.151±0.099 (9)	0.058±0.009 (8)	0.048±0.008 (9)

[1]Means with different superscripts are significantly different, $P \leq 0.05$.
[2]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table N17. Mean[1] ± SE Aroclor 1260 and PCB congener concentrations (ppm, wet wt) in carcass [2] of 6-week-old mink kits from dams fed diets of fish collected from various sources[3]

	Diet A	Diet B	Diet C	Diet E
CB 77	0.003±0.000 (9)	0.003±0.000 (9)	0.003±0.000 (8)	0.003±0.000 (9)
CB 81	0.003±0.000 (9)	0.003±0.000 (9)	0.003±0.000 (8)	0.005±0.001 (9)
CB 99	0.003^{a}±0.000 (9)	0.009^{a}±0.003 (9)	0.017^{a}±0.003 (8)	0.096^{b}±0.023 (9)
CB 101	0.003^{a}±0.000 (9)	0.004^{a}±0.001 (9)	0.006^{a}±0.001 (8)	0.017^{b}±0.002 (9)
CB 118	0.008^{a}±0.001 (9)	0.030^{a}±0.009 (9)	0.071^{a}±0.018 (7)	0.245^{b}±0.036 (9)
CB 123	0.003±0.000 (9)	0.011±0.005 (9)	0.003±0.000 (8)	0.008±0.001 (9)
CB 126	0.003±0.000 (9)	0.011±0.001 (9)	0.005±0.001 (8)	0.003±0.000 (9)
CB 128	0.003^{a}±0.000 (9)	0.011^{a}±0.004 (9)	0.012^{a}±0.002 (8)	0.054^{b}±0.007 (9)
CB 138	0.008^{a}±0.001 (9)	0.112^{a}±0.016 (9)	0.106^{a}±0.021 (7)	0.634^{b}±0.110 (9)
CB 146	0.003^{a}±0.000 (9)	0.013^{a}±0.002 (9)	0.019^{a}±0.003 (8)	0.103^{b}±0.017 (9)
CB 151	0.003±0.000 (9)	0.003±0.000 (9)	0.003±0.000 (8)	0.005±0.001 (9)
CB 153	0.009^{a}±0.001 (9)	0.141^{a}±0.024 (9)	0.119^{a}±0.025 (7)	0.619^{b}±0.096 (9)
CB 156	0.003^{a}±0.000 (9)	0.017^{ab}±0.003 (9)	0.022^{b}±0.003 (8)	0.058^{c}±0.008 (9)
CB 167	0.003^{a}±0.000 (9)	0.014^{bc}±0.002 (9)	0.010^{ab}±0.002 (8)	0.022^{c}±0.003 (9)
CB 170	0.003^{a}±0.000 (9)	0.073^{a}±0.012 (9)	0.047^{a}±0.007 (8)	0.238^{b}±0.036 (9)
CB 171	0.003^{a}±0.000 (9)	0.021^{a}±0.003 (9)	0.008^{a}±0.004 (8)	0.017^{b}±0.002 (9)
CB 180	0.004^{a}±0.000 (9)	0.203^{a}±0.026 (9)	0.121^{a}±0.019 (7)	0.611^{b}±0.080 (9)
CB 183	0.003^{a}±0.000 (9)	0.011^{a}±0.001 (9)	0.007^{a}±0.002 (8)	0.031^{b}±0.005 (9)
CB 189	0.003±0.000 (9)	0.003±0.000 (9)	0.003±0.000 (8)	0.008±0.001 (9)
CB 194	0.003^{a}±0.000 (9)	0.025^{a}±0.003 (9)	0.019^{a}±0.004 (8)	0.089^{b}±0.010 (9)
CB 195	0.003^{a}±0.000 (9)	0.003^{a}±0.000 (9)	0.004^{a}±0.001 (8)	0.023^{b}±0.003 (9)
CB 196	0.003±0.000 (9)	0.014±0.002 (9)	0.005±0.002 (8)	0.005±0.001 (9)
CB 201	0.003^{a}±0.000 (9)	0.013^{a}±0.002 (9)	0.012^{a}±0.002 (8)	0.050^{b}±0.009 (9)
Aroclor 1260	0.082±0.005 (9)	1.791±0.282 (9)	0.353±0.245 (8)	0.049±0.006 (9)

[1]Means with different superscripts are significantly different, $P<0.05$. Diet groups were separated based on lipid adjusted concentrations.
[2]Whole body minus liver tissue.
[3]Diet A = 75% ocean fish, Diet B = 75% fish collected above the OakRidgeReservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.

Table N18. Reproductive performance of female mink fed diets of 75% fish from various sources[1]

	Diet A	Diet B	Diet C	Diet D	Diet E
Females whelping	6	7	4	6	8
Female weights					
December[2]	1269±64[3]	1245±63	1374±64	1258±64	1230±64
June[4]	1168±84[a]	1016±81	1134±81	1020±81	935±81[b]
Gestation (days)	44.6	46.4	44.3	47.5	44.9
Kit Wts (6 wks)	328±14	311±10	333±20	307±12	295±11
Females	296±38				268±37
Males	376±42[a]				312±44[b]
Litter size[5]	6.9[a]	7.3[a]	7.8[a]	6.0[ab]	4.3[b]
EROD[6]	51±13[a]	134±26[ab]	124±32[ab]	276±33[b]	262.54±31[b]

[1]Diet A = 75% ocean fish, Diet B = 75% fish collected above the Oak Ridge Reservation, Diet C = 25% fish collected on the Oak Ridge Reservation and 50% ocean fish, Diet D = 50% fish collected on the Oak Ridge Reservation and 25% ocean fish, Diet E = 75% fish collected on the Oak Ridge Reservation.
[2]Beginning of study.
[3]Means followed by different superscripts are significantly different, $P<0.05$.
[4]End of study.
[5]Kits/female.
[6]Ethoxyresorufin-o-deethylase, pmoles/mg protein/min.

Table N19. Mean ± SE for bioindicators measured in female bluegill sunfish collected from various sites in the Clinch River, Poplar Creek, and Tennessee River

	CRM 1.0		CRM 20.0		PCM 1.0		TRM 570.0		TRM 555.0		CRM 125.0	
	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
EROD	4.78	0.82	8.18	1.62	4.25	0.92	7.74	1.34	5.67	0.85	4.70	0.37
MPRO	19.49	1.43	22.55	1.87	21.35	2.47	17.16	2.67	17.63	3.29	20.98	1.99
CDFC	1.84	0.03	1.92	0.04	1.95	0.06	1.95	0.05	1.88	0.05	1.85	0.04
LSI	1.43 B	0.08	1.29 B	0.06	1.76	0.09	1.48	0.07	1.37 B	0.08	1.64	0.07
VSI	3.76	0.09	2.62 B	0.13	3.05	0.14	4.09 B	0.20	3.74	0.19	3.30	0.20
VEIP	4.00	0.00	3.94	0.06	3.92	0.08	4.00	0.00	4.00	0.00	4.00	0.00
SSI	0.06	0.01	0.10 B	0.01	0.08 B	0.01	0.06	0.00	0.07	0.01	0.05	0.00
PSTO	95.00 B	5.00	24.69	5.73	28.75	9.54	72.50	7.48	79.58 B	10.84	47.31	7.59
PINT	33.00	6.02	45.31	5.01	25.00	6.48	42.92	5.62	20.42 B	3.04	41.92	6.78
LMACA	0.19	0.12	1.62 B	0.40	0.16	0.05	1.13 B	0.26	0.42	0.12	0.28	0.14
LPARS	3.45	2.24	1.28	0.79	9.20	6.04	1.48	0.59	2.88	1.90	0.00	0.00
SMACA	4.18	1.59	2.13	0.50	3.23	1.46	4.70	1.36	5.58	2.18	4.35	0.45
SPARS	0.43	0.43	1.93	1.93	8.73	8.73	0.00	0.00	1.75	0.74	0.00	0.00
LNPMA	0.58	0.38	1.25	0.60	0.12	0.07	2.95	0.92	0.50	0.33	0.25	0.25

Table N20. Mean ± SE for bioindicators measured in male bluegill sunfish collected from various sites in the Clinch River, Poplar Creek, and Tennessee River

	CRM 1.0		CRM 10.0		CRM 20.0		CRM 21.5		PCM 1.0		PCM 4 6		PCM 5.3		TRM 570.0		TRM 555.0		TRM 530.0		CRM 125.0	
	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
EROD	9.38	0.81	7.57	1.85	21.02 AB	2.95	11.34	2.80	13.20	1.57	19.53	6.21	16.19	1.78	11.77	1.95	11.72	2.64	8.11	2.96	9.44	1 79
MPRO	17.77 AB	1.21	13.46	1.13	15.70 A	0.88	15.14	0.66	14.12	1.16	16.37 A	0.65	15.69	0.83	16.02	1.66	18.49 AB	2.32	11.27	0.92	13 57	1.13
ALB	0.72 B	0.03	0.91	0.04	0.84	0 05	0.86	0.06	1.63 A	0.28	0.78	0.03	0.99	0.09	1.06 A	0.16	1.24 A	0.15	0 708 B	0 05	1.05 A	0 09
ALT	12.71	3.35	19.42	3.51	14.08	2.36	23.80	5.66	42.00 AB	5.71	8.64	1.36	10.00	2 34	31.40 A	8.05	32.46 A	5.85	11.25	1.38	23.63	4.67
AST	65.52	6.94	183.33 A	37.90	82.75	12.71	152.80	46.06	119.00	14 41	122.64	22.73	74.57	14.90	167.33	37.98	94.50	16.50	79.83	10.57	129.74	16.41
BPRO	2.34 B	0.10	2.83 B	0.12	3.03 B	0.15	3.04 B	0.09	3.74 A	0.28	2.78 B	0.10	3.37	0.11	2.72 B	0.14	3.96 A	0.21	2.90 B	0.14	3.83 A	0.25
BUN	1.24 AB	0.13	1.80 B	0.15	1.38 AB	0.14	0.89 AB	0.12	3.19	0.64	1.95 B	0.28	1.65 B	0.22	1.20 AB	0.25	2.74	0.26	2.41 B	0.19	3.47 A	0.38
CREAT	0.13	0.03	0.18	0.07	0.11	0.01	0.09	0.02	0.22 B	0.07	0.12	0.01	0.13	0.05	0.21	0.03	0.11	0.01	0.15	0.02	0.10	0.01
CDFC	1.99	0.04	1.93	0.06	2.10	0.05	2.00	0.04	2.13	0.04	1.88	0.03	1.75 B	0.02	2.05	0.03	1.95	0.04	1.96	0.06	1.97	0.05
LSI	0.98	0.06	0.80	0.06	1.12	0.08	0.99	0.09	1.06	0.08	0.89	0.06	0.88	0.03	0.86	0 04	0.91	0.07	1.08	0.08	0 99	0 05
VSI	4.23 B	0.13	3.73	0.21	3.251 A	0.15	3.22 A	0.19	3.20 A	0.09	4.29	0.22	3.68	0.10	3.92	0.16	3.45 A	0.15	4.26	0.20	3.67	0 13
VEIP	3.86	0.08	3.92	0.08	3.60	0.11	3.20 B	0.29	3.82	0.12	3.55	0.16	3.67	0.17	4.00 A	0.00	4.00 A	0.00	3.38	0.22	3.85	0.11
SSI	0.07	0.01	0.10 B	0.01	0.10 B	0.01	0.097 B	0.02	0.07	0.01	0.08	0.01	0.11 B	0.02	0.04	0.00	0.08	0.02	0 07	0.01	0.05	0.00
PSTO	45.91	9.94	18.75 A	9.05	25.21 A	5.25	4.50 AB	3 45	10.46 AB	7.02	17.73 A	6.01	10.56 AB	4.89	74.55	8 75	46.82	12.03	60.83	12.83	50.50	8.58
PINT	25.00 B	4.31	40.83	9.94	39.38	5.07	13.00 B	4.10	10.46 AB	3.72	15.91 B	6.21	40.56	11.56	40.46	7.15	31.36	5.40	42.08	8.71	52.75	6.92
BTRI	281.62 A	34.71	143.25 A	19.45	563.29 B	61.54	436.70	105.34	205.91 A	40.55	322.00	65.48	175 00 A	27.00	328.20	46 25	220.36 A	80.77	517.42	82 31	366.26	51.14
LMACA	0.20	0.09	0.69	0.19	0.28	0.11	0.27	0.09	0.46	0.22	1.92	1.67	0.90	0.60	0.26	0 11	0.58	0.27	0.35	0.20	0.35	0 08
LPARS	1.91	0.82	12.07 A	4.86	7.61	1.57	0.00	0.00	2.78	1.67	13 40 AB	4.53	10.13	2.71	0.22	0.14	1.58	1.58	0.48	0.44	3.24	1.42
SMACA	4.35	0.65	2.56	0.93	1.74	0.29	1.49	0.49	3.20	0.97	2.32	0.40	1.52	0.41	2.78	1.09	4.90	2.82	3.06	0.82	2.57	0.81
SPARS	1.32	0.74	2.51	1.43	4.02	1.64	1.11	1.03	4.16	2.97	4.46	2.01	7.26	2.87	2.82	1.74	0.00	0.00	1.26	0.86	1.72	1.11
LNPMA	0.74	0.38	2.01	1.22	0.72	0.27	0.37	0.24	1.06	0.57	1.84	1.18	2.43	2.03	7.98 AB	7.13	0.45	0.22	0.11	0 11	0.57	0.28

Table N21. Mean ± SE for bioindicators measured in female largemouth bass collected from various sites in the Clinch River, Poplar Creek, and Tennessee River

	CRM 1.0		CRM 10.0		CRM 20.0		CRM 21.5		PCM 1.0		PCM 4.6		PCM 5.3		TRM 570.0		TRM 555.0		TRM 530.0		CRM 125.0	
	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
EROD	3.10	0.59	8.80	1.48	13.45 B	3.11	7.73	1.34	13.41 B	2.03	27.61 B	10.31	28.14 B	9.22	5.94	1.66	3.15	0.52	11.40	5.86	2.53	0.30
MPRO	34.86	2.07	23.48 B	0.94	29.27 B	1.92	24.64 B	1.34	26.73 B	1.04	24.43 B	3.24	24.21 B	2.58	32.25	1.76	38.81 A	1.70	22.29 B	3.14	36.62 A	1.75
ALB	1.43	0.05	.	.	0.83	0.03	.	.	0.49	0.03	1.05	0.15	.	.	1.23	0.13	.	.	.	.	.	.
ALT	7.00	1.83	.	.	11.67	7.17	.	.	9.44	2.26	5.50	0.50	.	.	5.33	2.33	.	.	.	.	.	.
AST	31.00	5.67	.	.	45.33	32.90	.	.	30.67	8.58	42.00	1.00	.	.	52.00	36.02	.	.	.	.	.	.
BPRO	3.88	0.20	.	.	3.33	0.13	.	.	1.79	0.06	3.65	0.55	.	.	3.93	0.35	.	.	.	.	.	.
BUN	2.62	0.35	.	.	1.10	0.18	.	.	0.87	0.13	2.03	0.71	.	.	1.76	0.19	.	.	.	.	.	.
CREAT	0.20	0.05	.	.	0.26	0.04	.	.	0.21	0.01	0.26	0.01	.	.	0.11	0.01	.	.	.	.	.	.
CDFC	1.54 B	0.04	1.61 B	0.08	1.41	0.05	1.46 B	0.07	1.48 B	0.03	1.39	0.10	1.41	0.07	1.43 B	0.03	1.49 B	0.05	1.62 B	0.06	1.27 A	0.03
LSI	1.31	0.04	1.56 B	0.11	1.27	0.14	1.24	0.04	1.34	0.06	0.97 A	0.04	0.79 A	0.10	1.44 B	0.05	1.30	0.04	1.63 B	0.17	1.16 A	0.06
VSI	5.04 B	0.22	5.77 B	0.55	5.36 B	0.38	4.63 B	0.65	4.66 B	0.18	4.16	0.26	4.08	0.33	4.56 B	0.18	3.86	0 15	5.22 B	0.15	3.31 A	0.15
VEIP	1.64 B	0.12	2.10	0.25	2.50	0.21	2.25	0.25	2.62	0.16	3.07 A	0.39	3.00	0.27	2.91 A	0.17	3.25 A	0.17	1.50	0.29	2.74	0.28
SSI	0.09	0.01	0.10	0.01	0.16 B	0.05	0.10	0.02	0.10	0.01	0.07	0.01	0.14	0.04	0.09	0.01	0.11	0 02	0.11	0.02	0.08	0.01
PSTO	2.14	1.46	1.00	1.00	21.25	8.66	0.00	0.00	26.15 B	7.74	1.43	0.92	9.00	6.60	14.05	6.85	2.08	2.08	21.67	21.67	0.00	0.00
PINT	1.43	1.43	5.00	2.74	12.92	7.14 B	0.83	0.83	6.15	2.50	5.71	2.54	12.00	6.25	7.62	3.27	0.00	0 00	5.00	5.00	0.00	0.00
BTRI	348.25	48.40	.	.	381.67	153.04	.	.	138.00	17.24	205.50	43.50		.	477.00	170.56	.	.	.	.		.
LMACA	0.85	0.25	0.90	.	0.81	0.33	0.64	0.20	0.90	0.31	0.96	0.55	1.35	1 35	0.63	0.20	0.90	0.32	0.65	0 45	1.60	0.60
LPARS	0.13	0.09	0.00	.	0.83	0.28	0.40	0.40	1.08	0.44	1.16	1.02	0.00	0.00	0.28	0.21	0.26	0.26	0.00	0.00	0.03	0 03
SMACA	3.53	0.62	4.20	.	4.33	1.16	2.08	0.37	2.82	0.42	4.48	2.15	0.70	0.70	2.00	0.74	3.60	1.35	2.55	0.85	.	.
SPARS	0.80	0.80	9.60	.	1.91	1.70	0.62	0.43	4.78	3.41	3.88	1.58	8.35	8.35	8.66	7.56	2.00	1.85	0 00	0.00	.	.
LNPMA	1.03	0.65	0.70	.	0.84	0.30	0.20	0.13	0.51	0.20	1.04	0.38	0 85	0.85	0.41	0.18	0.00	0 00	0.05	0.05	0.30	0.30

Table N22. Mean ± SE for bioindicators measured in male largemouth bass collected from various sites in the Clinch River, Poplar Creek, and Tennessee River

	CRM 1.0		CRM 10.0		CRM 20 0		CRM 21 5		PCM 1 0		PCM 4 6		PCM 5 3		TRM 570 0		TRM 555 0		TRM 530 0		CRM 125 0	
	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
EROD	12.24	2.65	23.91 B	4.04	17.03	2.32	23.96	3.04	39 67 AB	5 32	43.68 AB	18.00	31.73	.	11.19	2.78	6.68	1.49	17.05	3.06	9.64	1.64
MPRO	22.00 A	1.47	14.36	1.19	24.77 A	1.84	16.59	1.43	21.08 A	1.03	15.94	4.78	25.78	.	16.55	1.80	26.37 AB	1.33	12.38 B	1.25	19.59 A	1.06
ALB	1.05	0.02	0.97	0.06	0.85 B	0.03	0.90	.	0.91	0.04	1.00	0.10	.	.	1.02	0 02	1.18 A	0.04	0.93	0.04	1.04	0.05
ALT	10.79 A	2.25	12.11	2.70	19.44	9.60	15.00	.	9.13	3.18	4.50	1.50	.	.	7.06 A	2.07	5.60 A	1.63	26.33 B	6.73	10.05 A	2.63
AST	59.58	7.89	65.33	16.09	70.44	25.57	42.00	.	36.13	11.66	46.00	23.00	.	.	65.06	18.85	30.50	4.06	89.67	24.53	37.84	10.25
BPRO	4.24	0.13	3.87	0.31	3.44 AB	0.13	4.10	.	3.83 A	0.32	3.75	0.45	.	.	4.04	0.13	4.68	0.14	4.67	0.15	4.25	0.14
BUN	1.48	0.16	1.70	0.27	1.89	0.25	0.95	.	2.29	0.43	2.61	0.67	.	.	1.66	0.21	2.69	0.31	1.67	0.13	1.90	0.16
CREAT	0.20	0.02	0.18	0.03	0.20	0.03	0.25	.	0.30 AB	0.08	0.25	0.09	.	.	0.18	0.01	0.26 AB	0.03	0.12	0.02	0.12	0.01
CDFC	1.47 B	0.03	1.40	0.03	1.34 A	0.05	1.32	0.16	1.42 B	0.03	1.44	0.03	1.34	.	1.45 B	0.04	1.35 A	0.05	1.53 B	0.04	1.27 A	0.01
LSI	0.79 A	0.04	1.42 B	0.14	0.90 A	0.08	0.80 A	0.12	0.97 A	0.09	1.07	0.23	0 49 A	.	1.25 AB	0.09	0.77 A	0.06	1.62 B	0 16	0.70 A	0.04
VSI	5.24 B	0.25	5.00 B	0.40	4.94 B	0.39	4.42	1.51	5.25 B	0.30	4 24	0.67	3.50	.	5.27 B	0.24	4.29 B	0.17	5.14 B	0.23	3.12 A	0.12
VEIP	1.66	0.14	1.85	0.17	2.12	0.22	2.75	1.25	1.75	0.15	2.00	0.50	4.00 A	.	2.21	0.18	3.10 AB	0.27	1.50	0.17	2 15	0 20
SSI	0 13	0.02	0.14	0.01	0.16 B	0.03	0.14	0.08	0.11	0.02	0.07	0.01	0.04	.	0.12	0.01	0.10	0.01	0.14	0.01	0.09	0.01
PSTO	0.00	0.00	0.50	0.50	2.69	2.69	32.50	32.50	6.50	6.50	2.50	2.50	0.00	.	18.53	8.47	20.00	13 33	10 00	9 39	0.00	0 00
PINT	0.00	0.00	2.00	1.53	1 15	1.15	17.50	17 50	2.00	1.53	2.50	2.50	0 00	.	6.47	2.87	10 00	10 00	3.33	1.67	2.75	1 87
BTRI	220.21 B	30.47	204.78	26 61	216.11 B	79.76	1210.00 AB	.	354.88 B	83 22	138.00	30 00	.		211 77 B	26.68	189.20	39 65	219 56 B	25 08	68.11 A	4 96
LMACA	2.02 AB	0.69	0.41	0.12	0.33	0.16	0.65	0.15	0.71	0.28	0 10	0.10		.	0.30	0.08	0.80	0 26	0.26	0.14	0.54	0 11
LPARS	0.64	0.38	2.49 AB	1.13	0.77	0.35	0.00	0.00	0.13	0.08	0.30	0.10	.		1.31	0.73	0.00	0.00	0.00	0.00	0.08	0 07
SMACA	3 82	0.87	2.38	0 44	3 43	0 59	1.10	0.50	3.43	0 90	1 40	0 30	.		2 60	0 65	5 08	1 83	2.68	0.84	5.03	0.88
SPARS	0.95	0.73	5 89	2 91	0.50	0.47	0.00	0.00	3.40	1.72	24 20 AB	12 70	.	.	9 18 AB	3 71	0.43	0.39	0 24	0.24	0.16	0 16
LNPMA	1.06	0.52	1.46	0 41	1.40	0.96	1 05	0.75	0 49	0.20	0.00	0 00		.	0 69	0 39	0.00	0 00	1 04	0.51	0.29	0 19

Table N23. Relative rankings of the severity of histopathological lesions in the liver and spleen of bluegill sunfish at collection sites in the Clinch River, Poplar Creek, and the reference site, Norris Reservoir (CRM 125). The overall rank for each site is the average of all liver and spleen lesions at that site. Lower ranks represent higher lesion rate.

	CRM 125	CRM 21.5	CRM 20.0	CRM 10.0	CRM 1.0	TRM 530	PCM 5.3	PCM 4.6
Liver								
Glycogen depletion	7	6	8	3	4	5	1.5	1.5
Vacuolated hepatocytes	2.5	4	8	2.5	5	6	1	7
Macrophage aggregates	4	1	8	2	3	6	5	7
Focal necrosis	3.5	1	5	6	7.5	7.5	3.5	2
Granulomas	0	0	1	0	0	0	0	0
Parasites	5	6	3	4	7	8	2	1
Spleen								
Macrophage aggregates	8	7	4	5	6	1	2.5	2.5
Parasites	5	7	2	6	1	8	3.5	3.5
Total	4.4	4.4	4.88	3.6	4.2	5.56	2.3	3.06
Overall rank	6	4	7	3	5	8	1	2

Table N24. Relative rankings of the severity of histopathological lesions in the liver and spleen of largemouth bass at collection sites in the Clinch River, Poplar Creek, Tennessee River, and the reference site, Norris Reservoir (CRM 125). The overall rank for each site is the average of all liver and spleen lesions at that site. Lower ranks represent higher lesion rate.

	CRM 125	CRM 21.5	CRM 20.0	CRM 10.0	CRM 1.0	TRM 570	TRM 530	PCM 5.3	PCM 4.6	PCM 1.0
Liver										
Glycogen depletion	5.5	2	5.5	10	5.5	9	7	5.5	1	8
Vacuolated hepatorytes	3	5	7.5	4	2	7.5	7.5	7.5	1	7.5
Macrophase aggregates	9	10	7.5	5	3	1	7.5	4	6	2
Focal necrosis	7.5	3	2	7.5	7.5	7.5	7.5	7.5	1	7.5
Granulomas	9.5	2	1	5	3	6	7	9.5	4	8
Parasites	8.5	6	1	5	8.5	3	2	4	7	8.5
Spleen										
Macrophase aggregates	1	9	2	3	4	8	7	10	6	5
Focal necrosis	8.5	3.5	9	2	8.5	6	10	1	3.5	7
Granulomas	6	4	1.5	5	3	8	9.5	7.5	1.5	7
Parasites	10	8	7	2.5	6	5	9	2.5	2.5	4
Total	6.85	5.30	4.40	4.90	5.10	6.10	7.40	5.1	3.35	6.45
Overall rank	9	6	2	3	4.5	7	10	4.5	1	8

Table N25. Reproductive status of male largemouth bass collected at the beginning of the 1993 breeding season from sites in Poplar Creek, Clinch River, Tennessee River, and Norris Lake

Site[a]	GSI[b]	Plasma testosterone (pg/mL)	Plasma estradiol (pg/mL)	Testes stage[c]
CRM 125	0.586±0.046 (9)	2441±662 (9)	89±39 (9)	4.1±0.1 (9)
PRM 30	0.534±0.035 (11)	2056±652 (11)	162±48 (11)	4.0±0 (11)
PCM 1	0.409±0.058 (5)	1071±476 (5)	50±0 (5)	4.0±0 (5)
CRM 20	0.439±0.050 (8)	1240±438 (8)	327±42 (8)	4.1±0.1 (8)
CRM 0.5	0.483±0.028 (13)	1971±348 (13)	292±47 (13)	3.9±0.1 (13)
TRM 570	0.463±0.023 (10)	2581±343 (10)	50±0 (10)	4.1±0 (10)
TRM 557	0.451±0.032 (10)	2015±494 (10)	170±49 (10)	4.0±0.1 (10)

[a]CRM = Clinch River mile, PRM = Powell River (Norris Lake) mile, PCM = Poplar Creek mile, and TRM = Tennessee River mile
[b]GSI = Gonadal-Somatic Index ([gonad wt./body wt.]*100)
[c]Stage 0 = no obvious germ cell tissue; stage 1 = primarily spermatogonia (may be some degenerating sperm); stage 2 = spermatogonia and spermatocytes; stage 3 = some spermatids and spermatozoa present as well; stage 4 = tubules filled with sperm, still active spermatogenesis; stage 5 = only sperm and possibly scattered spermatogenic cysts

Table N26. Reproductive status of female largemouth bass collected at the beginning of the 1993 breeding season from sites in Poplar Creek, Clinch River, Tennessee River, and Norris Lake

Site[a]	GSI[b]	Atretic[c] oocytes (oocytes/g)	Ovary parasites (cysts/g)	Vitellogenic oocytes (oocytes/g)	Batch[d] fecundity (oocytes/g)	Fecundity[e] (oocytes/g)	Plasma estradiol (pg/mL)	Plasma testosterone (pg/mL)
CRM125	4.90±0.47 (14)	1.29±0.40 (14)	0 (14)	60.2±10.7 (14)	22.3 ±2.7 (10)	58.1 ±10.6 (14)	4600±552 (14)	4635±1455 (14)
PRM 30	4.41±0.24 (12)	0.70±0.22 (12)	0 (12)	55.3±3.9 (12)	17.0 ±1.7 (12)	56.1 ±3.2 (12)	5810±1062 (12)	5454±942 (12)
PCM 1	4.20±0.62 (17)	2.20±1.39 (15)	0.01±0.01 (15)	59.2±12.1 (15)	18.1 ±2.9 (8)	44. 2±6.5 (15)	4082±1088 (15)	4103±1065 (15)
CRM 20	4.65±0.63 (5)	8.18±4.33 (5)	0 (5)	41.5 ±5.2 (5)	16.0 ±0.6 (4)	46.1 ±7.2 (5)	2041±756 (5)	3892±2648 (5)
CRM 0.5	6.34±0.70 (10)	0.98±0.53 (10)	0 (10)	54.9 ±6.9 (10)	17.2 ±2.7 (9)	57.0 ±6.1 (10)	2962±376 (10)	1063±119 (10)
TRM 570	6.42±0.34 (18)	0.84±0.22 (18)	0 (18)	60.6 ±3.6 (18)	17.0 ±1.4 (13)	60.0 ±2.3 (18)	3729±404 (18)	5479±1070 (14)
TRM 557	7.23±0.52 (8)	1.27±0.23 (8)	0 (8)	55.4 ±4.1 (8)	16.6 ±1.6 (6)	56.3 ±2.6 (8)	3704±818 (8)	3758±1297 (8)

[a]CRM = Clinch River mile, PRM = Powell River (Norris Lake) mile, PCM = Poplar Creek mile, and TRM = Tennessee River mile
[b]GSI = Gonadal-Somatic Index ([gonad wt./body wt.]*100)
[c]Atretic oocytes are dead and/or reabsorbing oocytes
[d]Batch fecundity is the enumeration of obviously maturing oocytes, mature eggs, and/or shed follicles in fish collected immediately prior to or during a spawn
[e]Fecundity is the enumeration of all oocytes and/or shed follicles in an ovary regardless of gamete developmental stage

Table N27. Reproductive status of male bluegill sunfish collected at the beginning of the 1993 breeding season from sites in Poplar Creek, Clinch River, Tennessee River, and Norris Lake

Site[a]	GSI[b]	Plasma testosterone (pg/mL)	Plasma estradiol (pg/mL)	Testes stage[c]	Testes composition[d]			
					Spermatagonia	Spermatocytes	Sperm	Duct
CRM 125	0.993±0.230 (10)	2399±550 (10)	71±22 (10)	3.6±0.2 (10)	0.47±0.30 (10)	8.37±1.90 (10)	3.07±0.68 (10)	0.43±0.09 (10)
CRM 0.5	0.616±0.138 (12)	1529±298 (11)	50±0 (11)	3.3±0.2 (12)	0.31±0.18 (12)	7.81±0.69 (12)	1.47±0.32 (12)	0.31±0.09 (12)
PRM 30	0.979±0.277 (10)	3777±906 (10)	50±0 (10)	3.7±0.1 (10)	0.63±0.25 (10)	7.67±1.48 (10)	3.40±0.65 (10)	0.30±0.12 (10)
TRM 570	1.000±0.131 (11)	3829±805 (10)	50±0 (10)	3.6±0.1 (11)	0.09±0.06 (11)	11.00±1.02 (11)	2.42±0.41 (11)	0.27±0.15 (11)
PCM 1	1.353±0.096 (11)	5475±5712 (10)	65±11 (10)	3.7±0.1 (11)	0.03±0.03 (11)	12.15±0.69 (11)	3.61±0.44 (11)	0.55±0.23 (11)
TRM 557	1.244±0.185 (11)	5430±928 (11)	192±52 (11)	3.7±0.1 (11)	0.15±0.15 (11)	9.39±0.53 (11)	3.55±0.48 (11)	0.06±0.06 (11)
CRM 20	0.748±0.125 (13)	3837±693 (12)	155±55 (12)	3.4±0.2 (13)	0.56±0.24 (13)	8.97±1.30 (13)	2.23±0.50 (13)	0.18±0.08 (13)

[a]CRM = Clinch River mile, PRM = Powell River (Norris Lake) mile, PCM = Poplar Creek mile, and TRM = Tennessee River mile
[b]GSI = Gonadal-Somatic Index ([gonad wt./body wt.]*100)
[c]Stage 0 = no obvious germ cell tissue; stage 1 = primarily spermatogonia (may be some degenerating sperm); stage 2 = spermatogonia and spermatocytes; stage 3 = some spermatids and spermatozoa present as well; stage 4 = tubules filled with sperm, still active spermatogenesis; stage 5 = only sperm and possibly scattered spermatogenic cysts
[d]mean relative units occupied by various spermatogenic stages measured along the diameters of three cross-sections through a testis

Table N28. Reproductive status of female bluegill sunfish collected at the beginning of the 1993 breeding season from sites in Poplar Creek, Clinch River, Tennessee River, and Norris Lake

Site[a]	GSI[b]	Atretic[c] oocytes (oocytes/g)	Ovary parasites (cysts/g)	Vitellogenic oocytes (oocytes/g)	Batch[d] fecundity (oocytes/g)	Plasma estradiol (pg/mL)	Plasma testosterone (pg/mL)
CRM 125	6.36±0.77 (13)	0.36±0.12 (13)	0.06±0.05 (13)	168±17(13)	143±14 (12)	4633±987 (11)	3449±1379 (11)
CRM 0.5	7.21±0.95 (10)	3.51±1.09 (10)	0 (10)	162±15 (10)	129±8 (10)	2051±394 (10)	2221±553 (10)
PRM 30	7.48±0.50 (12)	0.52±0.35 (12)	0.12±0.09 (12)	153±10 (12)	127±10 (12)	2877±554 (12)	1958±328 (12)
TRM 570	7.94±0.81 (12)	2.33±0.97 (12)	0 (12)	172±13 (12)	126±8 (11)	3579±663 (11)	4850±1196 (11)
PCK 1.0	9.87±1.20 (12)	4.47±1.97 (12)	0.36±0.14 (12)	225±27 (12)	155±16 (12)	1682±362 (12)	1472±349 (12)
TRM 557	7.80±0.98 (12)	1.07±0.48 (12)	0.05±0.05 (12)	154±19 (12)	121±13 (12)	2958±775 (12)	918±175 (12)
CRM 20	7.64±0.89 (16)	2.71±1.41 (16)	0 (16)	163±13 (16)	135±8 (15)	3433±559 (16)	3274±684 (16)

[a]CRM = Clinch River mile, PRM = Powell River (Norris Lake) mile, PCM = Poplar Creek mile, and TRM = Tennessee River mile
[b]GSI = Gonadal-Somatic Index ([gonad wt./body wt.]*100)
[c]Atretic oocytes are dead and/or reabsorbing oocytes
[d]Batch fecundity is the enumeration of a clutch of simultaneously developing oocytes, mature eggs, and/or shed follicles

Table N29. Total number of analyses, detectable results, minimum, maximum, mean, standard error, and upper 95% confidence bound for the 44 PCB congeners analyzed from fish tissue samples

ANALYTE	N	# DETECTS	MIN	MAX	MEAN	STDERR	UCB
PCB169T	326	1	0.010	0.01	0.010000	.	.
PCB018T	326	3	0.010	0.01	0.010000	0.000000	0.010000
PCB166T	326	3	0.010	0.07	0.010337	0.000293	0.010820
PCB076T	326	9	0.010	0.01	0.010000	0.000000	0.010000
PCB070T	326	21	0.005	0.01	0.005919	0.000292	0.006402
PCB167T	326	22	0.010	0.05	0.010337	0.000156	0.010594
PCB157T	326	38	0.005	0.20	0.007745	0.000816	0.009092
PCB126T	326	54	0.006	0.07	0.009411	0.000738	0.010628
PCB028T	326	61	0.010	0.01	0.010000	0.000000	0.010000
PCB031T	326	61	0.010	0.01	0.010000	0.000000	0.010000
PCB189T	326	61	0.005	0.02	0.006681	0.000230	0.007061
PCB044T	326	69	0.005	0.03	0.007290	0.000464	0.008056
PCB037T	326	91	0.005	0.04	0.007697	0.000402	0.008359
PCB158T	326	92	0.005	0.07	0.009763	0.000618	0.010782
PCB049T	326	98	0.005	0.07	0.010318	0.000537	0.011204
PCB195T	326	98	0.005	0.05	0.007730	0.000623	0.008758
PCB201T	326	99	0.005	0.10	0.011694	0.000770	0.012965
PCB128T	326	111	0.005	0.08	0.010798	0.000704	0.011959
PCB052T	326	113	0.006	0.10	0.012096	0.000710	0.013266
PCB099T	326	113	0.009	0.45	0.030291	0.002820	0.034943
PCB146T	326	129	0.006	0.11	0.015337	0.000946	0.016898
PCB194T	326	129	0.005	0.06	0.009824	0.000444	0.010556
PCB151T	326	142	0.006	0.11	0.014018	0.000834	0.015394
PCB183T	326	148	0.007	0.11	0.014356	0.000871	0.015792
PCB170T	326	169	0.007	0.20	0.013644	0.001027	0.015339
PCB101T	326	170	0.005	0.32	0.021701	0.001646	0.024416
PCB196T	326	194	0.006	0.10	0.014977	0.000893	0.01645
PCB114T	326	195	0.005	0.12	0.016226	0.000869	0.017658
PCB118T	326	213	0.005	0.30	0.030539	0.002131	0.034054
PCB138T	326	224	0.007	0.58	0.040282	0.003832	0.046603
PCB105T	326	261	0.006	0.05	0.009742	0.000218	0.010101
PCB095T	326	264	0.005	0.14	0.013320	0.000720	0.014508
PCB180T	326	269	0.01	0.40	0.045491	0.003435	0.051156
PCB087T	326	279	0.005	0.21	0.011701	0.000777	0.012983
PCB153T	326	283	0.01	0.48	0.055433	0.004337	0.062586
PCB171T	326	287	0.005	0.13	0.012910	0.000635	0.013958
PCB077T	326	293	0.006	0.35	0.024301	0.001880	0.027402
PCB081T	326	300	0.005	0.20	0.013337	0.000846	0.014734
PCB156T	326	302	0.005	0.09	0.013332	0.000586	0.014298
PCB066T	326	304	0.005	0.04	0.010675	0.000237	0.011065
PCB149T	326	307	0.005	0.12	0.015331	0.000819	0.016682
PCB123T	326	308	0.005	0.20	0.018597	0.001241	0.020644
PCB110T	326	310	0.006	0.18	0.021557	0.001283	0.023672
PCB132T	326	313	0.006	0.10	0.010176	0.000283	0.010644

Table N30. Summary of PCB congener detection percentage for catfish from 11 site/year samples in Watts Bar Reservoir

Congener	Fall 1992				Spring 1993		Fall 1993				Spring 1994
	CRM 1	PCM 1	TRM 545	TRM 570	CRM 1	CRM 20	CRM 10	CRM 1	PCM 5.3	TRM 530	CRM 10
PCB018T	.	.	.	.	.	.	.	.	.	.	.
PCB028T	o	o	o	o	.	.	.	.	.	.	.
PCB031T	o	o	o	o	.	.	.	.	.	.	.
PCB037T	-	.	.	-	+	+	.	-	.	-	.
PCB044T	-	.	.	.	+	+	.	.	.	.	.
PCB049T	-	.	.	.	-	-	.	-	-	+	.
PCB052T	-	-	.	.	-	+	.	-	-	-	.
PCB066T	+	o	+	+	o	o	o	o	o	o	o
PCB070T	.	.	.	.	.	.	.	.	.	.	.
PCB076T	.	.	.	.	.	.	.	.	.	.	.
PCB077T	+	o	o	-	o	o	o	o	o	o	o
PCB081T	+	+	+	+	o	o	o	o	o	o	o
PCB087T	-	-	.	.	o	o	o	o	o	o	o
PCB095T	+	+	-	-	+	+	o	o	o	o	o
PCB099T	o	o	o	-	.	.	.	.	.	.	.
PCB101T	+	+	+	-	.	.	o	o	o	o	-
PCB105T	.	-	.	.	o	o	o	o	o	o	o
PCB110T	o	o	o	o	o	o	o	o	o	o	o
PCB114T	o	+	o	o	+	o	-	+	o	o	-
PCB118T	o	o	o	-	-	o	+	o	o	o	+
PCB123T	o	+	+	o	o	o	o	o	o	o	o
PCB126T	-	-	.	.	-	+	.	-	.	+	.
PCB128T	+	+	+	.	-	-	-	+	-	o	.
PCB132T	o	o	o	o	o	o	o	o	o	o	o
PCB138T	o	o	+	-	o	o	o	o	o	o	.
PCB146T	+	+	+	-	.	+	+	o	o	o	.
PCB149T	o	o	+	+	o	o	o	o	o	o	o
PCB151T	+	+	+	-	-	o	-	o	o	o	
PCB153T	o	o	o	o	o	o	o	o	o	o	+
PCB156T	o	+	o	o	o	o	o	o	o	o	o
PCB157T	+	-	+	+	.	.	.	.	.	-	.
PCB158T	-	+	.	.	-	+	-	+	-	o	.
PCB166T	.	.	.	.	.	.	.	.	.	.	.
PCB167T	.	.	.	.	.	-	.	.	.	o	.
PCB169T	.	.	.	.	.	.	.	.	.	.	.
PCB170T	o	o	o	+	o	o	.	.	.	.	.
PCB171T	o	-	+	+	o	o	o	o	o	o	o
PCB180T	o	o	o	-	o	o	o	o	o	o	+

"o"= detected in >75% of samples
"+" = detected in 50-74% of samples
"- " = detected in 25-49% of samples
"." = detected in 0–24% of samples

Table 30 (continued).

Congener	Fall 1992				Spring 1993		Fall 1993				Spring 1994
	CRM 1	PCM 1	TRM 545	TRM 570	CRM 1	CRM 20	CRM 10	CRM 1	PCM 5.3	TRM 530	CRM 10
PCB183T	+	+	+	-	+	o	+	+	o	o	-
PCB189T	-	.	+	-	-	+	.	.	.	o	.
PCB194T	o	o	o	+	.	-	.	-	-	o	.
PCB195T	o	o	o	-	.	.	-	-	.	+	.
PCB196T	o	o	o	-	+	o	-	+	o	o	-
PCB201T	-	+	-	-	-	+	-	+	+	o	.

"o"= detected in >75% of samples
"+" = detected in 50-74% of samples
"– " = detected in 25-49% of samples
"." = detected in 0–24% of samples

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