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JAMES E. WORD
COMMISSIONER

NOV 12 1985

The pilot survey, conducted by Tennessee Department of Health and Environment with assistance of Center for Disease Control, to document body levels of mercury and assess the immediate health risk to persons exposed to mercury contaminated soil and fish, is reported in the attached document.

We are happy that there is no indication of increased health risk to the presumably exposed population. Results of the fish studies, still in progress, will assist in final determination about fish ingestion.

I trust this information will be useful to you.

James E. Word
Commissioner
Tennessee Department of Health and Environment

#403

A Pilot Survey of Mercury Levels in Oak Ridge, Tennessee

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SUMMARY

Between 1953 and 1977, as a result of activities at the Department of Energy Y12 plant in Oak Ridge, Tennessee, an estimated 220,000 to 470,000 pounds of mercury were discharged into East Fork Poplar Creek (EFPC), which traverses the city of Oak Ridge. The Tennessee Department of Health and Environment (TDHE) was concerned about the potential health risk from human exposure to mercury-contaminated soil and possibly contaminated fish. In June-July 1984, TDHE and the Centers for Disease Control conducted a pilot study to document human body levels of mercury at a time when exposure was likely to occur and to determine whether exposure to mercury-contaminated soils or consumption of fish presumed to be contaminated with mercury constituted an immediate health risk to the Oak Ridge population. Histories of exposure to mercury-contaminated soil and/or fish were collected on 2,627 residents and city workers. Urinary mercury concentrations were measured for 79 of the sample population with the highest exposure to soil and for 99 of those with the lowest exposure; hair mercury was measured for 11 people with a history of eating locally caught fish and for 46 with no history of ingestion. Adjusted mean urine mercury concentrations and mean hair mercury concentrations were not significantly different for presumably exposed and unexposed populations. It is unlikely that residents and city workers now exposed to contaminated soil are at risk for developing significantly higher mercury levels than unexposed populations. Urine and hair mercury concentrations were not at levels associated with known health risks. Final results of fisheries studies being conducted by the Oak Ridge Task Force will, however, assist in determining whether consumption of large amounts of locally caught fish is a potential health risk.

BACKGROUND

In Oak Ridge, Tennessee, the facilities of the U.S. Department of Energy (DOE) include the Y12 Plant that was operated by the Union Carbide Company from 1944-1983. During the period 1953-1963 the plant was involved in a lithium separation process that used elemental mercury to produce lithium deuteride fuel for thermonuclear weapons (1). The total amount of mercury used at the plant remains classified. However, it is known that activities involving mercury continued until 1977. At that time DOE's Oak Ridge Operations Office completed a report of mercury inventory at the Y12 plant. A declassified copy of the report was released in 1983. This report showed that between 1944 and 1977, as a result of activities conducted at the Y12 facility, an estimated 2.4 million pounds of mercury were spilled, unaccounted for or lost to the environment (2). Radionuclides, PCBs, and other chemicals were discharged with the mercury releases (1).

DOE has estimated that 220,000 to 470,000 pounds of the 2.4 million pounds of mercury were discharged into East Fork Poplar Creek (EFPC), a creek that traverses the city of Oak Ridge, eventually joining Poplar Creek, which is confluent with the Clinch River (Figure 1). Discharges of about 2 ounces of mercury per day continued through 1983 (1). These discharges were the result of routine releases from New Hope Pond, a settling pond for the Y12 facility that was constructed in 1963 (1). The pond empties into EFPC upstream of the city of Oak Ridge.

Past and recent environmental sampling conducted by DOE shows that most of the sediments and surface soils along EFPC are significantly contaminated with mercury (1), with levels as high as 2,000 ppm. Mercury sediment levels in Poplar Creek and in the lower Clinch River also exceed a previous EPA pollution classification level of 1 ppm (3). The extent of mercury contamination in the Tennessee River downstream of its confluence with the Clinch River has not been quantitated.

Residents and workers in the city of Oak Ridge may come into direct contact with pollutants discharged into EFPC because the creek floodplain extends into several urban neighborhoods. The playing fields of one junior high school extend to the bank of the creek. A soil sampling program begun in the summer of 1983 documented mercury levels as high as 2,000 ppm in the floodplain. In addition, soil dredged from the creek in 1983 was used to cover parts of the new sewer lines in Oak Ridge that are maintained by city employees.

INTRODUCTION

In the spring of 1983, a Memorandum of Understanding (MOU) was established between DOE, the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Health and Environment (TDHE) to serve as a "work plan for obtaining information, from which it is anticipated further plans, actions and remedial programs will be developed" (4). Under the MOU, Federal agencies (DOE, EPA) and TDHE created a Task Force to examine the potential for any long-term effects of exposure to chemical contamination and to assure "that

expeditious and thorough investigative and remedial measures be taken" (1,4). This work is being conducted over several years. Final recommendations for remedial action will not be available for several years. However, since preliminary sampling of soils and sediments from parts of the city of Oak Ridge demonstrated mercury levels that greatly exceeded background levels, TDHE was particularly concerned about the immediate potential for human exposure to mercury-contaminated soil. THDE, therefore, developed an interim level of 12 ppm for soil mercury concentration for use in environmental management decisions (5). Before disseminating this guideline, TDHE asked the Centers for Disease Control (CDC) to review its methodology and to comment on the health hazards from mercury in the Oak Ridge area.

CDC reviewed the methodology for the guideline level of mercury in the soil and advised that a potential health hazard could exist through exposure to methylmercury in contaminated fish and possibly through exposure to inorganic mercury in contaminated soils. CDC recommended that a pilot survey be conducted to determine whether populations at highest risk for mercury soil exposure did have elevated body burdens of mercury and that special attention be given to identify and protect any populations at risk for consumption of fish that were potentially contaminated with mercury (6).

The purpose of this pilot survey was to document human body levels of inorganic mercury at a time when exposure was likely to be occurring and to determine whether exposure to mercury-contaminated soils or consumption of fish presumed to be contaminated with mercury constituted an immediate health risk to the Oak Ridge population. Since classical clinical manifestations of

acute mercury poisoning (Table 1) had not been reported (nor were they expected at these soil and sediment levels), the study focused on (1) collecting soil exposure histories from residents and city employees who worked, lived, gardened, or played in contaminated soils and from a comparison group of presumably unexposed people, and (2) comparing mercury levels in urine or hair, or both, from subsets of the exposed and unexposed groups. The results of the survey would help determine if persons had been recently exposed to mercury and if any clinical health effects from mercury exposure should be expected.

METHODS

Environmental Data

All environmental samples were collected and analyzed for mercury by Oak Ridge Associated Universities, Oak Ridge, Tennessee. Soil surface grab samples and composite samples from the EFPC floodplain, from areas of the city where EFPC dredge material was known to be deposited, and from private property as requested by land and home owners were collected and analyzed between March 1983 and April 1984.

The city supplied us with a 1983 map of Oak Ridge, divided into 377 grids of approximately 900 square feet. Fifty-three grids were along the EFPC flood plain and the new sewer lines that were covered with soil dredged from the EFPC. Each grid was assigned a mercury soil concentration score by taking the average value of all soil levels measured within that grid. No mercury level

was available for 9 of the 53 grids along the EFPC floodplain and the new sewer lines. For those 9 grids, the value assigned to the grid was that of the average value reported in the contiguous grids. Grid areas not considered to be located in mercury-contaminated areas were assumed to have a mercury soil value of less than or equal to 1 ppm (3).

Survey Design

Phase I - The Household Survey

Census blocks defined in the 1980 U.S. Census were used as the primary sampling unit for the door-to-door survey. The survey was conducted in the 31 census blocks that approximated the 53 grids along the EFPC floodplain and the new sewer lines where soil mercury was assumed to be elevated; in the 7 census blocks closest to the Y12 plant; and in the 40 census blocks designated as the comparison group. The interviewers consisted of trained public health nurses and sanitarians employed by TDHE. Interviewers were instructed to ask for the head or cohead of each household and to inform him or her of the purpose of the survey and its voluntary nature. Household spokespersons were also informed that a subset of participants would be recontacted within 2 weeks of the initial interview and asked to give urine and/or hair samples. Interviewers were then instructed to obtain verbal consent for participation.

Three attempts were made to contact each household. The first attempt was by face-to-face contact. The other attempts were either by visit or phone call. If residents did not have a telephone, three visits were attempted.

A questionnaire designed to collect demographic data, to identify potential routes of mercury exposure by several soil pathways, (i.e., gardening, mowing, recreational activities, working in contaminated areas), to identify residents that consumed locally caught fish or game, or both, and to characterize confounding variables for mercury exposure was completed on each participating household (Appendix I).

The possibly mercury-exposed group was defined as people who, for at least one month before to the survey, resided, gardened, played, mowed grass, or worked in areas with mercury soil levels greater than or equal to 12 ppm. The survey included the following clusters of exposed individuals:

1. Residents of the 53 grids along the EFPC floodplain and the new sewer lines with soil concentrations greater than or equal to 12 ppm.

2. Residents of the Scarboro community, the residential area located closest to the Y12 plant settling pond. (Anecdotal reports had also suggested that residents of this community consumed local fish and turtles.)

3. All 17 storm drain workers and outdoor maintenance personnel, identified by the city of Oak Ridge, who maintained the sewer line or areas along the EFPC floodplain.

Three comparison groups were included in the survey, (1) Oak Ridge residents who lived in grids not known to be contaminated with mercury, (2) neighbors of Scarboro residents with no history of eating local fish or game, (3) a group of city employees who did not work outdoors.

Socioeconomic status (SES) appears to be associated with environmental exposures. Therefore, the comparison group were residents selected from neighborhoods that closely corresponded in SES to the neighborhoods of the possibly exposed group. Neighborhood boundaries were defined by city officials of the Neighborhood Statistics Program of the U.S. Census Bureau (7). Criteria for establishing neighborhood SES were based on an indirect approach for socioeconomic classification in Standard Metropolitan Statistical Areas developed by CDC (8). Briefly, three indices of neighborhood SES were used: median school years completed, percent of housing units with 1.01 or more persons per room, and percent of all families below the poverty level. The 13 Oak Ridge neighborhoods were ranked with regard to each indicator. Each neighborhood was then assigned an overall rank value by summing the rank of each of the indices. On the basis of overall SES rank value, each neighborhood was assigned a strata, upper, upper-middle, lower-middle, lower. Comparison neighborhoods were selected from the same strata as neighborhoods with contaminated areas.

After the household questionnaire was completed, quantitative mercury exposure values were estimated for each person in a household. The soil exposure value was equal to the mercury soil grid value multiplied by the number of times in the month before the interview the participant had been exposed to

contaminated soil. Each individual was assigned a soil exposure value for each exposure pathway -- gardening, recreational activities, and working in contaminated soil. Mercury food exposure values were taken to be equal to the number of servings of locally caught fish (defined as fish caught in EFPC or downstream as far as Watts Bar on the Clinch River) a person had consumed in the previous 3 months. For each type of exposure (working in contaminated soil, gardening/mowing, fish or game ingestion, sports/recreation), each individual was ranked according to his or her exposure value.

Phase II - Biologic Sampling

Participants considered to be exposed (a maximum of two per household) who were ranked highest in one of the soil exposure pathways were asked to provide a first morning urine sample and to complete a short questionnaire about their health. The exposed population was stratified by age (3 to 14 years, 15 to 24 years, 25 to 45 years, and over 45 years), since age may be related to mercury body levels (9). Participants who ranked lowest (a maximum of two per household) in each pathway and who were, therefore, considered to be nonexposed and were in the appropriate age group were also asked to provide biologic samples and to complete a health questionnaire. Participants reporting the highest number of locally caught fish meals in the 3 months before the survey were asked to provide a hair sample. The comparison group consisted of neighbors, or in the case of workers, other unexposed workers who reported not eating locally caught fish meals in the 3 months before the survey.

Each participant selected for biological sampling was informed of the risk and benefits as well as the voluntary nature of his or her participation and was asked to give written consent for participation. For a child less than 18 years of age, a parent was asked to give consent for the child.

Procedures for collecting and analyzing biologic samples were determined by the Clinical Chemistry Division (now the Division of Environmental Health Laboratory Sciences), Center for Environmental Health, CDC. Public health nurses were trained to instruct participants on urine collection procedures for a first morning void urine sample and to collect about 500 mg of hair according to the procedure outlined in Appendix II. The first morning urine sample was used to estimate inorganic mercury exposure and creatinine. The urine mercury was analyzed by using a CDC modification of the procedure described by Littlejohn et al (10). Creatinine was used to adjust for the dilutional effects of a single spot sample of urine as a measure of mercury concentration. The adjusted urinary mercury concentration (ug/gm) was equal to the urinary mercury concentration (ng/ml) divided by the urine creatinine (mg/dl) X 100. The analytical detection limit for mercury was 1.0 ng/ml.

Hair levels were considered to be indicators of organic mercury exposure. The analytic method used was an adaptation of Greenwood et al (11). A normal range of mercury hair levels in unexposed persons was determined by assay of hair from 30 employees of CDC in Atlanta, Georgia, who had not knowingly been exposed to mercury. The 5th and 95th percentiles for this group were 2.01 ug/gm and 6.50 ug/gm, respectively (CDC, Division of Environmental Health Laboratory Sciences).

Statistical methods used were the Chi-square test and the student's t test.

RESULTS

Phase 1 of the survey was conducted during the weeks of June 24 through July 2, 1984. Contact was attempted for 63% (1,851) of the 2,962 eligible households listed in the 1980 census. Interviews were completed on 952 (51%) households. Forty-three percent (779) of households where contact was attempted were not at home, 3% (63) of the households refused to participate, and 3% (57) were vacant. In addition, 31 city employees, 17 storm and drain workers, and 14 office workers, were interviewed. Responses were collected on 2,627 individuals who represented 10.7% of the Oak Ridge population. The age distribution of the respondents is listed in Table 2.

In response to questions about exposure to soils known to be contaminated with mercury, 336 individuals reported having participated in sports or recreational activities on contaminated soils (Table 3). Two of the city's most frequently used recreational sites were located on contaminated soil. The city jogging and play area was covered with top soil dredged from EFPC, and one end of a baseball field at a junior high school was located on the EFPC floodplain. Other activities less frequently reported in contaminated areas are listed in Table 3.

Phase II of the study, biological sampling, was conducted during the week of July 7. A total of 180 urine samples were collected; 80 were from residents

and workers with a history of exposure to contaminated soils, and 100 were from nonexposed participants.

Urinary mercury samples were available for 178 participants. Urinary mercury concentrations ranged from 0 to 22.6 ng/ml. All values were within the normal range reported in populations with no occupational, therapeutic, or demonstrable exposure to mercury (12). Urinary creatinine values were available for 177 participants and ranged from 18 to 386 mg/dl. Mean unadjusted mercury concentrations were highest in the 14- to 24-year age group (Figure 2). Urinary creatinine levels showed a similar peak. As a result, adjusted mean mercury concentrations were comparable for most ages, with a small trend for adjusted values to increase with increasing age.

The unexposed and exposed residents of Oak Ridge had similar mean unadjusted urinary mercury levels of 6.68 ng/ml and 7.88 ng/ml. Figure 3 demonstrates the mean adjusted urine mercury values by exposure group.

Two-thirds of exposed residents were males. When controlled for sex, mean adjusted urine mercury levels in exposed and unexposed residents was not significantly different (Table 4). Mean adjusted urinary mercury concentrations were inversely related to exposure values in males.

City workers with a recent history of exposure to contaminated soils did not have higher adjusted urinary mercury levels than unexposed city workers (Table 4).

Residents of the Scarboro neighborhood had a mean urinary mercury value similar to that for other Oak Ridge residents (unadjusted 6.19 ng/ml, adjusted for creatinine 6.22 ng/ml, N=13).

Hair samples were collected from 57 participants for whom exposure was recorded, 11 from those with a history of greatest ingestion of locally caught fish, and 46 from nonexposed individuals. Hair mercury concentrations ranged from 2.15 to 8.88 ug/gm. Consumers of locally caught fish had mean hair mercury concentrations comparable to those for nonconsumers (3.8 ug/gm vs. 3.9 ug/gm). Two of the 57 had hair mercury values above the 95th percentile of 30 CDC employees not known to be exposed to mercury who participated in a normal range study. The 5th and 95th percentiles for the CDC study were 2.10 ug/gm and 6.50 ug/gm, respectively. One participant from the possibly exposed group had a concentration of 7.12 ug/gm and one participant from the comparison group had a level of 8.88 ug/gm. These values, however, do not exceed the previously published "normal" value for mercury of 10 ug/gm (13).

DISCUSSION

The design of this exposure assessment has several limitations. First, mercury soil values were not available for all areas of Oak Ridge. Private properties were only tested upon request. Many areas within the city that were not close to EFPC or the sewer lines were not evaluated for mercury. These areas were assumed to be uncontaminated. In other areas along the EFPC and the sewer line, only a limited number of samples were collected and analyzed.

Second, with the exception of a small number of samples, the mercury soil values reported from the environmental sampling program were not speciated. Since soil samples from contaminated areas that were speciated had organic mercury concentrations of less than 1 ppm, we assume that the contaminated soils in Oak Ridge contained mostly inorganic mercury, either as elemental mercury or the salts of mercurous and mercuric ions. The consequences of ingesting mercury are dependent on its chemical form. Up to 15% of inorganic mercury salts may be absorbed by the gastrointestinal tract compared with 80 to 100% absorption of organic mercury (14). Furthermore, once in the bloodstream, inorganic mercury crosses cell membranes less readily than organic forms (14). Thus, much larger doses of inorganic mercury are needed to cause toxicity. The potential for human uptake of inorganic mercury may also vary with the salt formed. Mercury sulfates, for example, may be more tightly bound to soil than other mercury compounds and, therefore, the likelihood of human exposure may be less.

Third, the scoring method used to assign a soil exposure score has not been validated. Several hundred individuals reported exposure to contaminated soil, but biologic samples were collected only from individuals presumably with the highest soil exposure scores. If soil exposure scores were not an accurate measure of mercury exposure, then the survey may not have identified the most highly exposed participants.

The soil exposure score was heavily weighted for the concentration of mercury in soil which was multiplied by the numbers of days of exposure. A more refined exposure estimate can be made by including the number of hours per day

as well as the number of days that exposure took place. In addition, each activity, e.g., gardening, mowing, and recreation, was assumed to result in equivalent exposure. Finally, participants were not asked if they routinely smoked or ate while engaged in activities in contaminated soil. These habits may influence soil ingestion rates and thus may increase exposure.

The Oak Ridge survey was conducted in June and July, when activities that may lead to exposure to contaminated soils and fish are most prominent. General maintenance activities for gardens and lawns are high. Presumably, residents would be using outdoor recreational facilities. The summer months, however, are also a vacation period, perhaps explaining why interviewers completed contact with only 1,072 of the 1,851 households where contact was attempted.

Chronic low-level inorganic mercury exposures in nonoccupational settings, such as exposure to soil and indoor dusts, have not been well documented (15). At least one study has demonstrated significantly higher urinary mercury levels in a population residing near a mercury-emitting zinc smelter than a similar comparison population (9). Presumably, residents were exposed to mercury contaminated dust or soil. Humans can take up mercury from the soil directly by inhalating mercury vapors released by soil (14) or by ingesting particulate matter or, indirectly, by ingesting plants grown in contaminated soil. Large particulates cleared form the bronchociliary tract may be swallowed and may appear in the gastrointestinal tract. In addition, studies of lead exposure have demonstrated that hand-to-mouth transfer of soil and pica are both common methods of soil and dust ingestion for preschool and

school-aged children (16). Adults may also inadvertently ingest small amounts of soil or dust after smoking, eating, or digging. Plants grown in mercury-contaminated soil absorb mercury during the growth process, but the amount of mercury absorbed varies with the mercury soil concentration, the chemical composition of the soil, and the type of plant (17). No published data are available that describe this route of human exposure.

Urine is the medium most widely used to evaluate exposure to inorganic mercury (15). The kidney is the main organ that accumulates inorganic mercury. The estimated half-life of mercury in tissue is 64 days (15). A 24-hour urine sample is the ideal technique for measuring mercury in urine. Urinary excretion of mercury varies at different times of the day, but variation in the day-to-day total excretion of mercury is small (18). Sampling of urine over 24 hours is impractical in community settings, but creatinine adjusted urinary mercury can be used to obtain data comparable to that collected over 24 hours (9,19). For most urinary biological indicators, the analytical values determined from spot samples of urine are corrected for by a reference parameter such as creatinine (19). Creatinine is useful in adjusting for inconstant dilutions of spot urine samples and in obtaining data comparable to those collected on a 24-hour sample (19). For a given individual, daily creatinine production remains relatively constant, although interindividual variation may be great. The amount produced is correlated with muscle mass. Creatinine is an end-product of protein metabolism. In general, much less creatinine may be produced by women than men (20). Thus, when adjusted mercury urine results in the Oak Ridge population are examined, the sex of participants must be controlled for.

Oak Ridge residents and city workers thought to be exposed to contaminated soil are not likely to be at risk for developing significantly higher mercury levels than unexposed populations. All urine mercury concentrations were at levels considered to be within background ranges for the general population (12). Although unadjusted mean urine mercury concentrations were significantly higher for female residents exposed to contaminated soils, adjusted values were not significantly higher. For males, the mean unadjusted mercury concentrations were comparable in the exposed and comparison groups, and the adjusted urinary mercury concentration was inversely related to exposure. This inverse relationship was due to a significantly higher mean creatinine concentration in exposed adult males. We can only speculate that the increased creatinine excretion may be explained by a difference in lifestyle. In Oak Ridge, exposed males may spend more time outdoors involved in heavy workload activities. More muscular, physically active men excrete higher amounts of creatinine than ones with a sedentary lifestyle (20). Life styles and indicators of body mass, such as height and weight, were not collected in this survey.

This survey demonstrated that urinary mercury concentrations measured in Oak Ridge residents and city workers are below levels reported in association with known health effects. Health studies of chronic exposure to inorganic mercury in the form of mercury vapor or mercury dust have been conducted in occupational settings. Glomerular dysfunction has been reported in workers who had an average duration of mercury exposure of 6.8 years and urinary mercury concentrations of 50 ug/gm creatinine (21). Increased urinary excretion of B-galactosidase appears to be an early change that occurs at low

mercury urine levels (21). Excretion of this enzyme is followed at higher urine mercury levels by excretion of other high molecular weight proteins, including albumin (21). Asymptomatic sensorimotor neuropathies have been associated in workers with average mercury urine concentrations of 200 ng/ml (22).

No evidence of excess organic mercury levels was found in hair samples from Oak Ridge residents. Mercury hair levels were lower than previously published levels from Oak Ridge. The mean concentration report in 1965 was 7.6 ug/gm (range 0.1-33 ug/gm,) compared with a mean in this survey of 3.28 ug/gm (23). Environmental data on mercury levels are, however, incomplete. Final results of fisheries studies being conducted by the Oak Ridge Task Force will assist in determining whether consumption of large amounts of locally caught fish may be a potential health risk.

CONCLUSION

The results of this pilot survey suggest that residents and workers of Oak Ridge, Tennessee, are not likely to be at increased risk for having significantly high mercury levels. Urinary and hair mercury concentrations were below levels associated with known health effects.

RECOMMENDATIONS

1. Citizens of Oak Ridge should be informed of the low probability of harmful health effects from mercury as a result of current community exposure to

mercury-contaminated soil and sediment.

2. Current levels of the consumption of fish and other game caught in the vicinity of EFPC have not resulted in elevated levels of organic mercury. Until the final results of fisheries studies being conducted by the Oak Ridge Task Force have been completed, the fish ban along EFPC should continue.

Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or by the U.S. Department of Health and Human Services.

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Table 1
Adverse Health Effects of Mercury

Chemical Form	Type of Exposure	Toxic Effects
Mercury vapor, dusts of inorganic salts or elemental mercury	Chronic, occupational inhalation	General - insomnia, loss of appetite, weight loss, fatigue Oral cavity - swollen, bleeding gums, increased salivation Renal - proteinuria, nephrotic syndrome CNS - a) subclinical sensorimotor neuropathy b) tremors of the extremities, lips, or eyelids c) behavioral changes, i.e., shyness, memory loss, increased irritability, and anxiety Hypersensitivity - dermatitis, stomatitis, acrodynia
Organic mercury (methylmercury)	Inhalation	Irritation of mucous membranes
	In utero exposure	Low exposure - delayed developmental milestones, mild neurologic abnormalities Moderate to high exposure - mental retardation, cerebral palsy, convulsions, blindness
	Postnatal ingestion	Progressive neurologic symptoms from paresthesias to ataxia, constriction of visual fields, dysarthria, hearing loss, coma, and death

Table 2

Age and Sex Distribution of Survey Participants
Oak Ridge, Tennessee

AGE	MALE No. (%)	FEMALE No. (%)	TOTAL
0 to 9 yrs.	124(47)	142(53)	266
10 to 19 yrs.	212(51)	206(49)	418
20 to 39 yrs.	306(51)	295(49)	601
40 to 69 yrs.	533(47)	594(53)	1127
70 to 99 yrs.	91(48)	98(52)	189
Unknown			26
TOTAL	1266(49)	1335(51)	2627

Table 3

Number of survey participants potentially exposed to mercury contamination by type of activity
N=2627

Activity	Total No. No. (%)
Sports/Recreation in an uncontaminated area	786 (30)
Sports/Recreation in a contaminated area	336 (13)
Ingestion of local fish and game from a possibly contaminated area	281 (11)
Gardening/mowing in an uncontaminated area	1381 (53)
Gardening/mowing in a contaminated area[a]	165 (6)
Working in contaminated soil	138 (5)

[a]Residents in contaminated areas along EFPC tended to live in apartments or condominiums.

Table 4

Mean urinary mercury, urinary creatinine, and adjusted mercury levels for participants in the Oak Ridge mercury survey

Group	Mean Urine Hg			Mean Urine Cr			Mean Adj. Urine Hg		
	N	(ng/ml)	Range	N	(mg/dl)	Range	N	(ug/gm)	Range
Residents									
Males									
Unexposed	38	6.7	0-16.3	37	128.2[a]	18-318	37	6.3[a]	0-12.5
Exposed	40	7.5	0-16.2	40	166.6[a]	48-386	39	4.8[a]	0- 9.3
Females									
Unexposed	50	5.6[a]	0-22.6	50	102.3	22-348	50	6.2	1.5-22.2
Exposed	22	8.7[a]	1.4-21.7	21	131.6	34-256	21	6.6	2.9-22.7
Workers									
Unexposed	11	7.2	3.1-12.0	11	129.3	60-256	11	6.5	2.6-17.2
Exposed	17	6.5	2.7-12.5	17	132.9	26-334	17	5.9	2.5-13.8
Total	178			176			175		

[a] $p = 0.02$

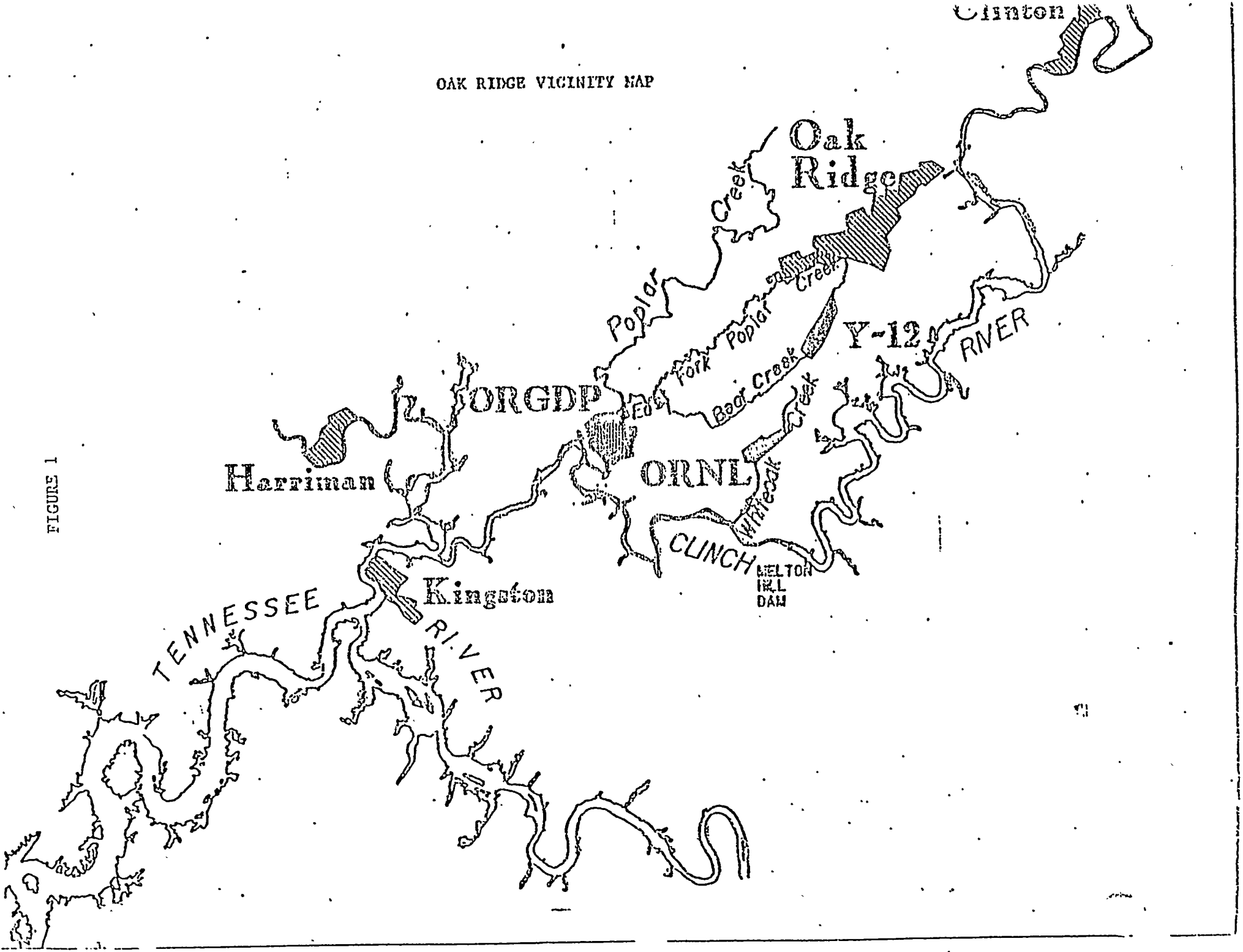
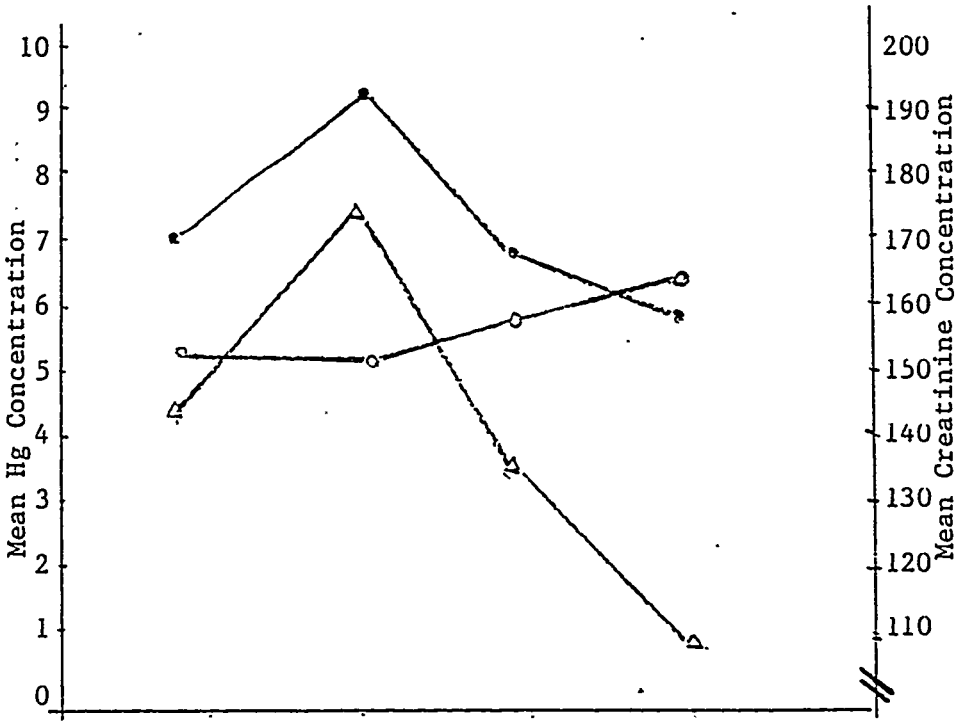

OAK RIDGE VICINITY MAP
Clinton
Oak Ridge
Poplar Creek
East Fork Poplar Creek
Bear Creek
Y-12
RIVER
ORGDP
Harriman
ORNL
Whiteoak Creek
CLINCH
MELTON HILL DAM
Kingston
TENNESSEE
RIVER

FIGURE 1

FIGURE 2

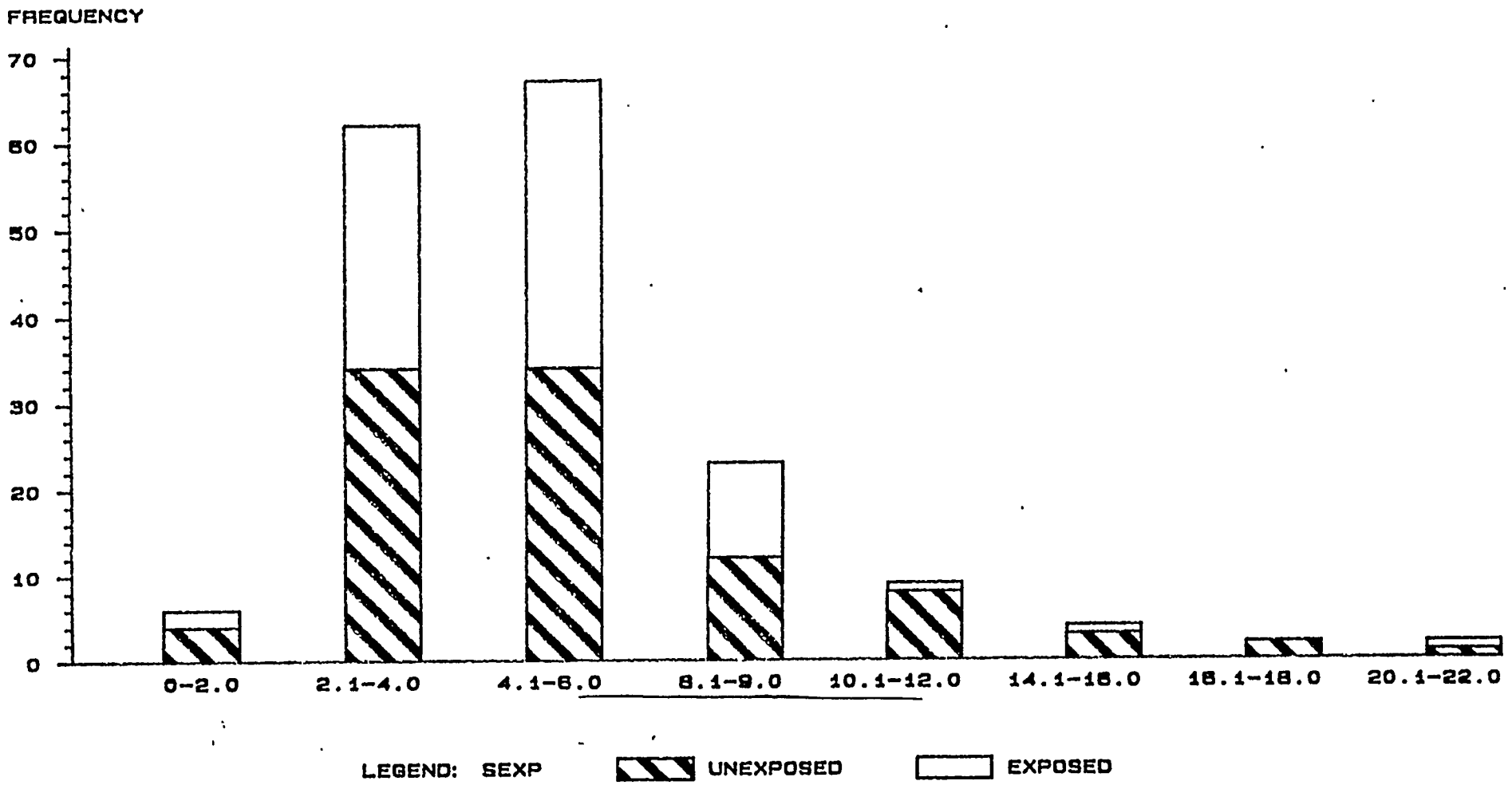
Mean undajusted, mean adjusted mercury concentrations and mean creatinine concentation by age, Oak Ridge, Tennessee, July 1985



	N	N	N	N	
Unadj Hg (ng/ml)	28	24	50	76	●—●—●
Adj Hg (ug/gm)	26	23	50	76	○—○—○
Creatinine (mg/dl)	26	24	50	77	△—△—△

DISTRIBUTION OF ADJUSTED URINE MERCURY LEVEL BY EXPOSURE STATUS

OAK RIDGE, TN. 1984



APPENDIX I

PLACE LABEL

HERE

HEALTH SURVEY QUESTIONNAIRE

Interviewer ID _____ Census Block No._____

Date of Interview ____ ____ ____
Mo. Day Yr.

1. What is your name? _____ _____ _____
First Middle Initial Last

2. What is your current address? _____
Street

_____
City State Zip

3. What is your telephone number? Home: (____) ____ - ____

Work: (____) ____ - ____

This page will be retained by the Tennessee Department of Health and Environment.

(1-11) Household I.D. No. _____

PLACE LABEL
HERE

(12-14) Census Block No._____

1. What is the total number of persons living in the house, including yourself?

(15-16) _____.

(17) 2. Race and Ethnic Origin of Family: (Circle one)

1 =White(not Hispanic)
2 =Black(not Hispanic)
3 =White Hispanic
4 =Black Hispanic
5 =Other Race Hispanic
6 =American Indian or Alaskan Native
7 =Asian or Pacific Islander
8 =Other

3. How long have you lived at your current residence?

(18-21) _____ Years and _____ Months

(22) 4. How is your household supplied water?

1 public water
2 private well or spring
3 bottled
4 other supply

(1-11) Household I.D. No. _____

5. I need some information about all the people who live in your household (including yourself). Please list them by age, beginning with the oldest:

A. What is his/her sex?

B. On what date was he/she born?

C. What is his/her relationship to you?

D. What is his/her name?

	Household Member Number	Sex 1=Male 2=Female	Date of Birth	Relationship to Respondent 1=self 2=spouse 3=child 4=other relative 5=unrelated	Name
(23-32)	01	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____
(33-42)	02	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____
(43-52)	03	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____
(53-62)	04	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____
(63-72)	05	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____
(73-82)	06	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____
(83-92)	07	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____
(93-102)	08	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____
(103-112)	09	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____
(113-122)	10	1 2	___ ___ ___ Mo. Day Yr.	1 2 3 4 5	_____

(1-11) Household I.D. No. _____

6. Have you or has any member of your household ever worked at the Gaseous Diffusion Plant, ORNL or Y12 Plant? If yes, please give the title of the job and the dates of employment. (Use a separate line for each job held at the plant.)

	Household Member No.	1=yes 2=no 9=Unk	Job Description	Dates of Employment From (Mo Day Yr)	To (Mo Day Yr)
(123-133)	_____	1 2 9	_____	___ ___ ___	___ ___ ___
(134-144)	_____	1 2 9	_____	___ ___ ___	___ ___ ___
(145-155)	_____	1 2 9	_____	___ ___ ___	___ ___ ___
(156-166)	_____	1 2 9	_____	___ ___ ___	___ ___ ___
(167-177)	_____	1 2 9	_____	___ ___ ___	___ ___ ___

(1-11) Household I.D. No. _____

7. NOTE: ASK THIS QUESTION ONLY IF CHILDREN UNDER THE AGE OF 18 RESIDE IN THIS HOUSEHOLD. OTHERWISE GO TO THE NEXT QUESTION.

A. In the past 3 months has anyone in the family attended one of these schools?

B. When did he/she last attend school?

	Household Member Number	A. Name of School 1=Robertsville Jr. High 2=Jefferson Jr. High 3=Le Petit 9=Unknown	B. Date Last Attended School
(178-184)	_____	1 2 3 9	___ ___ ___ Mo Day Yr
(185-191)	_____	1 2 3 9	___ ___ ___ Mo Day Yr
(192-198)	_____	1 2 3 9	___ ___ ___ Mo Day Yr
(199-205)	_____	1 2 3 9	___ ___ ___ Mo Day Yr
(206-212)	_____	1 2 3 9	___ ___ ___ Mo Day Yr
(213-219)	_____	1 2 3 9	___ ___ ___ Mo Day Yr
(220-226)	_____	1 2 3 9	___ ___ ___ Mo Day Yr

(1-11) Household I.D. No. _____

8. Does _____ use the Fitness Track at the Civic Center? This also includes working on the track, or supervising other people on the tract.

   If yes, how many times in the past month has _____ used the track? (probe)

	Household Member Number	1=yes 2=no 9=unk	How many times in the past month?
(227-231)	01	1 2 9	____
(232-236)	02	1 2 9	____
(237-241)	03	1 2 9	____
(242-246)	04	1 2 9	____
(247-251)	05	1 2 9	____
(252-256)	06	1 2 9	____
(257-261)	07	1 2 9	____
(262-266)	08	1 2 9	____
(267-271)	09	1 2 9	____
(272-276)	10	1 2 9	____

(1-11) Household I.D. No. _____

NOW I WOULD LIKE TO ASK YOU SOME QUESTIONS CONCERNING SOME OF THE ACTIVITIES YOU AND YOUR FAMILY ARE INVOLVED IN. FOR SOME OF THE QUESTIONS, PLEASE REFER TO THIS MAP. (MAPA)

9. In the past month has _____ ever worked in locations within any of the shaded areas on the map or along the creek?

   If yes, where?

   How many times in the past month? (probe)
   (Ask this question for each household member.)

ACTIVITY = WORKED

	Household Member Number	1=yes 2=no 9=unknown	Map Area Code	How many times in the past month?
(277-283)	01	1 2 9	__-__	_____
(284-290)	02	1 2 9	__-__	_____
(291-297)	03	1 2 9	__-__	_____
(298-304)	04	1 2 9	__-__	_____
(305-311)	05	1 2 9	__-__	_____
(312-318)	06	1 2 9	__-__	_____
(319-325)	07	1 2 9	__-__	_____
(326-332)	08	1 2 9	__-__	_____
(333-339)	09	1 2 9	__-__	_____
(340-346)	10	1 2 9	__-__	_____

(1-11) Household I.D. No. _____

10. In the past month has _____ ever gardened in locations within any of the shaded areas on the map or along the creek?

If yes, where?

How many times in the past month? (probe)
(Ask this question for each household member.)

Has _____ gardened in any of the non-shaded areas?

If yes, where? How many times in the past month?

ACTIVITY = GARDENED

		SHADED AREA/CREEK			UNSHADED AREA		
	Household Member No.	1=yes 2=no 9=unknown	Map Area Code	How many times in the past month?	1=yes 2=no 9=Unk	How many times in the past month?
(347-356)	01	1 2 9			1 2 9	
(357-366)	02	1 2 9			1 2 9	
(367-376)	03	1 2 9			1 2 9	
(377-386)	04	1 2 9			1 2 9	
(387-396)	05	1 2 9			1 2 9	
(397-406)	06	1 2 9			1 2 9	
(407-416)	07	1 2 9			1 2 9	
(417-426)	08	1 2 9			1 2 9	
(427-436)	09	1 2 9			1 2 9	
(437-446)	10	1 2 9			1 2 9	

(1-11) Household I.D. No. _____

11. In the past month has _____ ever mowed in locations within any of the shaded areas on the map or along the creek?

If yes, where?

How many times in the past month? (probe)
(Ask this question for each household member.)

Has _____ mowed in any of the non-shaded areas?

If yes, where? How many times in the past month?

ACTIVITY = MOWED

		SHADED AREA/CREEK				UNSHADED AREA	
	Household Member No.	1=yes 2=no 9=unknown	Map Area Code	How many times in the past	1=yes 2=no 9=Unk month?	How many times in the past month?	
(447-456)	01	1 2 9			1 2 9		
(457-466)	02	1 2 9			1 2 9		
(467-476)	03	1 2 9			1 2 9		
(477-486)	04	1 2 9			1 2 9		
(487-496)	05	1 2 9			1 2 9		
(497-506)	06	1 2 9			1 2 9		
(507-516)	07	1 2 9			1 2 9		
(517-526)	08	1 2 9			1 2 9		
(527-536)	09	1 2 9			1 2 9		
(537-546)	10	1 2 9			1 2 9		

(1-11) Household I.D. No. _____

12. In the past month has _____ ever dug dirt in locations within any of the shaded areas on the map or along the creek? This includes hauling dirt away from the creek or other areas.

    If yes, where?

    How many times in the past month? (probe)
    (Ask this question for each household member.)

ACTIVITY = DUG

		SHADED AREA/CREEK					UNSHADED AREA		
	Household Member No.	1=yes 2=no 9=unknown			Map Area Code	How many times in the past month?	1=yes 2=no 9=Unk		How many times in the past month?
(547-556)	01	1	2	9			1	2	9	
(557-566)	02	1	2	9			1	2	9	
(567-576)	03	1	2	9			1	2	9	
(577-586)	04	1	2	9			1	2	9	
(587-596)	05	1	2	9			1	2	9	
(597-606)	06	1	2	9			1	2	9	
(607-616)	07	1	2	9			1	2	9	
(617-626)	08	1	2	9			1	2	9	
(627-636)	09	1	2	9			1	2	9	
(637-646)	10	1	2	9			1	2	9	

13. In the past month has _____ ever played sports that would bring him into contact with soil in locations within any of the shaded areas on the map or along the creek?

If yes, where?

How many times in the past month? (probe)
(Ask this question for each household member.)

Has _____ played sports in any of the non-shaded areas?

If yes, where? How many times in the past month?

ACTIVITY = SPORTS

		SHADED AREA/CREEK			UNSHADED AREA		
	Household Member No.	1=yes 2=no 9=unknown	Map Area Code	How many times in the past month?	1=yes 2=no 9=Unk	How many times in the past month?
(647-656)	01	1 2 9	___-___	___	1 2 9	___
(657-666)	02	1 2 9	___-___	___	1 2 9	___
(667-676)	03	1 2 9	___-___	___	1 2 9	___
(677-686)	04	1 2 9	___-___	___	1 2 9	___
(687-696)	05	1 2 9	___-___	___	1 2 9	___
(697-706)	06	1 2 9	___-___	___	1 2 9	___
(707-716)	07	1 2 9	___-___	___	1 2 9	___
(717-726)	08	1 2 9	___-___	___	1 2 9	___
(727-736)	09	1 2 9	___-___	___	1 2 9	___
(737-746)	10	1 2 9	___-___	___	1 2 9	___

(1-11) Household I.D. No. _____

14. In the past month has _____ ever played in locations within any of the shaded areas on the map or along the creek?

If yes, where?

How many times in the past month? (probe)
(Ask this question for each household member.)

Has _____ played in any of the non-shaded areas?

If yes, where? How many times in the past month?

ACTIVITY = PLAYED

		SHADED AREA/CREEK					UNSHADED AREA		
	Household Member No.	1=yes 2=no 9=unknown			Map Area Code	How many times in the past month?	1=yes 2=no 9=Unk		How many times in the past month?
(747-756)	01	1	2	9			1	2	9		
(757-766)	02	1	2	9			1	2	9		
(767-776)	03	1	2	9			1	2	9		
(777-786)	04	1	2	9			1	2	9		
(787-796)	05	1	2	9			1	2	9		
(797-806)	06	1	2	9			1	2	9		
(807-816)	07	1	2	9			1	2	9		
(817-826)	08	1	2	9			1	2	9		
(827-836)	09	1	2	9			1	2	9		
(837-846)	10	1	2	9			1	2	9		

(1-11) Household I.D. No. _____

NOW SAY:

FOR THE NEXT SET OF QUESTIONS I AM INTERESTED IN WHAT YOU OR YOUR FAMILY MEMBERS HAVE DONE FOR THE PAST 3 MONTHS PLEASE REFER TO THIS MAP (MAPB)

15. In the past 3 months has _____ eaten any vegetables grown in Oak Ridge?

If yes, were they root vegetables such as carrots or potatoes or were they vegetables grown above the ground?

How many servings has _____ eaten in the past 3 month?

	Household Member No.	1=yes 2=no 9=Unk	Type of vegetable (Circle all that apply) 1=Root vegetable 2=Above ground 9=Unk	No. of Servings 999=Unk
(847-853)	01	1 2 9	1 2 9	_____
(854-860)	02	1 2 9	1 2 9	_____
(861-867)	03	1 2 9	1 2 9	_____
(868-874)	04	1 2 9	1 2 9	_____
(875-881)	05	1 2 9	1 2 9	_____
(882-888)	06	1 2 9	1 2 9	_____
(889-895)	07	1 2 9	1 2 9	_____
(896-902)	08	1 2 9	1 2 9	_____
(903-909)	09	1 2 9	1 2 9	_____
(910-916)	10	1 2 9	1 2 9	_____

(1-11) Household I.D. No. _____

17. Does _____ routinely eat fish served in your household?

	Household Member No.	1=yes 2=no 9=unknown
(977-979)	01	1 2 9
(980-982)	02	1 2 9
(983-985)	03	1 2 9
(986-988)	04	1 2 9
(989-991)	05	1 2 9
(992-994)	06	1 2 9
(995-997)	07	1 2 9
(998-1000)	08	1 2 9
(1001-1003)	09	1 2 9
(1004-1006)	10	1 2 9

[IF NO ONE RESPONDS "YES" TO QUESTION 17, THEN SKIP TO QUESTION 21.]

(1-11) Household I.D. No. _____

16. In the past 3 months, has _____ caught or dug any bait from East Fork Poplar Creek, Poplar Creek or the Clinch River? If yes, what type of bait?

Where did he/she get it?

	Household Member Number	1=yes 2=no 9=unknown	Type of bait 1=minnows, crawfish, grubs from water 2=worms, grubs from bank 9=Unk	Map Area Code Where Caught
(917-922)	01	1 2 9	1 2 9	__-__
(923-928)	02	1 2 9	1 2 9	__-__
(929-934)	03	1 2 9	1 2 9	__-__
(935-940)	04	1 2 9	1 2 9	__-__
(942-946)	05	1 2 9	1 2 9	__-__
(947-952)	06	1 2 9	1 2 9	__-__
(953-958)	07	1 2 9	1 2 9	__-__
(959-964)	08	1 2 9	1 2 9	__-__
(965-970)	09	1 2 9	1 2 9	__-__
(971-976)	10	1 2 9	1 2 9	__-__

(1-11) Household I.D. No. _____

18. In the 3 past months has _____ eaten fish caught in this area? This includes fish that might have been caught earlier and stored.

If yes, what type of fish was it?

How many times in the past 3 months has _____ eaten fish caught in this area?

How many fish servings did _____ eat per meal?

From what area of the map were the fish caught?

	Household Member No.	1=yes 9=Unk	Type of 2=no 1=bass, bream crappie, trout walleye, rockfish or other similar fish 2=catfish, drum carp, or other similar fish 9=Unk		No. of fish caught fish meals in the 3 past months 9=Unk	No. of locally per meal	Map Area Servings
(1007-1015)	01	1 2 9	1 2 9		__ __	_____	_____
(1016-1024)	02	1 2 9	1 2 9		__ __	_____	_____
(1025-1033)	03	1 2 9	1 2 9		__ __	_____	_____
(1034-1042)	04	1 2 9	1 2 9		__ __	_____	_____
(1043-1051)	05	1 2 9	1 2 9		__ __	_____	_____
(1052-1060)	06	1 2 9	1 2 9		__ __	_____	_____
(1061-1069)	07	1 2 9	1 2 9		__ __	_____	_____
(1070-1078)	08	1 2 9	1 2 9		__ __	_____	_____
(1079-1087)	09	1 2 9	1 2 9		__ __	_____	_____
(1088-1096)	10	1 2 9	1 2 9		__ __	_____	_____

19. In the past 3 months has _____ eaten fish purchased in a grocery store that was caught outside this area?

How many of these fish meals did _____ eat in 3 month?

How many fish servings did _____ eat per meal?

	Household Member No.	1=yes 2=no 9=Unk	No. of non-local fish meals in the past 3 months 9=Unk	No of servings per meal
(1097-1102)	01	1 2 9	__	____
(1103-1108)	02	1 2 9	__	____
(1109-1114)	03	1 2 9	__	____
(1115-1120)	04	1 2 9	__	____
(1121-1126)	05	1 2 9	__	____
(1127-1132)	06	1 2 9	__	____
(1133-1138)	07	1 2 9	__	____
(1139-1144)	08	1 2 9	__	____
(1145-1150)	09	1 2 9	__	____
(1151-1156)	10	1 2 9	__	____

(1-11) Household I.D. No. _____

20. In the past year have you or has any member of your household changed your/his/her level of consumption of locally caught fish?

	Household Member Number	1=yes 2=no 9=unknown	Change in consumption 1=eat more fish 2=eat less fish 3=no change 9=Unk
(1157-1160)	01	1 2 9	1 2 3 9
(1161-1164)	02	1 2 9	1 2 3 9
(1165-1168)	03	1 2 9	1 2 3 9
(1169-1172)	04	1 2 9	1 2 3 9
(1173-1176)	05	1 2 9	1 2 3 9
(1177-1180)	06	1 2 9	1 2 3 9
(1181-1184)	07	1 2 9	1 2 3 9
(1185-1188)	08	1 2 9	1 2 3 9
(1189-1192)	09	1 2 9	1 2 3 9
(1193-1196)	10	1 2 9	1 2 3 9

(1-11) Household I.D. No. _____

21. In the past 3 months, has _____ eaten any wild game, ducks or turtles caught from East Fork Poplar Creek, Poplar Creek or the Clinch River?

If yes, what type of animal did _____ eat?

Where was the game caught?

How many meals of the game did _____ eat?

How many servings per meal did _____ eat?

	Household Member Number	1=yes 2=no 9=unk	Type of Animal 1=wild game 2=ducks 3=turtles 4=other	Map Area Code Where Caught 99=unk	No. of meals served in 3 months 99=unk	No. of servings eaten per meal 9=unk
(1197-1205)	01	1 2 9	1 2 3 4	__	__	_____
(1206-1214)	02	1 2 9	1 2 3 4	__	__	_____
(1215-1223)	03	1 2 9	1 2 3 4	__	__	_____
(1224-1232)	04	1 2 9	1 2 3 4	__	__	_____
(1233-1241)	05	1 2 9	1 2 3 4	__	__	_____
(1242-1250)	06	1 2 9	1 2 3 4	__	__	_____
(1251-1259)	07	1 2 9	1 2 3 4	__	__	_____
(1260-1268)	08	1 2 9	1 2 3 4	__	__	_____
(1269-1277)	09	1 2 9	1 2 3 4	__	__	_____
(1278-1286)	10	1 2 9	1 2 3 4	__	__	_____

(1287) 22. Is anyone in the household pregnant?

1 = yes
2 = no
3 = Unknown

Who?

Household member No. _____

(1288) 23. During the past 3 years, has anyone who lived with you in this household for more than 1 year died?

1=yes
2=no
9=unknown

If yes, please tell me the following:

(1289-1291) Age at death (in completed years) _____

Cause of death _____

Usual occupation when working _____

Employer _____

(1292-1300) SSN ___ ___ ___

Place of Death
Hospital _____
Address _____
Street
_____
County State

APPENDIX II

Oak Ridge, Tennessee
Doc#4543S

URINE COLLECTION

(Revised 6/26/84)

Supplies needed for each participant:

1 urine collection cup (250-ml, plastic, capped, wrapped)
1 conical-bottom, 15-ml plastic centrifuge tube for trace metal analysis (contains nitric acid)
1 conical-bottom, 15-ml plastic centrifuge tube for trace mercury analysis (contains triton and sulfamic acid). This tube is marked with a yellow dot
1 flat-bottom, 6-ml plastic tube for reatinine analysis
1 conical-bottom, 50-ml plastic tube for the "reserve" urine.

Additional Supplies: Diaperene towelette, powder-free lab gloves, paper towels, clean stainless steel scissors

Note: The collection cup and conical-bottom tubes will have been prescreened at CDC to minimize arsenic and mercury contamination. Use ONLY containers supplied by CDC.

I. PRE-COLLECTION PREPARATION

A. Addition of nitric acid to trace metals: While wearing protective unpowdered gloves, apron and glasses, working under a laboratory hood, and using the pipettor provided, pipet 100 ul of ultrapure concentrated nitric acid (G. Frederick Smith Chemical Co., Columbus, Ohio 43223, Catalogue No. 63, ultrex grade) into the bottom of each of the 15-ml conical-bottom tubes which will be used for arsenic analyses. Process one tube at a time, removing the cap, adding the acid, and replacing and screwing the cap. Then place the tube in a test tube rack and proceed to the next tube. Do not touch the interior of the cap or tube or place the cap or pipet tip on external surfaces which may be contaminated for trace elements.

DO NOT ADD ACID TO TUBES FOR MERCURY ANALYSES WHICH ARE MARKED WITH A YELLOW DOT. (Triton and sulfamic acid will have been measured into the mercury tubes at CDC.)

In handling and transporting conical-bottom tubes (for trace metals mercury), the tubes must be kept in an upright position, so that the preservatives will not run down the sides.

B. Preparation of laboratory blanks: Still wearing protective clothing and working under a hood, select two of the tubes to which nitric acid has just been added. Into each of these two tubes, slowly pour 10 ml ± 1 ml of deionized water (supplied by CDC) to the mark indicated. Cap, label, seal, and invert each tube several times. Similarly, select two of the tubes supplied for mercury analysis and add 10 ml ± 1 ml of deionized water to each of these tubes as above. Using a ballpoint pen, write the words "Lab blank" and the date collected on the labels of each of these four tubes. Place them in a freezer and store for shipment to CDC with urine specimens.

II URINE COLLECTION---INSTRUCTIONS FOR FIELD PERSONNEL

1. Instruct adults and children (or the person who will be assisting the child) to wash hands with soap and water before collecting the first urine specimen of the day.
2 Instruct adults and persons assisting children in how to collect urine to minimize trace element contanination:

   a. The cellophane wrapping of the urine container should not be opened until just before voiding.

   b. The person should leave the cap in the wrapping while voiding, then recap the filled container immediately.

   c. IT IS MOST IMPORTANT that the inside of the container and the cap not be touched or come into contact with any parts of the body or clothing or external surfaces. Exposure to air should be minimized.

   d. The person should hold the capped specimen until the agreed pick-up time. If more than 30 minutes before the pick-up, the specimen should be placed in ziplock bag and refrigerated. NOTE: For this situation, and these analyses, strict adherence to the above precautions should minimize interferences, and it will not be necessry to obtain a clean-catch (midstream) specimen or prewash the genitalia. If any of the children have fecal contamination of the genitalia, however, it will be necessary to remove the fecal material before voiding as follows: Using a moist towelette (Diaperene), wipe the labia once (from front to back) or the urethral opening of the penis, taking care not to touch the surface of the towelette which will come in contact with the person's skin.

3. The pick-up field team should log in the specimen, initial the container and date. Transport the urine specimens on icepacks to the designated laboratory for further processing.

III. LABORATORY PROCESSING

1. Log in the urine specimen; note if any specimen is leaking; place on ice if any delay in processing.

2. Divide the urine specimen into the appropriate tubes as follows:
   a. Wear the powder-free lab gloves and work over the bathroom or laboratory sink.

   b. Gently swirl the specimen in the capped container to resuspend any solids.

   c. Immediately after mixing, pour aliquots of the urine into each of the four labeled tubes provided.

   d. First pour 10 ml ± 1 ml of urine into each of the two large conical-bottom tubes to the graduation line marked. Process each tube individually, removing the cap just before pouring and returning it immediately after filling the tube. (DO NOT TOUCH the inside of the tube or cap or place the cap on a potentially contaminated external surface; minimize exposure to ambient air.) Tighten the cap, and mix each tube vigorously to dissolve the preservatives.

   e. Pour 4 ml ± .5 of the urine specimen (to a maximum of two-thirds full) into the small flat-bottom tube. Pour the remainder of the urine specimen (maximum of 45 ml) into the "reserve" tube.

   f. Using a ballpoint pen, add the date collected and your initials to the prenumbered labels of each of the three tubes.

   g. Rinse the specimen cup, and dispose of it in the designated garbage bag.

   h. Immediately transport and freeze the tubes of urine in an upright position in a -20°C freezer. (If the urine is not placed in the freezer within 1 hour of collection, note this on the specimen log sheet. Also record on the log sheet any <u>known</u> contamination of the specimen.)

3. Collection of field blanks for the mercury trace metal and creatinine tubes: For every 10 participants, one set of the two trace element tubes (large, conical-bottom) will be prepared as "field blanks", using ultrapure water in place of urine. If you are to collect such blanks, a second sheet of labels will be in the subject's file, and the Urine labels will be circled. Prepare these blanks under the same conditions as for processing specimens (whether in the bathroom, lab, etc.) as follows:

   a. Immediately after processing the preceding urine specimen, obtain one each of the mercury and arsenic tubes. Using the distilled water provided, pour 10 ml ± 1 ml of water into each tube to the graduation mark; then recap amd mix as for urine specimens.

b. On the labels for the field blanks, use a ballpoint pen to write the words "field blank", the date, and your initials.

c. Freeze the blanks in an upright position and store them frozen with the urine specimens.

NOTE: Specimens should be collected and aliquotted and blanks processed under as clean conditions as possible to minimize contamination from dust in the ambient air.

4. Collection of duplicate samples:
Every fifth participant will have two sets of urine tubes collected. For this, extra labels and an additional set of the three specimen tubes will be provided.

a. After processing the first set of urine tubes, use urine remaining in the collection cup to fill the second set. Process, date, initial, and freeze as for the first set.

b. If the initial amount of urine collected is not at least 50 ml(the collection cup is graduated and marked), DO NOT process a second set of tubes; write "insufficient specimen" on the second set of labels and put these labels with the first set of specimens.

5. Log in all urine specimens and blanks and store them frozen at -20°C until they are processed for shipment.

IV INSTRUCTIONS FOR TRANSPORTING OR SHIPPING SPECIMENS:

a. Assemble shipper (styrofoam or similar material), dry ice (5 to 15 lbs, dependent on the size of the shipper) and packing materials. Work quickly, so that the frozen urine will not be exposed to ambient temperature for more than 5 to 10 minutes. They must be kept in a hard frozen state.

b. Wrap each tube with a folded paper towel or a strip of bubble-pack packing material and secure with tape or a rubber band. Return each wrapped tube to the freezer until all are wrapped.

c. Place paper towels or bubble-pack material in the bottom of the shipper. Place the wrapped tubes in a single layer on this packing material.

d. On top of the tubes, place several additional layers of paper towels or bubble-pack material.

e. Fill the shipper with dry ice, close it, and secure the top with strapping tape.

f. If specimens are to be shipped, rather than transported, label appropriately for shipment via Express Mail such that specimens will be received at CDC within 24 hours. (Inquire about regulations and obtain shipping labels before packing specimens for shipment). SHIP ONLY ON MONDAYS THROUGH WEDNESDAYS, and never the day before a holiday.

g. On an insert within the shipper, or in an envelope attached securely to the outside, provide information about the contents of the shipment.

July 3, 1984
Project 8407
Oak Ridge, TN

HAIR COLLECTION

I. Supplies Needed for Each Participant:

1 pair of stainless steel surgical scissors

3 aluminum clips

1 nylon combs

2 ziplock bags

isopropyl alcohol

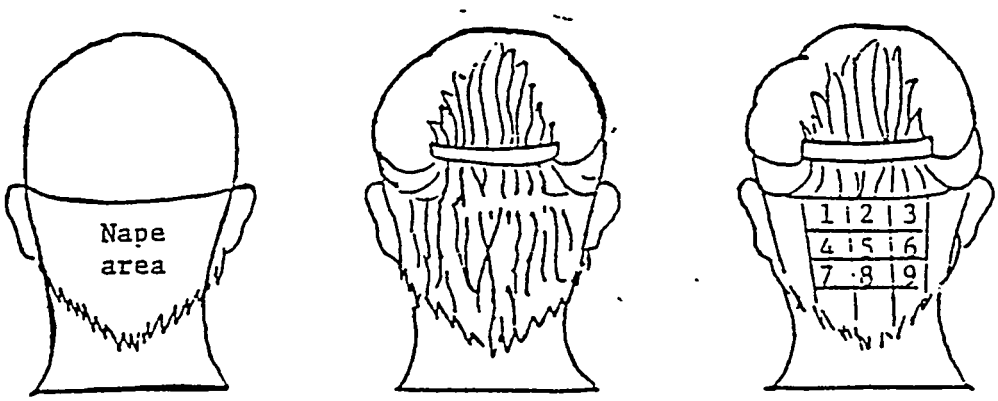
polyethylene squeeze bottle

powder-free plastic gloves

II. Collection Procedure

1. Store the stainless steel surgical scissors, the aluminum clips, and the nylon combs in ziplock plastic bags when not in use.
2. Disinfect the scissors, combs, and clips after each use:
   a. Dip the scissors, clips, and combs into 70% isopropyl alcohol (2-propanol, ACS reagent grade and distilled water).).
   b. Rinse them with distilled water.
   c. Rinse again with 70% isopropyl alcohol from a polyethylene squeeze bottle.
   d. Dry in a dust-free environment (ziplock bag).
3. Use disposable, powder-free plastic gloves to handle the hair specimens.

4. Collecting the hair samples:



A. B. C.

a. Collect the hair samples from the nape area.

b. With a clean nylon comb, partition the hair between the ears as shown in the diagram.

c. Fasten the hair above the ears, out of the way, with aluminum clips.

d. At each of 8 to 10 sites on the nape area, gather 15 to 20 strands of hair. Hold the end of the hair and cut the hair as close to the scalp as possible with stainless steel surgical scissors. A minimum of 500mg of nape hair is needed for analysis.

e. From each cutting of hair from the scalp, cut-off the <u>two inches</u> of hair which were <u>closest to the scalp</u> (scalp hair) and put in a ziplock plastic bag.

f. Place a pre-printed label on the bag, add the word "scalp" to the label, seal the bag, and staple the questionnaire to the bag above the ziplock.

g. As the scalp hair is cut off each strand, lay the remaining hair (if any) in a pile on a piece of lassine paper, aligning the cut ends.

h. Tightly tie the bundle of hair near the cut ends with a piece of braided surgical silk or other thread provided.

i. Put the untied hair in a separate ziplock plastic bag, place a pre-printed label on the bag, add the word "remainder" to the label, and seal the bag.

j. Staple the two bags together above the ziplock.

5. Hair samples may be shipped with the other specimens to CDC. Place the hair samples on top of the shipper so that the hair does not get wet.

6. Disinfect the scissors, clips, and combs with 70% isopropyl alcohol.