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ENVIRONMENTAL SCIENCES DIVISION
National Environmental Research Park

RESULTS OF THE Y-12 AREA RARE PLANT AND WETLAND SURVEY

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INTRODUCTION

The National Environmental Policy Act (NEPA) requires an evaluation of "environmentally sensitive" areas for proposed projects which may affect these areas. Environmentally sensitive areas include:

- federally-listed endangered, threatened, proposed, and candidate plant and animal species;

- state-listed endangered and threatened plant and animal species; and

- critical habitats for these plant and animal species, and wetlands.

The Y-12 NEPA Program requested a survey of such areas for the Y-12 vicinity. The area was divided into three priority groups (see map 1):

1) Phase I area, the areas within the Y-12 plant boundaries.

2) Phase II areas, which are special interest sites outside of the Y-12 plant boundaries; and

3) Phase III area, which includes a broad area around the Y-12 vicinity.

Sections one through three discuss the results of each phase of the survey. Sections four and five discuss in greater detail rare plants and wetlands found in the Y-12 area.

SECTION ONE. PHASE I AREA

HABITAT DESCRIPTION

Most of this area is dominated by buildings, parking lots and lawns, and thus little natural vegetation. Almost all of the natural vegetation present was on Chestnut Ridge (see map 2). There were also some small forested areas in the valley. Overstory vegetation was dominated by various Oak species (see appendix I for scientific names of species mentioned in this report). The west end of forested area #3 had some large individual Beeches and Oaks. Rocky outcrops were also present. The herbaceous, ground level vegetation was dominated by Japanese honeysuckle in many forested areas, which is common on the Reservation. However, a few forested areas supported a surprising variety of native vegetation.

RARE PLANTS PRESENT

No rare plants were found in the Phase I area. The forested areas on Chestnut Ridge do, however, appear to be suitable habitat for two state listed species, Ginseng and Lesser ladies-tresses. The draft document *Rare Plants on the Oak Ridge Reservation* (see appendix VIII) states that Ginseng and Lesser ladies-tresses occur in rich, moist woods and can be found growing in association with each other. Eight sites for ginseng were seen during the survey of Chestnut Ridge west of the Phase I area (see section three of this report). Ginseng is state-listed as threatened due to heavy commercial exploitation for its reputed medicinal properties; it would be fairly common otherwise. One possible Lesser ladies-tresses plant was also noted on Chestnut Ridge to the west of the Phase I area. The plant could not be located when checked later for flowering to confirm its identification. It may have died back without flowering, which is common. Lesser ladies-tresses is state-listed as a species of special concern. However, it is very inconspicuous and may be more common than previously thought.

WETLANDS PRESENT

Wetlands were surveyed and identified using guidelines established in the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (U.S. Interagency Cooperative Publication, January 1989, see Appendix XI). Section five of this report contains a more thorough discussion on wetlands identification and the wetlands of the Y-12 area in general.

Two small areas of wetland were found in the Phase I area (see map 2). Wetland A included a small pond and stream surrounded mostly by a small forest. Less than .4 acres in size, Wetland A was dominated by Sedges along the edges of the pond, and

Cutgrass where the stream entered the pond (see appendices III and IV for wetland classification. Wetland B occurred along a section of Bear Creek, where the drainage border widened into a marsh dominated by cattails. Approximately 30 ft. in diameter, this wetland was previously described in another survey (see appendix V).

ADDITIONAL COMMENTS

The areas in Phase I that are not identified as having significant natural vegetation or wetlands should require no further surveying for rare plants or wetlands Exceptions to this case would be areas where natural vegetation had been allowed to re-establish or if a drainage would be altered, creating the possibility of wetland development. Those areas in Phase I identified as having significant natural vegetation do have the potential to support two state-listed species. If any of these areas are targeted for development in the future, a resurvey of that particular area is recommended.

SECTION TWO. PHASE II AREA

Four areas of special interest were identified in the area immediately outside the Y-12 boundaries (see map 1). Two areas, the Y-12 Centralized Sanitary Landfill II and the Kerr Hollow Quarry, were eliminated from the survey after discussion between L. Pounds, the principal surveyor, and C. Wilkinson, the primary Y-12 NEPA contact person. The Ash Disposal/Roger's Quarry area has already been written and was sent to C. Wilkinson on October 21, 1991 (see Appendix VI). The last area, the Bear Creek Burial Grounds, is described here.

Bear Creek Burial Grounds.

HABITAT DESCRIPTION

The Bear Creek Burial Grounds include burial mounds, buildings and surrounding area (see map 3). A powerline right-of-way with a large haul road runs generally through the middle of this area. Due to the complexity of the site, the right-of-way will be used as a dividing line for description purposes.

Area north of the powerline right-of-way.

This area was mostly wooded, with the exception of the northwest corner (see map 3). This area is situated at the base and lower reaches of Pine Ridge, and thus has rolling topography with side ridges and valleys. The overstory vegetation was dominated by Oak and Hickory species, with a few scattered Pines. The understory was dominated by Dogwood, Blackgum, and Sweetgum. The amount and types of groundcover were variable. Some areas, especially the slopes, had large amounts of Japanese honeysuckle and Poison ivy. The valleys tended to have a greater variety of natural herbaceous ground cover. Part of this area was surveyed for the Sewer Upgrade Soil Storage Project (see Appendix VII). The northwest corner was highly disturbed and contained little natural vegetation.

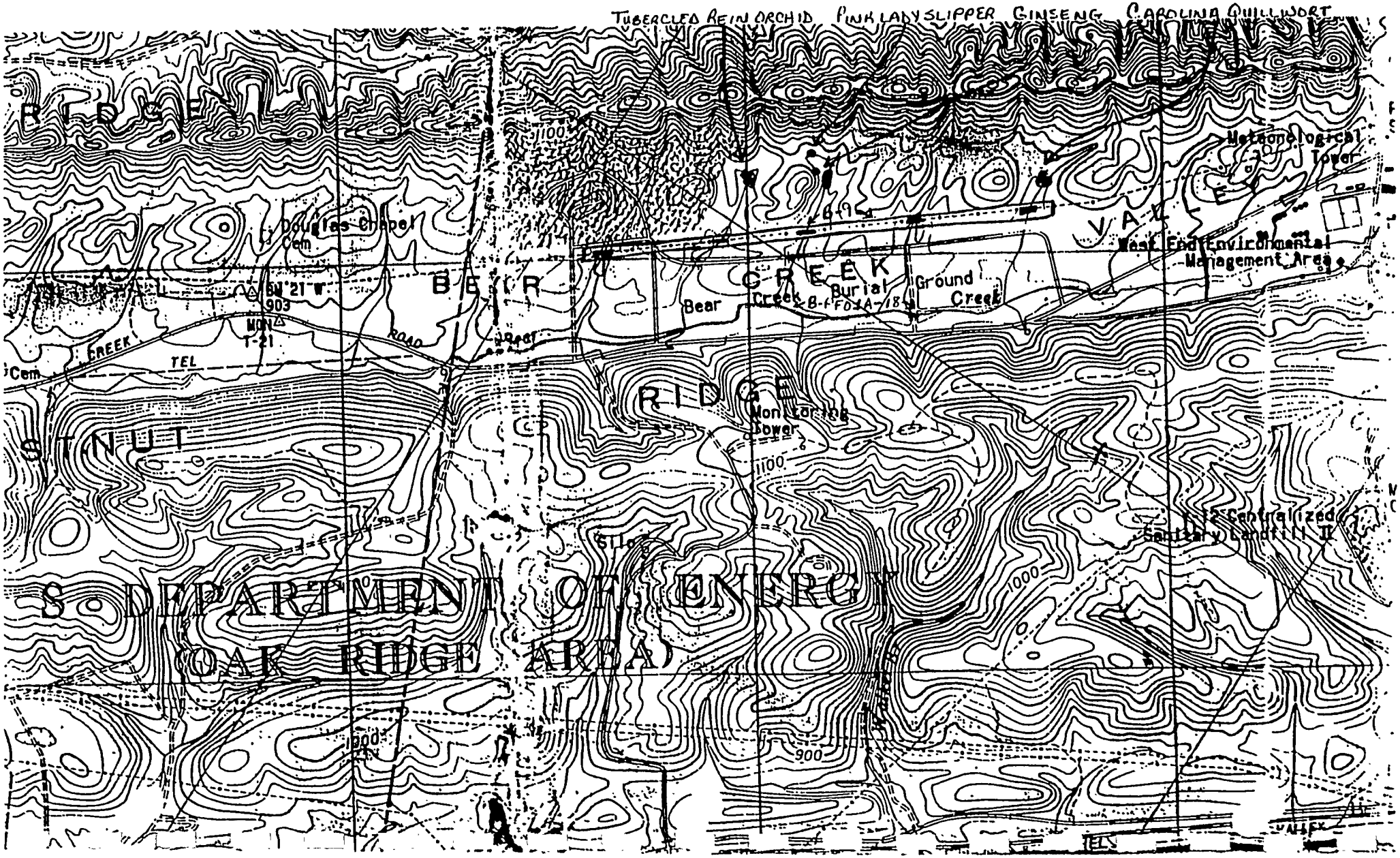
Area south of the powerline right-of-way.

Most of this area contained buildings, lawns, etc., with little natural vegetation. The southeast corner (see map 3) had lawn areas, power line right-of-ways, and some small forested areas. The southwest corner was more wooded, with flood plain forest, pine plantations, and very young, early successional forest. Part of this area is designated a Research Area (RA 7). See the section four of this report for a more detailed discussion. Along the extreme southern edge of this area, Bear Creek runs roughly

Map 3. Map of Bear Creek Burial Grounds, Oak Ridge Reservation, Oak Ridge, TN

Wetlands

Rare plants



parallel with Bear Creek Road. In the area between the Creek and the road, grassy mowed areas were interspersed with branches of flood plain forest and pine plantations.

RARE PLANTS PRESENT

Three State-listed plants were found in the section of forest north of the powerline right-of-way (see map 3). These plants are discussed in Site A of the Y-12 Sewer Upgrade Soil Storage Rare Plant and Wetland Survey Report, sent January 9, 1992 (see appendix VII). A fourth plant species, the Carolina quillwort, was found in a wetland and may soon be described as a new species. As a result, this species may become state- and\or federally-listed. Please see section four of this report for a more detailed discussion.

WETLANDS PRESENT

Wetlands were surveyed and identified using guidelines established in the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (U.S. Interagency Cooperative Publication, January 1989). Section five of this report contains a more thorough discussion on wetlands identification and the wetlands of the Y-12 area in general.

Along the power line right-of-way, a series of small wetlands were labeled B-9 and described in the document *Wetlands of the Oak Ridge Reservation* (see Map 3, and appendix IX). In the area north of the powerline right-of-way, two wetlands were found and described in Site A of the Sewer Upgrade Soil Storage Rare Plant and Wetland Survey Report (see appendix VII). One wetland contained the state-listed Tubercled rein-orchid. An additional wetland found contained the Carolina quillwort, which could be state and\or federally listed in the near future.

In the area south of the powerline right-of-way, the area along Bear Creek contained numerous small forested wetlands and was identified by the Wetlands document as B-PFOlA-18 (see Map 3 and appendix IX).

ADDITIONAL COMMENTS

It would be useful to visit the wetland containing the Carolina quillwort when standing water is present, to look for additional species of interest which might have disappeared when the water went down.

SECTION THREE. PHASE III AREA

The Phase III includes sections of Chestnut Ridge, Pine Ridge, East Fork Ridge, Bear Creek Valley and sections of Bethel Valley (see map 4). This area had the lowest priority and the surveyors did not have enough time left in the growing season to look at this area in detail. Therefore, sites of particular interest to the surveyors (areas of known unique vegetation and/or where little was known botanically) were visited. These visits might be better termed "explorations" rather than surveys since they were not as systematic in method.

Site A. Hembree Marsh. This site (see map 4) was visited and the presence of the rare Fen orchid was confirmed by viewing the plants in flower. These were photographed for the NERP rare plant file.

Site B. "Red Barrens". These barrens are located along the south side of Chestnut Ridge and are cedar barrens where the rock is often reddish. So far, red barrens have not had the rare species seen on other types of cedar barrens, with the possible exception of Torrey's mountain mint (see section four of this report for a detailed discussion).

Site C. A large spring near a rifle range was visited. This appeared to be suitable habitat for the rare plant Nutall's waterweed, which is present further down stream. No plants, however, were found.

Site D. The powerline right-of-way that runs parallel to Bear Creek was visited. Two rare species and an number of uncommon species had been noted along this right-of-way previously (see Appendix IX). Nothing new of note was found in the right-of-way itself, but three new sites for the rare species Tubercled rein-orchid were found in wet areas just north of the right-of-way (see section four).

Site E. The single site on the Oak Ridge Reservation for the rare shrub Mountain witch-alder was relocated.

Site F. Chestnut Ridge. The north side of Chestnut Ridge, from Chestnut road to the Y-12 boundary fence, was visited. Several Ginseng sites were found. A single site for Whorled balm was also found. Please see the section four of this report for a more detailed discussion.

Site G. Pine Ridge. Various sections of Pine Ridge were visited. Much of Pine Ridge had not been seen before by botanists. The east-facing slope of Pine Ridge, above the East Fork of Poplar Creek was looked at and though it would appear to have potential for rare plants, none were found.

Site H. A wetland, labeled B-12 in the Wetlands document (see Appendix IX), was revisited. The uncommon species Twining screwstem was found here. Though not state- or federally-listed, this is the only known site for this species on the Reservation.

Though quite a bit of area was covered in the time allotted for this Phase, two major areas remain to be explored. The western end of Pine Ridge and the East Fork Ridge were not visited and need to be looked at. The rest of Pine Ridge, especially the north facing slopes, needs to be looked at more closely. It is recommended these areas be visited during the next growing season, in order to "complete the picture" of Phase III.

SECTION FOUR. RARE PLANTS IN THE Y-12 AREA

The Department of Energy recognizes that, in addition to the specific legal responsibilities the federal government has with regard to rare plant or animal species (and their habitats) on federal land, there are also responsibilities presented by stewardship of natural resources under its authority. The National Environmental Research Parks were established by DOE in 1976 and given the responsibility for protecting rare plant and animal species through a Natural Area (NA) designation. In addition, areas that are representative of vegetational communities or biotic features unique to the area are designated as Reference Areas (RA). Both types of areas are set aside for protection from habitat destruction through development. A current list of all Natural and Reference Areas are included in Appendix X.

Rare plants which occur on the Oak Ridge Reservation are coded by the Tennessee Department of Conservation and the U.S. Fish and Wildlife Service. Appendix II provides a current list of rare plants which occur on the Reservation, and an explanation of the codes used. In the following subsections, rare plants which are known to occur in the Y-12 vicinity are listed and discussed. In addition, a list and discussion of plant species that were either found or could be found in the Y-12 vicinity, and might become listed in the near future, is included.

STATE- AND/OR FEDERALLY-LISTED PLANTS OCCURRING IN THE Y-12 AREA

The following plant species were found in the Y-12 area and warrant special protection from habitat destruction. Map 5 shows rare plant sites, Natural Area sites, and Reference Area sites on the Y-12 area. Please see appendix X for a more complete description of the Natural and Reference areas present.

1. Pink lady-slipper (Cypripedium acaule)
Status: State listed as Endangered

This species is endangered due to commercial exploitation rather than current rarity and is thus treated differently by the Research Park than other species with the same status. Not all areas where Pink lady-slipper is found are designated as Natural areas or Reference Areas, which would normally be the case for other endangered plant species. An unusually large population of this species in the Y-12 vicinity, however, has been designated as a Reference area (RA-6, see map 5). One plant was found in site A of the Sanitary Sewer Upgrade Rare Plant and Wetland Report (see Appendix VII) and another large population, near the Mountain witch-alder site (labeled NA 12), was found

on Walker Branch. It is expected that this species will be found scattered throughout Pine Ridge and Chestnut Ridge on dry, non-limestone areas, often in association with Pine tree species.

2. Nutall's waterweed (Elodea nuttallii)
Status: State listed as a Species of Special Concern

This is a floating aquatic species which was first reported in the east Tennessee about 30 years ago. It may be more common than previously thought, however, and might be taken off the state list in the foreseeable future. A site on the Phase III area has been designated as RA-28.

3. Mountain witch-alder (Fothergilla major)
Status: State listed as Threatened

This is a truly rare shrub. As part of the Phase III survey, the only known site on the Oak Ridge Reservation was sighted again. The site appears to be a single clonal colony (all plants connected by a single root system). It has been designated as Natural Area 12.

4. Canada lily (Lilium canadense)
Status: State listed as Threatened

This species was found in the past in Natural Areas 2 and 13, but has not been seen recently (see map 5). The area of habitat suitable for this species was substantially reduced by the enlargement of a haul road in NA-13 to carry dirt from a borrow pit to the Bear Creek Burial Grounds.

5. Fen Orchid (Liparis loeselii)
Status: State listed as Endangered

The finding of this northern orchid on the Reservation was quite a surprise. Presumably this species is dependent on the habitat created by an extensive seepage area. It has been designated as Natural Area 24. The identification of this species was confirmed by viewing plants in flower during the Phase III survey. It had previously only been seen in fruit.

6. Ginseng (Panax quinquefolium)
Status: State listed as Threatened, Federally listed as 3C

This species is threatened by commercial exploitation rather than current rarity. It is found in scattered small populations throughout the Reservation in moist forested areas. Generally, Reference and Natural Areas are not established where Ginseng is found. The exception is a very large population in the Phase III area (Fanny Knob), which has been designated as Reference Area 14.

7. Tubercled rein-orchid (Platanthera flava var herbiola)
Status: State listed as Threatened

Before this survey, only one location was known for this species on the Reservation, along Bear Creek down stream from the Y-12 vicinity. Three populations were found in the Phase III area along three branches of Bear Creek. This area has now

been designated as Natural Area 13. An additional population (NA-28) was found on the Bear Creek Burial Ground Phase II area (see the Sanitary Sewer Upgrade Report, appendix VII).

8. Purple Fringeless Orchid (Platanthera peranoena)
Status: State listed as Threatened, Federally listed as 3C

All sites for this species except one have been in small wetlands on or near a powerline right-of-way that parallels Bear Creek. This area has been designated as Natural Area 13 (see map 5).

9. Lesser ladies-tresses (Spiranthes ovalis)
Status: State listed as a Species of Special Concern

This species may be very inconspicuous rather than rare. Though two sites were found in the Y-12 area, only one has been designated a Reference Area (RA 27, see map 5).

PLANT SPECIES THAT MAY BE LISTED IN THE NEAR FUTURE

All but one of the following plants species were found in the Y-12 area and are worth being made aware of.

1. Butternut (Juglans cinerea)
Status: State listed as Threatened and Federally listed as C2

This species of walnut has been recently listed as a federal candidate due to a disease outbreak that is destroying the trees. We know little about the distribution of this species on the Reservation since it has just been listed. The only known record found for the Reservation was on a site that was flooded by Melton Lake. It could be widely scattered, as its habitat requirements are not very specific (i.e. not a rock outcrop or wetland area). It was not found in the Y-12 area during this survey, but continuing efforts will be made to search for this species.

2. Whorled balm (Collinsonia verticillata)
Status: Not listed

Though not State or Federally listed as yet, the Nature Conservancy, a well-respected private conservation organization, classifies this species as a G-2 (Globally threatened 2, G-1 is the rarest). In east Tennessee, this species occurs in mature forest at low elevations, a type of forest not being protected at this time. Two known sites are on the Reservation, including the one found by this survey on Chestnut Ridge (see map 5).

3. Carolina quillwort (Isoetes caroliniana)
Status: Not listed

This will soon be described as a new species in the scientific literature. If accepted, it might well be deserving of state and/or federal listing. A specimen obtained

by this survey from the Bear Creek Burial Grounds was identified as this new species by Joel Duff, a graduate student at the University of Tennessee who is studying this genus. Quillworts of unknown species were also found in the Phase III area (see Map 5). The area surrounding this site has been designated as RA-5.

4. Torrey's mountain mint (Pycnanthemum torrei)
Status: new for Tennessee

A specimen from the Oak Ridge Barren near the Reservation was identified by an expert on the genus as this species. Similar plants were found along the south slope of Chestnut Ridge in barren-like areas (see map 5). This is a difficult genus taxonomically, and currently requires an expert to correctly identify species within the genus. There is the possibility that this species could be state listed. See the draft rare plant document (Appendix VII) for further discussion of this species.

SECTION FIVE WETLANDS IN THE Y-12 AREA

Wetlands have received a great amount of attention in the last few years and have been shown to be an important component of an ecosystem. The quantity and quality of water in local and regional hydrologic systems is greatly influenced by wetland systems. Flood waters can be absorbed by wetlands and water quality greatly improved after passing through wetlands. Wetlands also provide necessary habitat for both resident and migratory wildlife. Considering the benefits wetlands provide and the fact that they are disappearing at an alarming rate, the federal government, including DOE, has mandated a policy of no net loss of wetlands.

Wetlands on the Oak Ridge Reservation have been identified using the methods described in the document *Wetlands on the Oak Ridge Reservation* and guidelines established in the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (U.S. Interagency Cooperative Publication, January 1989)(see Appendices IX and XI).

The process of identifying and delineating "jurisdictional" wetlands has had its problems. Major points that we wrestle with are:

1) The definition of wetlands. What constitutes a wetland is now under a storm of controversy, both within political and scientific realms. The federal definition of wetlands and the federal manual we now use to delineate wetlands are both being proposed for substantial revisions at the present time.

2) The process of identifying wetlands. In the past, the presence of wetland community vegetation and hydrology (presence of saturated soil and/or standing water) were the two criteria we used to determine a wetland. The federal manual, however, states that three criteria should be used: wetland vegetation, soil type, and hydrology (we are adding soil testing this year). The manual further identifies a variety of different methods, depending on the type of area in question (whether a site has disturbed soil, time of year, etc.) Many of these methods are time consuming and costly to carry out. Finding a method that will work in the majority of situations found on the Reservation and also be cost-effective and timely has been a challenge.

3) The size of wetlands. It has been difficult to decide at what scale wetlands should be identified. At what point do we decide that a wetland is too small to deal with? A consistent loss of small areas of wetlands in a region could quickly add up a major deficit in the long run. And with the federal mandate of no *net* loss, it has been difficult to decide what our cutoff point should be. At the present time, we have decided to identify all areas that support a wetland *community* (a variety of wetland plants that exist together). This usually consists of at least 10-20 square meters, or in other words, enough space to accommodate several different wetland vegetative species and develop

the right soil types. We do not identify every spot that supports a wetland plant here and there.

4) The extent of wetlands. In a place as large as the Oak Ridge Reservation, it is nearly impossible to identify all wetlands that are present without spending massive amounts of money and time to systematically survey and sample the entire area. There are, however, certain areas that one could safely assume small areas of wetland vegetation would be found. All drainages termed blue-line (not intermittent) drainages on a United States Geological Survey (USGS) quadrangle map would be expected to have small scattered areas of wetland vegetation. These areas are created where stream banks are low, along side channels, and where seepage enters a floodplain. The edges of lakes and ponds are usually considered wetlands as they are shallow enough to support wetland vegetation. Wetlands also tend to develop upslope from road culverts and along powerline right-of-ways. "Right-of-way" wetlands occur where drainages pass through areas where trees are suppressed by mowing or cutting. These wetlands sometimes extend into forested areas on the upslope side. Surprisingly enough, several rare plant species have been found in this type of wetland, especially along the right-of-way that parallels Bear Creek to the north (see map 5 and section four of this report).

MAPS OF WETLANDS IN THE Y-12 AREA

Map 6 shows all of the wetlands found during the survey that resulted in the Wetlands document. With the addition of the wetlands found during the Phase I and II surveys (see maps 2 and 3), most of the significant wetlands should have been found.

The wetland map needs a bit of explaining. This map is based on the maps in the Wetlands document, which were in turn developed by making additions to the U.S. National Wetlands Inventory Map (NWIM). The identification codes that are present on the map (i.e. PFOlA-97) are explained in the Wetlands document, pages 2-11 (see Appendix IX). Each identification code is also enclosed by an oval, a rectangle, or an elongated hexagon. Those enclosed with an oval indicate that they were identified by the NWIM as wetlands, but were not visited during that survey due to time constraints and/or other reasons (see Appendix IX, methods section). Those enclosed with rectangles were identified by the NWIM as wetlands and were verified by the surveyors as wetlands. Those enclosed with elongated hexagons were identified by the NWIM as wetlands but were determined by the surveyors not to be wetlands.

In addition, to look up descriptions of a wetland shown on map 6 in the Wetlands document, it is necessary to know which quadrangle map it is on, the Bethel valley or the Lovell quadrangle. The dividing line is shown on the map. In the Wetlands document, codes for the Bethel valley quadrangle are prefaced with a B. For example, a code of PFOlA-97 in the Bethel valley section of the map will have a code of B-PFOlA-97 in the Wetlands document. Similarly, Lovell codes are prefaced with an "L". The exception are wetlands found during the survey that were not identified at all by the NWIM. These are labeled with the prefix already attached (e.g. B-1 or L-2). We apologize for any confusion; with the complexity of information involved and system already present on the NWIM maps, this was the best system we could come up with.

SUMMARY

During the growing season of 1991, the Y-12 area was surveyed for rare plants and wetlands, at the request of the Y-12 NEPA program. Three Phases (I, II, and III) were surveyed.

No rare plants were found in the Phase I area, but it was determined that wooded sections along Chestnut Ridge had suitable habitat for two state-listed species. Two small wetlands were identified. With the exception of areas supporting natural vegetation, this area would not need to be resurveyed for rare plants and wetlands for future projects.

Phase II included two separate areas, the Ash Disposal Area and the Bear Creek Burial Grounds. One state-listed species and several small areas of wetlands were found in the Ash Disposal Area. In the Bear Creek Burial Ground, three state-listed species and numerous small wetland areas were found.

Phase III covered quite a bit of area and due to time constraints, only specific sites were visited. At least eight state- and federally-listed species and numerous wetland areas of various sizes were located in this area.

Two additional sections were included to discuss rare plants and wetlands in more detail. Several documents and past surveys on the Y-12 area were included as appendices.

APPENDIX I. Scientific names of plant species mentioned in the proposed Sewage Upgrade Soil Storage Project rare plant and wetland report, Oak Ridge Reservation, Oak Ridge, TN.

Common Name	Scientific Name
Aster sp.	*Aster sp.*
Blackgum	*Nyssa sylvatica*
Bugleweed	*Lycopus sp.*
Cardinal flower	*Lobelia cardinalis*
Cutgrass	*Leersia oryzoides*
Ditch stonecrop	*Penthorum sedoides*
Ginseng	*Panax quinquefolium*
Hedge hyssop	*Gratiola virginiana*
Hickory	*Carya sp.*
Nepal microstegium	*Microstegium vimineum*
Oak	*Quercus sp.*
Pine	*Pinus sp.*
Pink ladies-slipper	*Cypripedium acaule*
Red maple	*Acer rubrum*
Sedges	*Carex sp.*
Spotted touch-me-not	*Impatiens capensis*
Sweetgum	*Liquidamber styraciflua*
Tubercled rein-orchid	*Platanthera flava var herbiola*

APPENDIX I. Scientific names of plant species mentioned in the Y-12 Area Rare Plant and Wetland Report, Oak Ridge Reservation, Oak Ridge, TN.

Common Name	Scientific Name
Beech sp.	*Fagus sp.*
Blackgum	*Nyssa sylvatica*
Butternut	*Juglens cinerea*
Canada lily	*Lilium canadense*
Carolina quillwort	*Isoetes caroliniana*
Cattail	*Typha latifolia*
Cutgrass	*Leersia oryzoides*
Dogwood	*Cornus florida*
Fen orchid	*Liparis loeselii*
Ginseng	*Panax quinquefolium*
Hickory sp.	*Carya sp.*
Japanese honeysuckle	*Lonicera japonica*
Lesser ladies-tresses	*Spiranthes ovalis*
Mountain witch-alder	*Fothergilla major*
Nutall's waterweed	*Elodea nuttallii*
Oak sp.	*Quercus sp.*
Pine sp.	*Pinus sp.*
Pink ladies-slipper	*Cypripedium acaule*
Poison ivy	*Rhus toxicodendron*
Purple fringeless orchid	*Platanthera peranoena*
Sedges	*Carex sp.*
Sweetgum	*Liquidamber styraciflua*
Torrey's mountain mint	*Pycnanthemum torrei*
Tubercled rein-orchid	*Platanthera flava var herbiola*
Twining screwstem	*Bartonia paniculata*
Whorled balm	*Collinsonia verticillata*

APPENDIX I. Mid to late summer abundant vegetation of the Old Ash Disposal Area and down stream drainage, Oak Ridge Reservation, Oak Ridge, TN.

Site	Species Name	Wetland Classification[1,2]
Site A		
Earthen Dam	*Pueraria lobata*	No Classification
Wooded Area	*Acer negundo*	FACW
	Microstegium vimineum	FAC, FACW
	Populus deltoides	FAC+, FACW
	Spiranthes ovalis	FAC
Alder Thicket	*Alnus serrulata*	FAC+, FACW
Open Ash-fill Area	*Arthraxon hispidus*	FAC+, FACW
	Carex sp.	OBL, FACW, FAC
	Equisetum sp.	FACW, FAC+
	Juncus sp.	OBL, FACW
	Salix sp.	OBL, FACW
Northwest Pond	*Callitriche heterophylla*	OBL
Northeast Pond	*Potamogeton foliosus*	OBL
	Typha latifolia	OBL
Site B		
Down Stream Area	*Salix nigra*	OBL
	Typha latifolia	OBL
	Lythrum alatum	FACW+, OBL
Site C		
Roger's Quarry Area	*Juniperus virginiana*	FACU-, FACU

1. National List of Plant Species That Occur in Wetlands: Tennessee. May 1988 Biological Report, Reed Porter Jr., U.S. Fish and Wildlife Service. NERC-88/18.42.
2. See Appendix II for explanation of symbols.

APPENDIX II.

NERC-88/18.42
May 1988
Supersedes WELUT-86/W12.42

National List of Plant Species That Occur in Wetlands: 1988

Tennessee

by

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In cooperation with the National and Regional Interagency Review Panels:

U.S. Fish and Wildlife Service
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Soil Conservation Service

NAT-IND. (National Range Of Indicators)

The National Indicators reflect the range of estimated probabilities (expressed as a frequency of occurrence) of a species occurring in wetland versus nonwetland across the entire distribution of the species. A frequency, for example, of 67%-99% (Facultative Wetland) means that 67%-99% of sample plots containing the species randomly selected across the range of the species would be wetland. A question mark (?) following an Indicator denotes a tentative assignment based on the botanical literature and not confirmed by regional review. When two indicators are given, they reflect the range from the lowest to the highest frequency of occurrence in wetlands across the regions in which the species is found. A positive (+) or negative (-) sign was used with the Facultative Indicator categories to more specifically define the regional frequency of occurrence in wetlands. The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands), and a negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).

INDICATOR CATEGORIES:

Obligate Wetland (OBL). Occur almost always (estimated probability >99%) under natural conditions in wetlands.

Facultative Wetland (FACW). Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in nonwetlands.

Facultative (FAC). Equally likely to occur in wetlands or nonwetlands (estimated probability 34%-66%).

Facultative Upland (FACU). Usually occur in nonwetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).

Obligate Upland (UPL). Occur in wetlands in another region, but occur almost always (estimated probability >99%) under natural conditions in nonwetlands in the region specified. If a species does not occur in wetlands in any region, it is not on the National List.

APPENDIX II. STATUS OF RARE AND ENDANGERED PLANTS ON THE OAK RIDGE RESERVATION[1]

Scientific Name	Common Name	State Stat	Fed Stat
Aureolaria patula	Spreading False-foxglove	T	C1
Cimicifuga rubifolia	Appalachian Bugbane	T	C2
Cypripedium acaule	Pink Lady-slipper	E*	
Delphinium exaltatum	Tall Larkspur	E	C2
Diervilla lonicera	Northern Bush-honeysuckle	T	
Elodea nuttallii	Nutall Waterweed	S	
Fothergilla major	Mountain Witch-alder	T	
Hydrastis canadensis	Golden Seal	T	3C
Lilium canadense	Canada Lily	T	
Lilium michiganense	Michigan Lily	T	
Liparis loeselii	Fen Orchid	E	
Panax quinquefolium	Ginseng	T	3C
Platanthera flava var herbiola	Tubercled Rein-orchid	T	
Platanthera peranoena	Purple Fringeless Orchid	T	3C
Saxifraga careyana	Carey Saxifrage	S	3C
Spiranthes ovalis	Lesser Ladies-tresses	S	

EXPLANATION OF SYMBOLS USED[2]

State

E- ENDANGERED: Species now in danger of becoming extinct in Tennessee because of:
(a) their rarity throughout their range, or
(b) their rarity in Tennessee as a result of sensitive habitat destruction or restricted area of distribution.

E*- TAXA considered to be endangered in Tennessee due to evidence of large numbers being taken from the wild and lack of commercial success with propagation or transplantation.

APPENDIX II. CONTINUED.

T- THREATENED: Species likely to become endangered in the immediately foreseeable future as a result of rapid habitat destruction or commercial exploitation.

S- SPECIAL CONCERN: Species requiring special concern because of:
(a) their rarity in Tennessee because the State represents the limit or near-limit of their geographic range, or
(b) their status is undetermined because of insufficient information.

Federal[3]

C1- Taxa for which the U.S. Fish and Wildlife Service has on file substantial information on biological vulnerability and threats to support the appropriateness to list them as endangered or threatened species. Included are those taxa whose status in recent past is known, but may have already become extinct. Such possibly extinct taxa are indicated by an asterisk (*). Double asterisk (**) indicate taxa believed to be extinct in the wild, but known to be extant in cultivation.

C2- Taxa for which information now in possession of the Service indicated that proposing to list them as endangered or threatened is appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support a proposed rule. Such possibly extinct taxa are indicated by an asterisk (*). Double asterisk (**) indicate taxa believed to be extinct in the wild, but known to be extant in cultivation.

C3- Taxa that are no longer being considered for listing as threatened or endangered species. The following subcategory(ies) is(are) used to further indicate the reason(s) for removal from consideration.

3C- Taxa that have proven to be more abundant or widespread than was previously believed and/or those that are not subject to any identifiable threat.

NOTE: The taxa listed in Categories 1 and 2 may be considered candidates for addition to the list of Endangered and Threatened plants, and, as such, consideration should be given them in environmental planning.

1. *As of August, 1991*
2. *Adapted from the Tennessee Department of Conservation, Ecological Services Division, Rare and Endangered Plant Listing, January 17, 1991.*
3. *Determined by the U.S. Fish and Wildlife Service.*

APPENDIX III. Abundant vegetation of the Y-12 area wetlands, Oak Ridge Reservation, Oak Ridge, TN.

Site	Species Name	Wetland Classification[1,2]
Phase I		
Wetland A	Sedges	OBL, FACW
	Cutgrass	OBL
Wetland B	Cattail	OBL
Phase II		
see section two for referral to other documents containing this information		
Phase III		
see section three for referral to other documents containing this information		

1. National List of Plant Species That Occur in Wetlands: Tennessee. May 1988 Biological Report, Reed Porter Jr., U.S. Fish and Wildlife Service. NERC-88/18.42.
2. See Appendix II for explanation of symbols.

APPENDIX III. Late summer and autumn abundant vegetation of wetland sites on the proposed Sewar Upgrade Soil Storage Project Sites, Oak Ridge Reservation, Oak Ridge, TN.

Site	Species Name	Wetland Classification[1,2]
Site A		
Wetland A	Cardinal flower	FACW+, OBL
	Cutgrass	OBL
	Ditch stonecrop	OBL
	Hedge hyssop	OBL
Wetland B	Bugleweed	OBL
	Nepal microstegium	FAC, FACW
	Sedges	OBL, FACW
Site B		
Wetland A	Aster sp.	FACW
	Blackgum	FAC
	Cutgrass	OBL
	Nepal microstegium	FAC, FACW
	Red maple	FAC
	Spotted touch-me-not	FACW, FACW+
	Sweetgum	FAC+, FACW

1. National List of Plant Species That Occur in Wetlands: Tennessee. May 1988 Biological Report, Reed Porter Jr., U.S. Fish and Wildlife Service. NERC-88/18.42.
2. See Appendix IV for explanation of symbols.

Appendix IV

NERC-88/18.42
May 1988
Supersedes WELUT-86/W12.42

National List of Plant Species That Occur in Wetlands: 1988

Tennessee

by

Porter B. Reed, Jr.
Inland Freshwater Ecology Section
U.S. Fish and Wildlife Service
Suite 101, Monroe Building
9720 Executive Center Drive
St. Petersburg, FL 33702

for

National Wetlands Inventory
U.S. Fish and Wildlife Service
Suite 101, Monroe Building
9720 Executive Center Drive
St. Petersburg, FL 33702

In cooperation with the National and Regional Interagency Review Panels:

U.S. Fish and Wildlife Service
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Soil Conservation Service

NAT-IND. (National Range Of Indicators)

The National Indicators reflect the range of estimated probabilities (expressed as a frequency of occurrence) of a species occurring in wetland versus nonwetland across the entire distribution of the species. A frequency, for example, of 67%-99% (Facultative Wetland) means that 67%-99% of sample plots containing the species randomly selected across the range of the species would be wetland. A question mark (?) following an Indicator denotes a tentative assignment based on the botanical literature and not confirmed by regional review. When two indicators are given, they reflect the range from the lowest to the highest frequency of occurrence in wetlands across the regions in which the species is found. A positive (+) or negative (-) sign was used with the Facultative Indicator categories to more specifically define the regional frequency of occurrence in wetlands. The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands), and a negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).

INDICATOR CATEGORIES:

Obligate Wetland (OBL). Occur almost always (estimated probability >99%) under natural conditions in wetlands.

Facultative Wetland (FACW). Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in nonwetlands.

Facultative (FAC). Equally likely to occur in wetlands or nonwetlands (estimated probability 34%-66%).

Facultative Upland (FACU). Usually occur in nonwetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).

Obligate Upland (UPL). Occur in wetlands in another region, but occur almost always (estimated probability >99%) under natural conditions in nonwetlands in the region specified. If a species does not occur in wetlands in any region, it is not on the National List.

Internal Correspondence

April 5, 1991

MARTIN MARIETTA ENERGY SYSTEMS, INC.

J. C. Hughey, K-1550-E, MS-7233, K-25

RESULTS OF PRELIMINARY SURVEY

Preliminary surveys of three sites, on the Production Waste Treatment Facilities (PWTF) at Y-12, were conducted by Larry Pounds during March 1991.

GENERAL DESCRIPTION:

Site 1. The proposed Oil/Solvents Treatment Facility (OSTF) site is characterized by areas of high disturbance in the form of paved parking lots, with very little supporting vegetation present.

Site 2. The proposed Packaging, Certification and Staging Facility (PCSF) site is essentially the same characteristically as site 1, and is also bordered on one side by a portion of the Bear Creek drainage system. This section of Bear Creek has been highly disturbed in the past and is posted as contaminated.

Site 3. The proposed Material Treatment Facility (MTF) site is characterized by the same conditions as site 2.

OCCURRENCE OF RARE PLANTS- Sites 1,2, and 3 are unlikely to support rare plants due to the high disturbances present.

OCCURRENCE OF WETLANDS:

Site 1. No wetlands are present on this site.

Site 2. Approximately 5-7 feet of wetland vegetation is present in scattered areas along the Bear Creek drainage border of this site.

Site 3. The Bear Creek drainage border widens into a cattail (*Typhus spp.*) marsh approximately 30 feet in diameter.

If you have any questions or comments, please feel free to call me.

Carol T. Hardy

Carol Hardy, 1505, MS-6038, ORNL, 6-7544

cc: S.L. Cross, 9204-1, MS-8048, Y-12
S.E. Poligone, 9115, MS-8219, Y-12
E. Harrington, 1000, MS-6342, X-10
J. Stone, 9115, MS-8219, Y-12

Appendix VI

Internal Correspondence

MARTIN MARIETTA

MARTIN MARIETTA ENERGY SYSTEMS, INC.

October 18, 1991

Cory Wilkinson, Bldg. 9115, MS-8219, Y-12

RESULTS OF THE Y-12 OLD ASH DISPOSAL AREA SURVEY

A rare plant and wetland survey was requested for the Y-12 Old Ash Disposal Area and its downstream drainage, as part of a general Y-12 survey. This part of the survey was conducted by Larry Pounds and Rebecca Cook from July to September, 1991.

HABITAT DESCRIPTION

Due to the complexity of the area involved, the surveyed area was divided into three sites (see map) for description purposes.

Site A: Earthen dam and ash-filled area.

The earthen dam itself was covered with Kudzu (*Pueraria lobata*). Directly behind the dam, a wooded area had become established on the fly ash substrate. Cottonwood (*Populus deltoides*) was dominant in the overstory and Box elder (*Acer negundo*) abundant in the understory. Nepal microstegium (*Microstegium vimineum*) was the dominant groundcover. An Alder (*Alnus serrulata*) thicket occurred just north of the cottonwood stand. Lesser ladies-tresses orchid (*Spiranthes ovalis*) was found growing in this thicket. This was an unusual find, as this plant usually occurs in drier habitats.

Continuing north from the alder thicket (see map), the area became more open. The vegetation was dominated by a grass, Joint-headed arthraxon (*Arthraxon hispidus*). Horsetails (*Equisetum sp.*), Sedges (*Carex sp.*), and Rushes (*Juncus sp.*) also occured. Scattered Willows (*Salix sp.*) and some Alders were found throughout the area and along a well-defined stream course to the east side of the ash fill. The stream course was apparently a continuation of an existing natural stream that enters the ash fill area further up the valley. Its flow appeared to be intermittent at the time of this survey. A less well-defined stream course was also observed on the west side of the ash fill area.

A small pond was found in the northwest corner of the valley (see map). Its water level dropped to just below the surface during the course of this survey. A floating aquatic

species, Larger water-starwort (*Callitriche heterophylla*) dominated the vegetation on the pond. A larger pond was also found in the northeast corner of the area (see map). Cattails (*Typha latifolia*) and Sedges surrounded the edge of this pond and Leafy pondweed (*Potamogeton foliosus*) dominated vegetation on the pond surface.

Site B. Down Stream Area
Immediately below the earthen dam, Kudzu continued to dominate the vegetation. Continuing south along the stream course (see map), mixed deciduous forest vegetation became dominant. The banks of the stream were forested until just north of Roger's Quarry, where area opened up for about a quarter of an acre (see map). There was evidence of significant past disturbance at this site. Black willow (*Salix nigra*) and cattail dominated the vegetation along both sides of the stream. Winged loosestrife (*Lythrum alatum*) also was found here, which represents the only known site on the Oak Ridge Reservation for this particular species.

Site C. Roger's Quarry Area
This area was viewed from just outside an existing fence, because the surveyors did not have access to the area at the time of the survey. The quarry had very steep banks with many areas of bare rock. Red cedar (*Juniperus virginiana*) occured sporadically throughout this area. The quarry contained a deep pond that had embankments too steep to support any significant vegetation communities along its edge.

RARE PLANTS PRESENT
About ten Lesser ladies-tresses orchids were found on site A (see site description and map). This inconspicuous orchid is classified by the State of Tennessee as a Species of Special Concern, but may be more abundant than previously thought. It is not a federally listed species.

WETLANDS PRESENT
Site A. The two ponds located in the northeast and northwest corners of the site (see site description and map) do meet the wetland requirements established by the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (U.S. Federal Interagency Cooperative Publication, January 1989). There was standing water at both locations for over a month during the time of the survey. The vegetation present (see Appendix I) was dominated by Obligate and Facultative Wetland species (see Appendix II for explanation of terms).

The rest of the fly ash fill area represents an unique situation. The vegetation present (see site description and Appendix I) was dominated by Obligate and Facultative Wetland species and water was present at or near the surface for the duration of the survey. Fly ash, however, is not considered a wetland soil. Water flow into the ash fill area has also decreased due to recent rerouting activities. How significantly the area's hydrology will change is uncertain at this time. As a result of these factors, it is unclear whether this area should be classified as a jurisdictional wetland.

Site B. The open area just north of Roger's Quarry meets the requirements for a jurisdictional wetland. The vegetation was dominated by Obligate and Facultative Wetland species (see site description and Appendix I). The .25 acre area had standing water and water just at the surface throughout the time of this survey.

Site C. There were no wetlands present at this site.

If you have any questions, please feel free to call me.

Carol L. Hardy

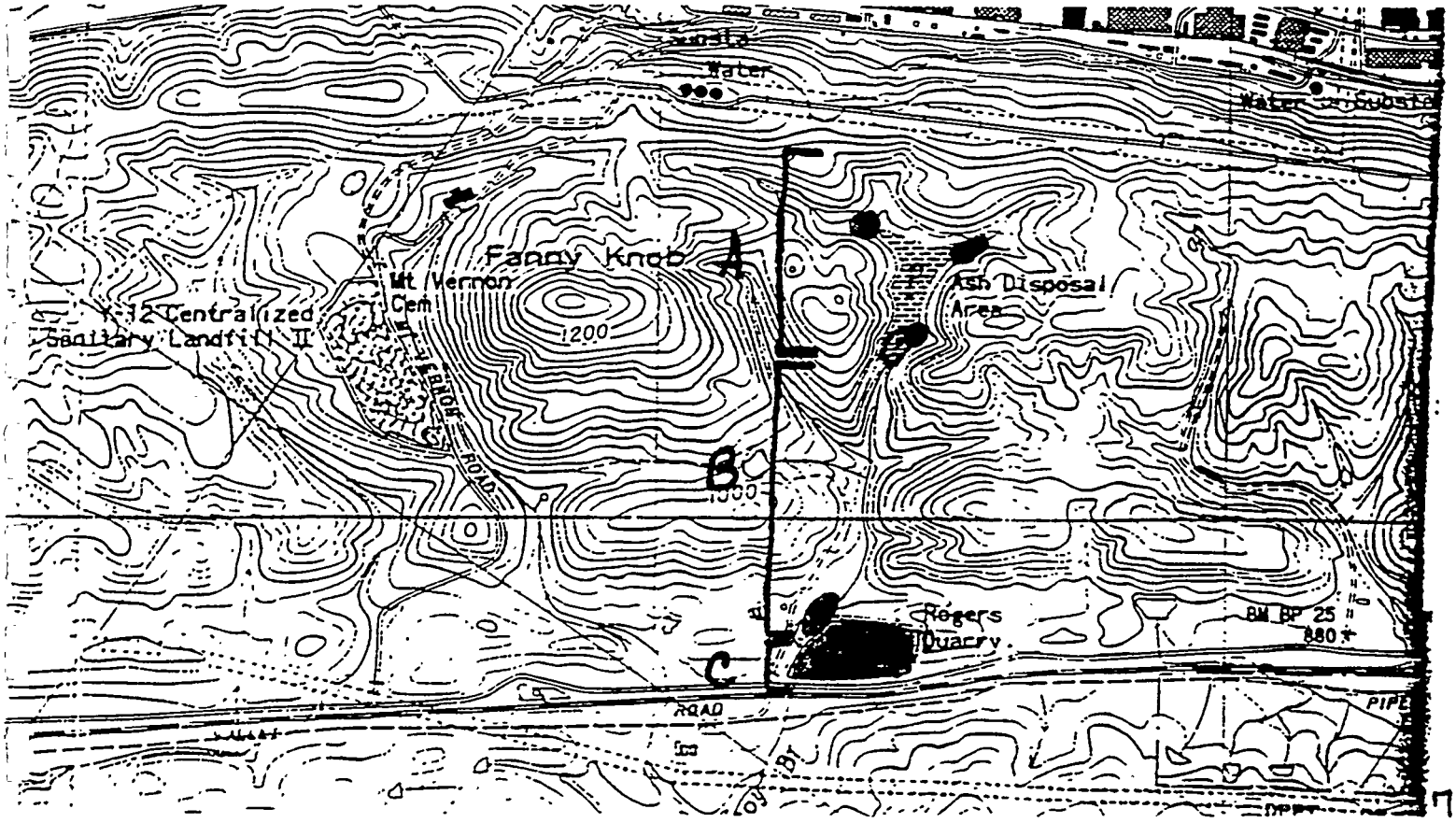
Carol L. Hardy, Coordinator, Rare Plant and Wetland Surveys, Environmental Sciences Division, Bldg. 1506, MS-6034, (6-7544)

enclosure

cc: Don Ainley, Bldg. 9739, MS-8209, Y-12
Mick Wiest, Bldg. 9116, MS-8098, Y-12

Map of the Old Ash Disposal Area and its down stream drainage, Oak Ridge Reservation. Oak Ridge, TN

- Questionable forested wetland
- Questionable open wetland
- Open wetland
- Deep water
- *Spiranthes ovalis* site



Appendix VII

Internal Correspondence

MARTIN MARIETTA

MARTIN MARIETTA ENERGY SYSTEMS, INC.

January 7, 1992

Jim Siberell, Bldg. 9204-1, MS-8048, Y-12

RESULTS OF THE PROPOSED SEWER UPGRADE SOIL STORAGE PROJECT

A rare plant and wetland survey was requested for the Sewer Upgrade Soil Storage Project, which was conducted by Larry Pounds, Rebecca Cook, and Suzanne Oberholster from August to October, 1991.

HABITAT DESCRIPTION

The project has two proposed sites, Site A and Site B (see maps 1 and 2). Both sites were predominately wooded by Oak and Hickory species, with a few scattered Pines (see Appendix I for scientific names). Both sites were characterized by rolling ridges and valleys.

RARE PLANTS PRESENT

Site A. Three rare plant species were found on this site. One plant of Pink ladies-slipper, State listed as Endangered due to commercial exploitation (see map 1 and Appendix II), was located at the western end of the site in an upland area. This plant was found on the extreme northern boundary. A small population of about a dozen Tubercled rein-orchids, State listed as Threatened, were located in wetland B (see map 1). In addition, about 25 Ginseng plants, State listed as Threatened due to commercial exploitation, were found on a slope on the southeastern corner of the site.

Site B. No rare plants were found on this site.

WETLANDS PRESENT

Wetlands were surveyed and identified using guidelines established in the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (U.S. Interagency Cooperative Publication, January 1989). Wetlands identified can be flagged to allow for more accurate mapping.

Site A. Two wetlands were located in this area (see map 1). Wetland A was approximately .4 acre in size and located in the southeastern corner of the proposed site. It is possible that construction of the haul road created this wetland area due to blockage of a small stream. Standing water was present at this site for the duration of the survey. The wetland was dominated by Cutgrass, Hedge hyssop, Ditch Stonecrop, and Cardinal flower (see Appendix III and IV for wetland classification).
Wetland B was also about .4 acre in size and was located on the western end of the site (see map 1). The wetland area was found in a low area where a small stream widened. Dominant vegetation included Nepal microstegium, Sedges, and Bugleweed (see Appendix III and IV). The Tubercled Rein-orchid (see Rare plant section) was also found at this site.

Site B. One probable wetland (wetland A) was located on the eastern end of the site (see map 2). The wetland was forested and continued eastward outside of the site boundaries. Within the site, the wetland was about an acre in size. The area had saturated soil (water just at or below the soil surface) for the duration of the survey. Overstory vegetation was dominated by Sweetgum, Red maple, and Blackgum (see Appendix III and IV for wetland classification). Ground-cover vegetation was dominated by Cutgrass, Nepal microstegium, Spotted touch-me-not, and Aster species.

ADDITIONAL COMMENTS
There were indications of possible research on Site B. Several places had stakes, tags, and small wire mesh circles, possibly exclosures or enclosures. ESD research references held by Pat Parr (Manager, National Environmental Research Park) were checked, and no reference to this site was found.

If you have any questions, please feel free to call me.

Carol L. Hardy

Carol L. Hardy, Coordinator, Rare Plant and Wetland Surveys, Environmental Sciences Division, Bldg. 1506, MS-6034, (6-7544)

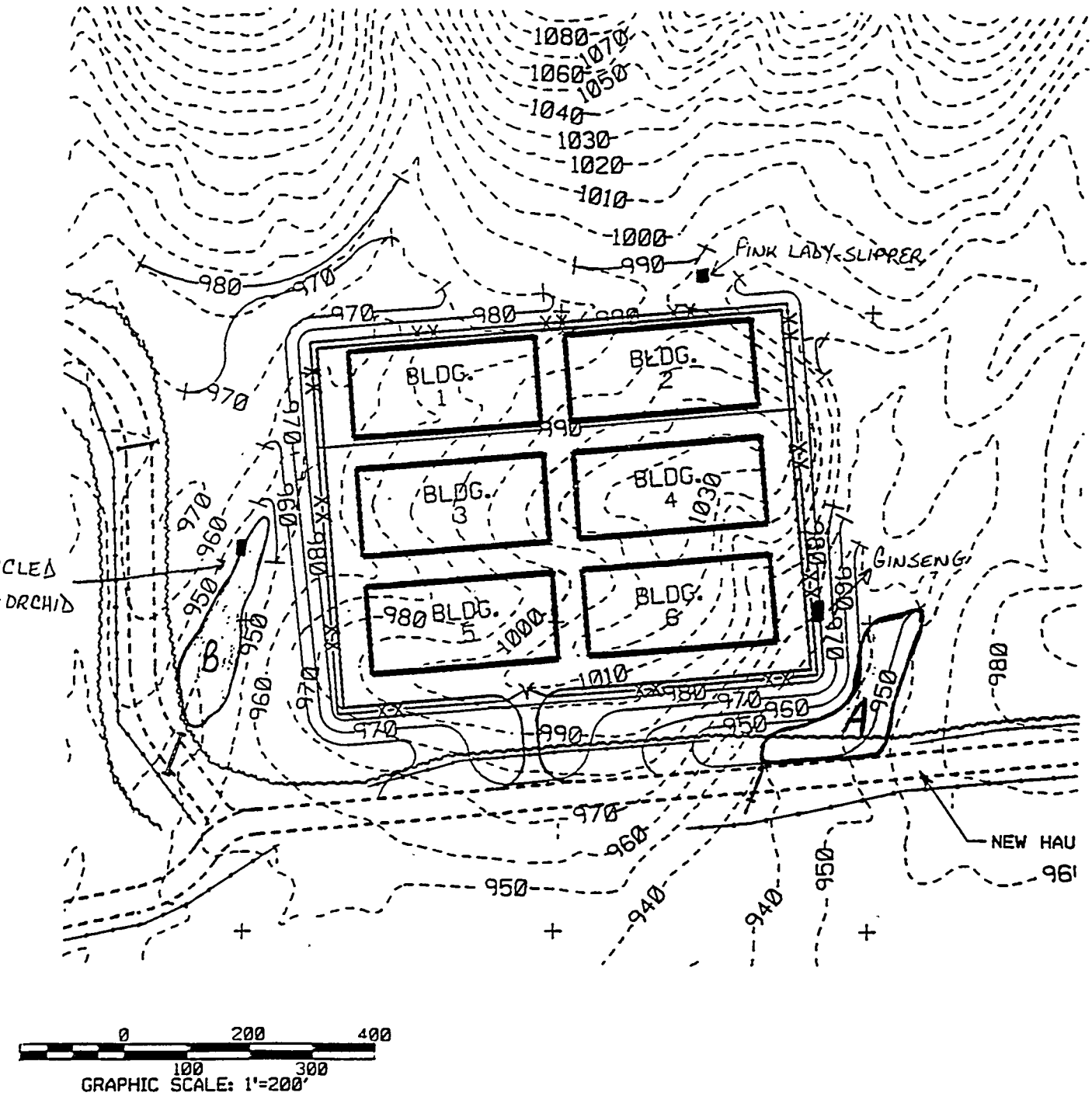
enclosure

cc: Cory Wilkinson\Sheila Poligone, Bldg. 9115, MS-8219, Y-12

Map 1. Map of a proposed site for the Sewar Upgrade Soil Storage Project, Oak Ridge Reservation, Oak Ridge, TN.

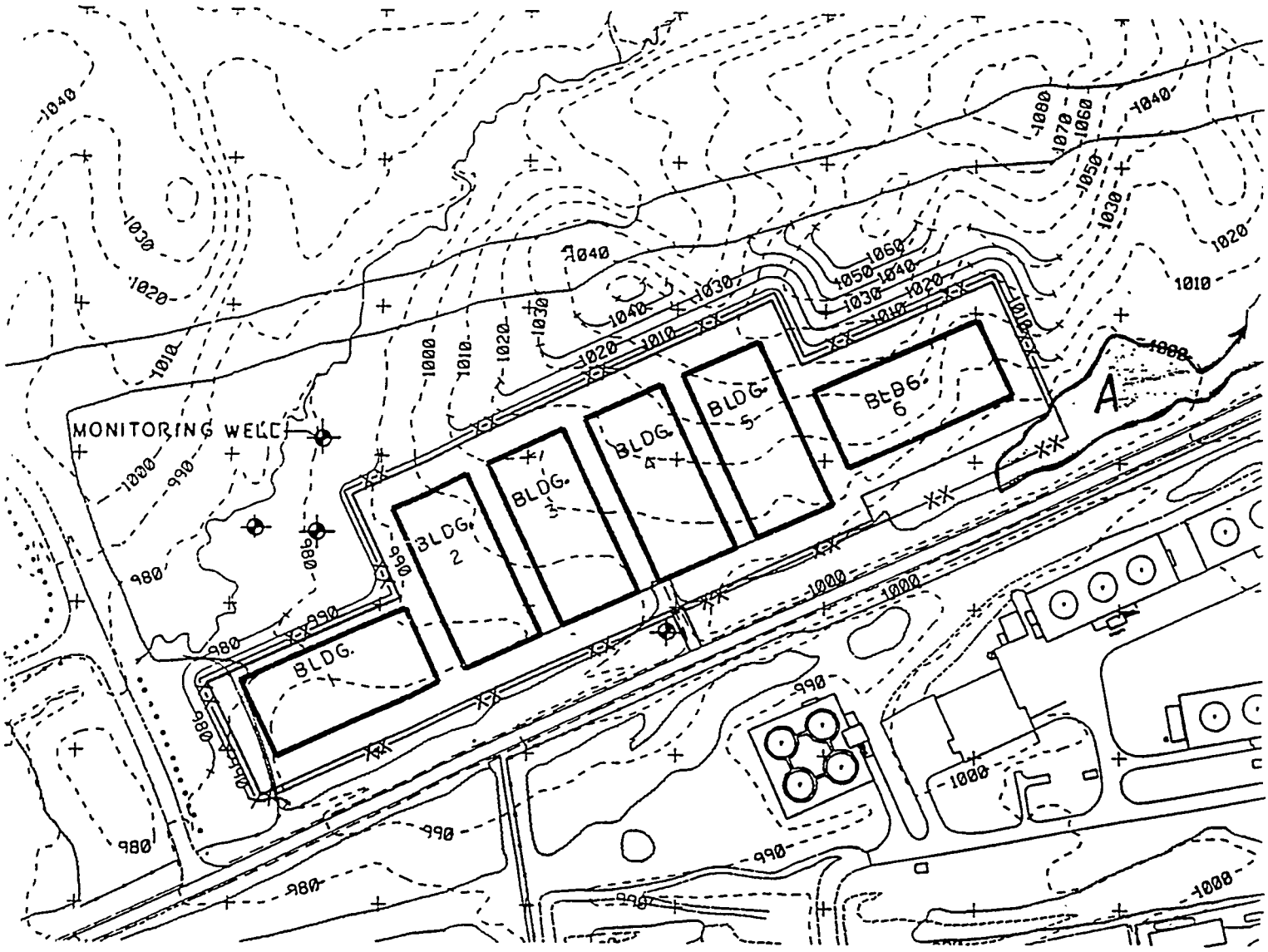
Wetland Areas

Rare Plant Areas



Map 2. Map of a proposed site for the Sewar Upgrade Soil Storage Project, Oak Ridge Reservation, Oak Ridge, TN.

Wetland Areas



Appendix VIII

DRAFT

Rare Plants on the Oak Ridge Reservation

Maureen Cunningham, Larry Pounds, Pat Parr, and Lonnette Edwards

April 1991

RARE PLANTS ON THE OAK RIDGE RESERVATION

I. ABSTRACT

Rare plant species listed by state or federal agencies and found on the Department of Energy's Oak Ridge Reservation (ORR) are identified. Fourteen species present on the ORR are listed by the Tennessee Department of Conservation as either endangered, threatened or of special concern. Three of these are under review by the U.S. Fish and Wildlife Service for possible listing as threatened or endangered species. Ten species listed by the state occur near and may be present on the ORR; four are endangered in Tennessee and one is a candidate for federal listing. A range of habitats supports the rare taxa: river bluffs, calcareous barrens, wetlands, and deciduous forest. Sites for listed rare species on the ORR have been designated as National Environmental Research Park Natural Areas. Consideration of rare plant habitats is an important component of resource management and land-use planning; protection of rare species in their natural habitat is the best method of ensuring their long-term survival. In addition, the National Environmental Policy Act requires that federally funded projects avoid or mitigate impacts to listed species. The list of rare plant species and their location on the ORR should be considered in evolution since the entire ORR has not been surveyed.

II. OBJECTIVES

The objectives of a management plan for rare plant species are:

1. To identify plant species found on the Department of Energy's Oak Ridge Reservation (ORR) that are listed or proposed for listing by state or federal agencies as endangered, threatened or of special concern.

2. To identify listed plant species that may be present on the ORR based on occurrence near the ORR and presence of suitable habitat.

3. To provide information on the location and habitats of rare species known to occur on the ORR.

4. To consider significant threats to the rare plant populations on the ORR.

5. To recommend rare species protection through natural area designation and habitat preservation and management.

III. INTRODUCTION

The Oak Ridge Reservation (ORR) is an island of primarily natural vegetation surrounded by dramatically different land uses. Since 1942 when the land was purchased for the wartime Manhattan Project, the 15,000 ha reservation has been undisturbed except for project development activities of the Department of Energy (DOE) and its predecesors. Today residential, commercial, industrial, and agricultural land uses outside the reservation boundaries contrast with the natural vegetation on the ORR. The ORR is thus an important large tract of natural habitats and in 1989 was designated a unit of the Southern Appalachian Biosphere Reserve by the United Nations Man and the Biosphere Program.

Federal environmental regulations require that significant natural resources on the ORR be considered in Department of Energy project development. The policy of the DOE Oak Ridge Operations office for project planning on the ORR requires that:

"Prior to initiation of any project that could directly or indirectly impact significant land area that might contain resources protected under the Endangered Species Act or the National Historic Preservation Act, a thorough and up-to-date survey of the specific land area proposed for the project should be conducted by appropriate professionals to confirm the absence of any protected resources.... In addition to resources protected under federal law, state statutes and regulations pertaining to wildlife protection and historical protection should also be considered." (Lenhard 1988).

The purpose of this document is to present information on the listed rare plant species currently known to occur on the ORR, as well as listed species potentially occurring on the ORR based on geographic range and habitat availability. **It should be noted that for most of the ORR detailed rare plant surveys have not been performed. It is not the intention of this report imply that the**

ORR has been entirely surveyed or that the rare species list for the ORR is complete. For project planning purposes this report is most useful in alerting planners that rare species are known to exist in certain areas that have been systemically surveyed.

GENERAL VEGETATION

Rare plant resources are best described in the context of the general vegetation and species richness of an area. Significant habitats for rare species occur within the vegetation matrix on the ORR described in the following paragraphs.

The general vegetation of the ORR was described by Kitchings and Mann (1976). Major plant communities of the ORR were group into seven categories by Dahlman et al (1977). Mann (1990) summarized the previous descriptions with more current information on communities and their distribution on the ORR:

"Plant communities on the ORR are characteristic of those found in the intermountain regions of Appalachia from the Allegheny Mountains in southern Pennsylvania to the southern extension of the Cumberland Mountains in northern Alabama. The dominant association on the ORR is **oak-hickory forest** which is most widely distributed on ridges and dry slopes. Common overstory species are chestnut oak, black oak, northern and southern red oak, scarlet oak, white oak, and several species of hickory. Shortleaf and Virginia pine are also present. Abundant understory species include red maple, blackgum, and sourwood.

Northern hardwoods are found in coves that are interspersed along the dissected ridge system. Common overstory species in these areas are tulip-poplar, beech, sugar maple, buckeye, and white ash. Some white pine, hemlock, basswood and magnolias also occur in these areas. **Hemlock and white pine** are abundant in the Cumberland Mountains but are uncommon in natural stands on the ORR. Small areas on steep slopes and limestone bluffs along Poplar Creek on Black Oak Ridge and McKinney Ridge are good examples of this type. **Cove communities** often grade into **floodplains** in lower slope positions where more flood tolerant tree species such as boxelder, elm, sycamore, and green ash become abundant.

The original forests were extensively cleared and the land cultivated during settlement. Except on very steep slopes, most of the forest had been cut for timber, though not necessarily cleared and put into cultivation. Since cultivation ended on the ORR in 1942, cultivated fields have developed into forest either through natural succession or planting of pines. Many of these old abandoned fields that were not planted in pines now support stands of tulip-poplar while others contain mixtures of pine, hickory, dogwood, and other hardwoods. Between 1948 and 1954, many of the abandoned fields which were not already well-stocked with naturally regenerating timber species were planted with loblolly, shortleaf, and white pines. Most of these plantations have been maintained with little or no invasion by hardwoods. Additional pine plantations have since been established in some areas that have been harvested. Most pine stands that currently exist are on lower slopes, relatively level, wide ridgetops, and well-drained bottomlands.

Although small in area, cedar barrens are common on the ORR. These drought tolerant plant communities occur on shallow, flaggy, limestone soils. Dominant species are grasses, such as little bluestem and dropseed, and a variety of forbs with scattered cedars and stunted oaks. Bare rock is fairly common. Cedar barrens are habitat for several species of rare plants. Prairie species more common in the midwestern United States are characteristic of cedar barrens."

The vascular flora of the ORR has been inventoried and updated (Olson et al 1966; Mann and Bierner 1975; Mann et al 1985; L. R. Pounds, University of Tennessee, personal communication 1989). Field surveys on the ORR conducted in 1990 by Cunningham and Pounds resulted in 57 additions to the checklist for the site; the number of vascular plant taxa now known to be present on the ORR is 1011 (Appendix 3). Previous reports (Kroodsma 1985, and Dahlman et al 1977) list the number of species on the ORR as 1370; these earlier checklists included taxa likely to occur on the site based on composite county records.

Portions of the ORR have been systematically surveyed for the presence of rare plant species. In general, such surveys were performed to address environmental issues associated with specific development projects on the ORR. Survey methods for large areas involve: 1) using soils maps and topographic maps to identify habitats that may support rare taxa known to occur on the ORR, 2) traversing the area in a systematic fashion to ensure that the range of habitats and general vegetation are known, 3) scanning unusual habitats for the presence of rare species, and 4) identifying unknown taxa. Changes are periodically made to the state and federal rare species

lists, and our information on rare species on the ORR is constantly being updated. For example, several listed plant species previously unknown on the ORR were discovered in the 1990 season. In future surveys information on these taxa will be included in the range of habitats carefully scrutinized and in the "search image" in the eye of the field botanist conducting the survey.

The U.S. Fish and Wildlife Service (1990) and the Tennessee Department of Conservation (1991) list rare species in one of several status categories; these categories are explained in Appendix 1. A brief history of rare plant listings in Tennessee (Somers 1989) and a summary of Tennessee law governing the harvesting and sale of ginseng are presented in Appendix 2.

IV. PLAN

Rare plant species on the ORR are listed in Table 1 and described in Section A. Listed species that occur close to and may be present on the ORR are listed in Table 2 and described in Section B. Listed species that occur in the Ridge and Valley physiographic province of Tennessee and that occur in habitat similar to those on the ORR are listed in Table 3. Species listed in Table 3 are considered to be potentially present on the ORR, but with lesser likelihood than those in Table 2.

General habitat information for each species was taken from "The Vascular Flora of the Carolinas" (Radford et al 1968). If the species was not included in that manual, then other references were, in order of use,: 1) "Guide to the Vascular Plants of the Blue Ridge" (Wofford 1989); 2) "Vascular Flora of the Southeastern United States" (Cronquist 1980); 3) "Some Rare and Endangered Plant Species of the Southeastern United States" (Kral 1983); 4) "An Atlas and Guide to the Threatened and Endangered Vascular Plants of the Mountains of North Carolina and Virginia" (Massey et al 1983); and 5) "The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada" (Gleason 1952). Range information was compiled from the above sources, the Tennessee Department of Conservation, and a recent survey of government and private conservation organizations conducted by Edwards (unpublished data 1991). Descriptive information for each species focuses on distinguishing characteristics.

Table 1. Habitats and rarity status of plant species listed by state or federal agencies that occur on the Oak Ridge Reservation (ORR).

Species	Common Name	Habitat on ORR	Status
Aureolaria patula	Spreading false-foxglove	river bluffs	C1, E
Cimicifuga rubifolia	Appalachian bugbane	river slopes	C2, T
Cypripedium acuale	Pink lady-slipper	dry to rich woods	E*
Delphinum exaltatum	Tall larkspur	barrens, woods	C2, E
Diervilla lonicera	Norhtern bush-honeysuckle	river bluffs	T
Elodea nuttallii	Nuttall waterweed	ponds, embayments	S
Fothergilla major	Mountain witch-alder	woods	T
Hydrastis canadensis	Golden seal	rich woods	T
Lilium canadense	Canada lily	moist woods	T
Liparis loeselii	Fen orchid	forested wetland	E
Panax quinquifolius	Ginseng	rich woods	3C, T
Platanthera flava v. herbiola	Tuberculed rein-orchid	forested wetland	T
Platanthera peramoena	Purple fringeless orchid	wet meadow	3C, T
Saxifraga carevana	Carey saxifrage	river bluffs, sinks	C3, S

Spiranthes ovalis	Lesser ladies tresses	moist to dry woods	S

Status codes (see Appendix 1 for full explaination):

C1 - Candidate for federal listing. Proposed listing conisdered likely.

C2 - Candidate for federal listing. More information needed to determine status.

C3 - Taxa no longer considered for federal listing. Subcategories indicate reasons.

3C - Taxa more widespread or abundant than previously thought, or taxa not subject to immediate threat.

E - Endangered in Tennessee.

E* - Endangered in Tennessee due to commercial exploitation.

P - Possibly extirpated in Tennessee.

T - Threatened in Tennessee.

S - Special Concern in Tennessee.

Table 2. Habitats and rarity status of plant species listed by state or federal agencies that occur near and may be present on the Oak Ridge Reservation (ORR).

Species	Common Name	Habitat near ORR	Status
Berberis canadensis	American barberry	rocky bluffs	S
Draba ramosissima	Branching whitlow-grass	river bluffs	S
Gnaphalium helleri	Catfoot	dry forest edge	S
Liatris cylindracea	Slender blazing star	barren	E
Lonicera dioica	Mountain honeysuckle	rocky river banks	S
Meehania cordata	Heartleaf meehania	river slopes	T
Pedicularis lanceolata	Swamp lousewort	wet meadow, seeps	T
Pycnanthemum verticillatum	Whorled mountain-mint	wet woods	E-P
Solidago ptarmicoides	Prairie goldenrod	barren	E
Tomanthera auriculata	Earleaf false-foxglove	barren	C2, E

Status codes (see Appendix 1 for full explaination):

C1 - Candidate for federal listing. Proposed listing conisdered likely.

C2 - Candidate for federal listing. More information needed to determine status.

C3 - Taxa no longer considered for federal listing. Subcategories indicate reasons.

3C - Taxa more widespread or abundant than previously thought, or taxa not subject to immediate threat.

E - Endangered in Tennessee.

P - Possibly extirpated in Tennessee.

T - Threatened in Tennessee.

S - Special Concern in Tennessee.

Table 3. Rare plant species listd by state or federal agencies that occur in the Ridge and Valley physiographic province of east Tennessee and grow in habitat types found on the Oak Ridge Reservation.

Species	Common Name	Habitat	Status
Arabis patens	Spreading rockcress	limestone slopes	E-P
Aster ericoides	White heath aster	dry, open areas	T
Aster pratensis*	Aster	dry prairies	T
Chrysogonum virginianum	Green-and-gold	rocky woodlands	T
Heuchera longifolia v.aceroides	Maple-leaf alumroot	calcareous woods	S
Lonicera flava	Yellow honeysuckle	woodlands	S
Polymnia laevigata	Tennessee leafcup		C3, S
Rhamnus alnifolia	Alderleaf buckthorn	swamps, low woods	E
Rhynchospora capillacea	Capillary beakrush	limestone seeps	E-P
Silphium laciniatum	Compass plant	prairies	T
Synandra hispidula	Gyandotte beauty	rich wooded slopes	C3, T
Tetragonotheca helianthoides	Pineland squarehead	woods, thickets	E-P
Woodwardia virginica	Virginia chainfern	wet acid soils	S

* Formerly listed as A. sericeus

Status codes (see Appendix 1 for full explaination):

C1 - Candidate for federal listing. Proposed listing conisdered likely.

C2 - Candidate for federal listing. More information needed to determine status.

C3 - Taxa no longer considered for federal listing. Subcategories indicate reasons.

3C - Taxa more widespread or abundant than previously thought, or taxa not subject to immediate threat.

E - Endangered in Tennessee.

P - Possibly extirpated in Tennessee.

T - Threatened in Tennessee.

S - Special Concern in Tennessee.

Section A. Rare Plants on the Oak Ridge Reservation

Aureolaria patula (Chapm.)Pennell

COMMON NAME:	Spreading false-foxglove
FAMILY:	Scrophulariaceae
FEDERAL STATUS:	Category 1
TENNESSEE STATUS:	Threatened
HABITAT:	Wooded, calcareous, river and creek bluffs (Kral 1983).
HABITAT ON ORR:	In shade on calcareous bluffs and talus slopes along the Clinch River and several tributaries.
RANGE:	c. Ky. to n Ga. (B&B), AL (Collins)
TENNESSEE COUNTIES:	Anderson, Coffee, Knox, Morgan, Roane
DESCRIPTION:	Erect to decumbent perennial herb with stems up to 12 dm in length. Stem not glaucus. Lower leaves lobed. Corolla yellow, pedicels 15-25 mm long, capsule glabrous.
FLOWERING DATE:	late August-early October
FRUITING DATE:	October-November
LOCATIONS ON THE ORR:	1) Research Park Natural Area 19. River bank and talus slope on north side of Clinch River, between river mile 10.5 and 11.5. Last

observed in 1990. Roane County.

2) Research Park Natural Area 1. River bluff on Campbell Bend side of Clinch River, approximately at river mile 12.5. Last observed in 1990. Roane County.

3) Research Park Natural Area 20. Wooded rocky bluffs on Poplar Creek, a tributary to the Clinch River. Also noted at scattered locations on rocky bluffs on Poplar Creek outside the natural area. Last observed in 1990. Roane County.

4) Research Park Natural Area 14. Wooded bluff on the Clinch River, approximately at river mile 32.25. Last observed in 1990. Anderson County.

5) Research Park Natural Area 17. Steep slope and bluffs along the Clinch River from river mile 25-26. Population was not located during a survey in 1990. Roane County.

LOCATIONS ADJOINING THE ORR:

6) Grassy Creek. Formerly Research Park Natural Area 3; the land has been transferred to the Tennessee Valley Authority. Rocky woods on slope above Grassy Creek, a tributary of the Clinch River. Last observed in 1988. Roane County.

7) Rocky bluffs along the Clinch River, on the opposite shore of the river from the ORR. Known locations are approximately at river miles 24, 28, and 35.5. Last observed in 1990. Knox County and Loudon County.

COMMENTS: Other rare or uncommon species co-occurring with A. patula on the ORR are Cimicifuga rubifolia, Diervilla lonicera, Thuja occidentalis, and a mat-forming variant of Blephilia ciliata.

THREATS ON ORR: Habitat destruction from project development, reservoir water level fluctuations, contaminants in reservoir, recreational activity on river banks, and tree canopy removal.

Cimicifuga rubifolia Kearney

COMMON NAME:	Appalachian bugbane
FAMILY:	Ranunculaceae
FEDERAL STATUS:	Category 2
TENNESSEE STATUS:	Threatened
HABITAT:	Wooded bluffs, ravines, coves, or north-facing talus slopes; prefers limestone or calcareous shale (Massey et al 1983).
HABITAT ON ORR:	Wooded talus slopes along the Clinch River and Grassy Creek, a tributary of the Clinch River.
RANGE:	IL, KY, NC, TN, VA (Massey et al), AL, TN, VA (Kral), IN, PA (Cook?)
TENNESSEE COUNTIES:	Anderson, Claiborne, Grainger, Hamblin, Hancock, Hawkins, Jefferson, Knox, Loudon, Meigs, Montgomery, Roane, Stewart, Sullivan
DESCRIPTION:	Perennial herb with mostly basal, compound leaves of 3-9 leaflets. Base of terminal leaflet is deeply cordate. Solitary, wand-like flowering stem up to 14 dm tall. Flowers white.
FLOWERING DATE:	July to October
FRUITING DATE:	September to October
LOCATIONS ON THE ORR:	1) Research Park Natural Area 11. North-facing, wooded talus

slope at Bull Bluff on the Clinch River. Approximately at river mile 36.75. Population size is 400-500 individuals. Last observed in 1990. Anderson County.

2) Research Park Natural Area 19. Wooded talus slope on the north side of the Clinch River at approximately river mile 10.5. Last observed in 1990. Roane County.

3) Research Park Natural Area 1. Wooded, gentle slope with rock ledges along the Clinch River at about river mile 9.5. Located on Campbell Bend side of river. Last observed in 1988. Roane County.

4) Research Park Natural Area 15. Wooded slope on Hickory Creek Bend along the Clinch River. Approximately at river mile 29. Last observed in 19??. Roane County.

LOCATIONS ADJOINING THE ORR:

5) Wooded slope along Grassy Creek, a tributary of the Clinch River. Formerly Research Park Natural Area 3; the land has been transferred to the Tennessee Valley Authority. Population size is about 2000 individuals. Last observed in 1990. Roane County.

6) Steep, east-facing, wooded slope of Pine Ridge along the Clinch River at approximately mile 49.5. On property owned by the City of Oak Ridge. Population size is about 300 plants. Last observed in 1989. Anderson County.

7) Hewitt Bluff, a steep wooded bluff along the Clinch River at approximately river mile 39. Last observed in 1982. On private property. Knox County.

COMMENTS: C. rubifolia may be present at Stubbs Bluff,located at river mile 30.5 and at an unnamed bluff at river mile 35, both in Knox County. These areas are very similar to and downstream from Hewitt Bluff. Other rare species co-occurring with C. rubifolia on the ORR are Saxifraga careyana, Diervilla lonicera, and Aureolaria patula.

THREATS ON ORR: Habitat destruction from project development, and tree canopy removal.

Cypripedium acaule Ait.

COMMON NAME: Pink lady-slipper

FAMILY: Orchidaceae

FEDERAL STATUS: --

TENNESSEE STATUS: Endangered *

HABITAT: Bogs and dry, acid pine woods (Radford 1968)

HABITAT ON ORR: Moist to dry acid woods

RANGE:

TENNESSEE COUNTIES:

DESCRIPTION: Two large, ribbed ovate leaves are at the base of a single flowered scape. Flower pink, fissured in front.

FLOWERING DATE: April- July

FRUITING DATE:

LOCATIONS ON THE ORR: Several locations across the ORR.

LOCATIONS ADJOINING ORR:

COMMENTS: C. acaule is a showy species much prized in the wildflower trade. Evidence to date indicates that not only is the species being dug in large numbers across the state but also there are no propagation techniques known to be successful. For this reason, the Tennessee Department of Conservation lists the species as endangered in Tennessee.

THREATS ON ORR: Habitat loss from project development activities, tree canopy removal, illegal digging.

Delphinium exaltatum Ait.

COMMON NAME:	Tall larkspur
FAMILY:	Ranunculaceae
FEDERAL STATUS:	C2
TENNESSEE STATUS:	Endangered
HABITAT:	Rich, moist, loamy soils of open, calcareous, wooded ravines (Kral 1976).
HABITAT ON ORR:	Open, rocky, calcareous woods and barrens.
RANGE:	IN, MO, NC, OH, PA, TN, VA, WV
TENNESSEE COUNTIES:	Anderson, Hamilton, Roane
DESCRIPTION:	Erect, solitary, stems to 15 dm in height. Branched racemes with blue flowers late in season.
FLOWERING DATE:	August-September
FRUITING DATE:	September-October
LOCATIONS ON THE ORR:	1) Research Park Natural Area 8. In Bethel Valley on shallow, calcareous soil in power line opening and in open, cedar-dominated woods on the north-facing slope of Haw Ridge near McCoy Branch embayment of the Clinch River. Population size is estimated to be about 1000 individuals. Last observed in 1990. Anderson County.

2) Research Park Natural Area 7. On shallow soil in open, cedar-dominated woods with numerous limestone outcrops. Located on lower slope of Haw Ridge just west of Natural Area 8 and next to Walker Branch embayment of the Clinch River. Last observed in 1990. Anderson County.

LOCATIONS ADJOINING THE ORR:

3) In open woods at west end of Haw Ridge Park. The Park is leased to the City of Oak Ridge and borders the Clinch River from mile 44 to 48. Population is small. Last observed in 1988. Anderson County.

4) In a calcareous barren on Campbell Bend on the Clinch River. Property now owned by Boeing Tennessee, Inc., and significant habitat is protected by a conservation agreement between the Tennessee Department of Conservation and Boeing. Small population, last observed in 1990. Roane County.

COMMENTS: Habitats on the ORR for D. exaltatum are more xeric than those described for other parts of its range. No other rare species are known to co-occur with D. exaltatum on the ORR. Three species endangered in Tennessee, Tomanthera auriculata, Liatris cylindracea, and Solidage ptarmicoides occur at the Boeing site on Campbell Bend.

THREATS ON ORR: Habitat destruction from project development, and invasion of woody species leading to heavy shade.

Diervilla lonicera P. Mill.

COMMON NAME:	Northern bush-honeysuckle
FAMILY:	Caprifoliaceae
FEDERAL STATUS:	--
TENNESSEE STATUS:	Threatened
HABITAT:	Woodlands and rocky bluffs (Radford et al 1968).
HABITAT ON ORR:	Calcareous, rocky bluffs along the Clinch River.
RANGE:	CT, GA, IA, IL, IN, KS, MA, MI, MN, NC, NH, NY, OH, PA, SC, TN, VA, VT, WI, WV
TENNESSEE COUNTIES:	Anderson, Cheatham, Polk, Sevier
DESCRIPTION:	Deciduous shrub to 20 dm tall. Simple, opposite, lanceolate leaves. Light yellow flowers resembling honeysuckle turn red with age.
FLOWERING DATE:	June-July
FRUITING DATE:	August-October
LOCATIONS ON THE ORR:	1) Research Park Natural Area 11. Plants grow at the base of a north-facing limestone cliff, Bull Bluff, at approximately mile 36.75 on the Clinch River. Last observed in 1990. Anderson County.
	2) Research Park Natural Area 14. Wooded bluff and cliff on the

Clinch River, approximately at river mile 32.25. Last observed in 1990. Anderson County.

LOCATIONS ADJOINING THE ORR:

None known.

COMMENTS: Other rare or uncommon species co-occurring with D.Ionicera on the ORR are Thuja occidentalis, Cimicifuga rubilfolia and Aureolaria patula.

THREATS ON ORR: Habitat destruction from project development.

Elodea nuttallii (Planch.) St. John

COMMON NAME:	Nuttall waterweed
FAMILY:	Hydrocharitaceae
FEDERAL STATUS:	---
TENNESSEE STATUS:	Special Concern
HABITAT:	Lakes, ponds, and sluggish streams (Radford et al 1968).
HABITAT ON ORR:	Ponds and embayment of Clinch River
RANGE:	
TENNESSEE COUNTIES:	
DESCRIPTION:	Submerged aquatic with whorls of 3 leaves. Leaves are linear, acute, and densely imbricate at growing tips. Free-floating staminate flowers.
FLOWERING DATE:	July-September
FRUITING DATE:	??
LOCATIONS ON THE ORR:	1) Spring-fed pond on road to rifle range just north of ORNL. Last observed in 1990. Roane County. 2) Ponds behind the Aquatic Ecology Laboratory (building 1504) in the Environmental Sciences Division complex. Last observed in 1990. Roane County.

3) Embayment on Watts Bar Lake separated from main channel by a culvert. Located approximately at river mile 20 on the Clinch River, near Jones Island. Last observed in 1990. Roane County.

LOCATIONS ADJOINING THE ORR:

None known.

COMMENTS: No other rare species are known to co-occur with E. nuttallii on the ORR.

THREATS ON ORR: Habitat loss from project development, water temperature change, and drying of ponds.

Fothergilla major (Sims) Lodd.

COMMON NAME:	Mountain witch-alder
FAMILY:	Hamamelidaceae
FEDERAL STATUS:	---
TENNESSEE STATUS:	Threatened
HABITAT:	Rocky woodlands (Wofford 1989).
HABITAT ON ORR:	On west-facing slope in woods.
RANGE:	AL, NC, SC, TN
TENNESSEE COUNTIES:	Anderson, Grainger, Greene, Scott, Sevier
DESCRIPTION:	Stoloniferous shrub or small tree. Alternately arranged, deciduous leaves are pinnately-veined. Flowers are white, epetalate, and occur in terminal spikes.
FLOWERING DATE:	April-May
FRUITING DATE:	July
LOCATIONS ON THE ORR:	1) Research Park Natural Area 12. On upper, west-facing slope in Walker Branch Watershed. Last observed in 1986. Anderson County.

LOCATIONS ADJOINING THE ORR:

None known.

COMMENTS: No other listed species are known to occur with F. major on the ORR.

THREATS ON ORR: Habitat destruction from project development, severe fire, and canopy removal.

Hydrastis canadensis L.

COMMON NAME:	Golden seal
FAMILY:	Ranunculaceae
FEDERAL STATUS:	Category 3 (3C)
TENNESSEE STATUS:	Threatened
HABITAT:	Rich woods (Radford et al 1968).
HABITAT ON ORR:	Rich, moist woods.
RANGE:	AL, AR, CT, IA, IL, IN, KY, MI, MO, MS, NC, MY, OH, PA, TN, VA, VT, WI, WV
TENNESSEE COUNTIES:	Anderson, Blount, Campbell, Cannon, Carter, Clay, Coffee, Cumberland, Davidson, DeKalb, Fentress, Franklin, Grundy, Hancock, Hardin, Jackson, Knox, Loudon, Marion, Montgomery, Morgan, Obion, Putnam, Rhea, Roane, Scott, Shelby, Stewart, Sullivan, Sumner, Tipton, Van Buren, Warren, Wayne, White
DESCRIPTION:	Erect, perennial herb with thick yellow rhizomes. Stems 1.5 to 5 dm tall. Solitary, greenish-white, epetalate flowers with numerous stamens.
FLOWERING DATE:	April-May
FRUITING DATE:	June-July
LOCATIONS ON THE ORR:	1) Research Park Natural Area 2. On slopes and in stream

bottoms of mesic forest on East Fork Ridge. Last observed in 1987. Roane County.

2) Research Park Natural Area 6. Moist stream bottom near Raccoon Creek embayment of the Clinch River. Large population, last observed in 1990. Also scattered plants near Ish Creek embayment, just downstream of Racoon Creek. Roane County.

3) Research Park Natural Area 10. Gentle slope of maturing woodland, locally called Lazy Beaver forest. Size of plants in this population is dwarfed compared to others on the ORR. Small population, last observed in 1990. Anderson County.

4) Research Park Natural Area 21. Wooded slopes near Rainy Knob. Small population, last observed in 1987. Anderson County.

LOCATIONS ADJOINING THE ORR:

Private property on Loudon County side of the Clinch River, approximately at river 21.5. Last observed in 1990. Loudon County.

COMMENTS: Hydrastis canadensis is a valued medicinal herb on both national and international markets. Like ginseng, its rarity is primarily due to digging of the plants by herb collectors. Other rare species that co-occur with H. canadensis on the ORR are Spiranthes ovalis and Lilium canadense.

THREATS ON ORR: Habitat destruction from project development, unauthorized digging of plants, and tree canopy removal.

Lilium canadense L.

COMMON NAME:	Canada lily
FAMILY:	Liliaceae
FEDERAL STATUS:	---
TENNESSEE STATUS:	Threatened
HABITAT:	Wet meadows, bogs and balds (Radford et al 1968).
HABITAT ON ORR:	Moist woods, forest edges, and power line openings through moist forest.
RANGE:	Que. and Me. to Minn., s. to Ala., O., and Ind. (B&B)
TENNESSEE COUNTIES:	Anderson, Campbell, Claiborne, Cumberland, Davidson, DeKalb, Johnson, Montgomery, Morgan, Overton, Putnam, Roane, Rutherford, Scott, Sevier, Stewart
DESCRIPTION:	Stems to 20 dm tall with whorls of 5-11 leaves. Flower segments are yellow-orange to red, spotted, and slightly recurred to spreading. Petals and sepals more than 6 cm long.
FLOWERING DATE:	June-July
FRUITING DATE:	July-September
LOCATIONS ON THE ORR:	1) Research Park Natural Area 2. Mesic forest on East Fork Ridge. Scattered individuals, last observed in 1978. Roane County.

2) Research Park Natural Area 13. Wet forest edge and powerline opening in the lower, south-facing slope of Pine Ridge. This area has been disturbed recently by use of the powerline opening as a haul road. Scattered individuals, last observed in 1978. Roane County.

3) Research Park Natural Area 22. Stream bottom near intersection of Bull Bluff road and road to Freels Bend Cabin. Relatively large population has not yet been seen in flower. Last observed in 1990. Anderson County.

LOCATIONS ADJOINING THE ORR:

None known.

COMMENTS: This species is very similar to and may be confused with Lilium michiganense, which is also state-listed as threatened. The population in Natural Area 22 may be either L. canadense or L. michiganense.

THREATS ON ORR: Habitat destruction from project development, and indiscriminant use of herbicides.

Liparis loeselii (L.) L.C.Rich.

COMMON NAME:	Fen orchid
FAMILY:	Orchidaceae
FEDERAL STATUS:	---
TENNESSEE STATUS:	Endangered
HABITAT:	Cool ravines and moist seepage slopes (Radford et al 1968).
HABITAT ON ORR:	Wetland with immature forest cover.
RANGE:	N.S. and Que. to Manit., s. to N.J., Ala., O., Ind. and Neb.
TENNESSEE COUNTIES:	
DESCRIPTION:	Succulent, scapose herb with 2 basal leaves. Stem slender, 6 to 26 cm tall. Flowers yellowish-green to white. Pedicels 3-6 mm long.
FLOWERING DATE:	May-July
FRUITING DATE:	July-August
LOCATIONS ON THE ORR:	1) In wet forest adjoining the Hembree Cemetery marsh, an open area with seeps near Bear Creek. This site, combined with Bear Creek wetland, is a registered Tennessee Natural Area. Last observed in 1990. Roane County.

LOCATIONS ADJOINING THE ORR:

None known.

COMMENTS: The only known population of this species on the ORR was discovered during the 1990 season. It was in fruit at the time of discovery. Specimens of capsules were taken to facilitate identification. The pedicels, a key character, are considerably shorter than those of L. lilifolia, the only other Liparis species in our area. Identification should not be considered positive until the plants have been seen in flower.

THREATS ON ORR: Habitat destruction from project development, change in hydrologic regime, and tree canopy removal.

Panax quinquifolius L.

COMMON NAME:	Ginseng
FAMILY:	Araliaceae
FEDERAL STATUS:	Category 3 (3C)
TENNESSEE STATUS:	Threatened
HABITAT:	Rich woods (Radford et al 1968).
HABITAT ON ORR:	Rich, moist to dry woods.
RANGE:	AL, AR, CT, GA, IA, IL, IN, KY, LA, MA, MI, MO, MS, NC, NE, NH, NY, OH, PA, SC, SD, TN, VT, WI, WV
TENNESSEE COUNTIES:	Virtually all counties
DESCRIPTION:	Glabrous, perennial herb arising from tuberous roots. Stems erect, 1.5 to 6 dm tall. Petioluate, palmately-compound leaves in a whorl at apex of the solitary stem.
FLOWERING DATE:	May-June
FRUITING DATE:	August-October
LOCATIONS ON THE ORR:	In rich woods at scattered locations across the ORR. Numerous observations in 1989-1990.

LOCATIONS ADJOINING THE ORR:

Scattered locations on Haw Ridge, Chestnut Ridge, and Blackoak

Ridge.

COMMENTS: Ginseng is prized in this country and abroad for its reputed medicinal properties and is highly sought by herb collectors. Its rarity in Tennessee is due to commercial exploitation. See Appendix 2 for a description of Tennessee laws regarding the harvesting and sale of ginseng.

THREATS ON ORR: Habitat destruction from project development, unauthorized digging of plants, and tree canopy removal.

Platanthera flava var. herbiola (R.Br.) Luer

COMMON NAME:	Tubercled rein-orchid
FAMILY:	Orchidaceae
FEDERAL STATUS:	---
TENNESSEE STATUS:	Threatened
HABITAT:	Alluvial woods, wet meadows, and marshes (Radford et al 1968).
HABITAT ON ORR:	Forested wetland.
RANGE:	N.S. to s. Ont., c. Minn., s. to Mo., e. to mtns. of N.C., Va., and Tenn.
TENNESSEE COUNTIES:	
DESCRIPTION:	Erect, glabrous plant with lanceolate leaves sheathing the stem, reduced to bracts on upper stem. A spike of yellow-green flowers on stems to 5 dm in height. Floral bracts much exceed the flowers.
FLOWERING DATE:	May-August
FRUITING DATE:	??
LOCATIONS ON THE ORR:	1) Research Park Natural Area 4. Bear Creek forested wetland. This site, combined with the Hembree Cemetary marsh area, is a registered Tennessee Natural Area. Last observed in 1990. Roane County.

LOCATIONS ADJOINING THE ORR:

None known.

COMMENTS: Variety herbiola is the northern variety of P. flava and is more rare in Tennessee than the southern variety flava. It is noteworthy that the Bear Creek wetland and Hembree Cemetary marsh both support typically northern taxa that are rare in Tennessee. Liparis loeselii, the northern counterpart of Liparis lilifolia, occurs in the forested wetland adjoining Hembree Cemetery marsh.

THREATS ON ORR: Habitat destruction from project development, change in hydrologic regime, and tree canopy removal.

Platanthera peramoena (Gray) Gray

COMMON NAME:	Purple fringeless orchid
FAMILY:	Orchidaceae
FEDERAL STATUS:	Category 3 (3C)
STATE STATUS:	Threatened
HABITAT:	Moist woods, meadows, and stream banks.
HABITAT ON ORR:	Wet power line openings.
RANGE:	
TENNESSEE COUNTIES:	
DESCRIPTION:	Erect, glabrous herb with elliptic to lanceolate leaves. Inflorescence is a showy raceme of purple flowers up to 10.5 dm tall.
FLOWERING DATE:	July- Aug.
FRUITING DATE:	??
LOCATIONS ON THE ORR:	1) Wet stream drainages between Flannigan Loop Road and the Clinch River on the powerline right-of-way paralleling Bear Creek Road. Discovered in 1990. Roane County. 2) Wet powerline right-of-way southeast of ORGDP and paralleling the Oak Ridge Turnpike. Discovered in 1990. Roane County.

3) Two wet stream drainages near Gum Branch Road on the powerline opening paralleling Bear Creek Road. Discovered in 1990. Roane County.

LOCATIONS ADJOINING THE ORR:

None known.

COMMENTS: No other listed species are known to occur with P. peramoena on the ORR.

THREATS ON ORR: Habitat destruction from project development, indiscriminant use of herbicides, change in hydrologic regime, and tree canopy closure.

Saxifraga careyana Gray

COMMON NAME:	Carey saxifrage
FAMILY:	Saxifragaceae
FEDERAL STATUS:	Category 3
TENNESSEE STATUS:	Special concern
HABITAT:	Moist rocks and seepage slopes (Radford et al 1968).
HABITAT ON ORR:	Rocky, calcareous bluffs and sinks along the Clinch River.
RANGE:	MA, NC, PA, TN, VA
TENNESSEE COUNTIES:	Anderson, Bledsoe, Blount, Carter, Cocke, Franklin, Grainger, Hamilton, Hancock, Knox, Loudon, Marion, Monroe, Pickett, Polk, Rhea, Roane, Sevier, Sullivan, Unicoi, Van Buren
DESCRIPTION:	Small, perennial herb forming rather fleshy rosettes and short offsets from the crown. Hairy leaves are slightly concave on the upper-surface, rounded and frequently reddish on the underside. White to pale-pink flowers with scapes up to 3 dm tall.
FLOWERING DATE:	April-June
FRUITING DATE:	May-June
LOCATIONS ON THE ORR:	1) Research Park Natural Area 11. In shade at Bull Bluff, a calcareous bluff along the Clinch River at approximately river mile 36.75. Last observed 1990. Anderson County.

2) Research Park Natural Area 15. Rocky bluff and rock outcrops at northern end of Hickory Creek Bend on the Clinch River at river mile 29. Last observed in 1986. Roane County.

3) Research Park Natural Area 16. Rocky bluff and outcrops at southern end of Hickory Creek Bend on the Clinch River, approximately at river mile 28.5. Last observed in 1986. Roane County.

4) Research Park Natural Area 17. Rocky bluffs along the Clinch River from river mile 25-26, southeast of the ORNL Tower Shielding Facility. Last observed in 1986. Roane County.

5) Research Park Natural Area 18. Rock outcrops on Copper Ridge above Bearden Creek embayment of the Clinch River. Last observed in 1986. Anderson County.

6) Research Park Natural Area 21. A large sink with massive rock on two sides and a flooded cave entrance at the bottom. On the northeast side of Rainy Knob on the Freels Bend peninsula on the Clinch River. Last observed in 1989. Anderson County.

7) Research Park Natural Area 23. On calcareous rock outcrops above the Clinch River at approximately river mile 43.5 near Solway Bridge. About 50 plants, apparently more robust than those in other locations on the ORR. Last observed in 1988. Anderson County.

LOCATIONS ADJOINING THE ORR:

8) Wooded slope with limestone outcrops along Grassy Creek, a tributary of the Clinch River. Formerly Research Park Natural Area 3; the land has been transferred to the Tennessee Valley Authority. Scattered individuals, last observed in 1979. Roane

County.

COMMENTS: The taxonomy of S. careyana and S. caroliniana is confusing, so much so that the species have been called "the careyana-caroliniana complex". Saxifrage careyana is no longer considered a candidate for federal listing, however S. caroliniana is a category 2 candidate for federal listing and is listed as endangered in Tennessee. Some of the populations noted above have not been determined in the flowering stage, a stage necessary to distinguish the two species. Saxifraga caroliniana is not reported to occur in the Ridge and Valley Province in east Tennessee so the populations are likely S. careyana. Rare species that co-occur with S. careyana on the ORR are Aureolaria patula, Cimicifuga rubifolia, and Diervilla lonicera.

THREATS ON ORR: Habitat destruction by project development.

Spiranthes ovalis Lindl.

COMMON NAME:	Lesser ladies'-tresses
FAMILY:	Orchidaceae
FEDERAL STATUS:	---
TENNESSEE STATUS:	Special Concern
HABITAT:	Moist, shady woods, thickets, and swamp margins (Radford et al 1968).
HABITAT ON ORR:	Moist second-growth woods.
RANGE:	Va. to O., Mo., and Okla., s. to Ga. and La. (B&B)
TENNESSEE COUNTIES:	Anderson, Cannon, Franklin, Lake, Lewis, Montgomery, Obion, Putnam, Roane, Sevier, Tipton, Warren
DESCRIPTION:	Erect stems to 4.5 dm tall with two to four basal oblanceolate leaves. Small white flowers are congested on the slender spike.
FLOWERING DATE:	August-November
FRUITING DATE:	October-November
LOCATIONS ON THE ORR:	1) Research Park Natural Area 9. Mesic, second-growth forest over karst terrain. Small population in a shallow sink. Last observed in 1978. Roane County.
	2) Research Park Natural Area 10. Small population on lower

slope in mesic, second-growth forest. Last observed in 1990. Anderson County.

LOCATIONS ADJOINING THE ORR:

3) On Parcel A of the ORR, soon to be transferred to the City of Oak Ridge for residential and industrial development. Large population on lower slope and stream bottom on north side of Chestnut Ridge. Area will be designated as City-owned greenbelt. Last observed in 1989. Anderson County.

COMMENTS: Ginseng and goldenseal co-occur with S. ovalis on the ORR.

THREATS ON ORR: Habitat destruction from project development, and tree canopy removal.

SECTION B. RARE PLANT SPECIES THAT OCCUR NEAR AND MAY BE PRESENT ON THE OAK RIDGE RESERVATION

Berberis canadensis Mill.

COMMON NAME: Barberry

FAMILY: Berberidaceae

FEDERAL STATUS: --

TENNESSEE STATUS: Special concern

HABITAT: Rocky bluffs, creek banks and roadsides (Radford et al 1968)

HABITAT NEAR ORR: Rocky bluff on the Tennessee River

RANGE: VA and WV to GA and AL; MO and IN

TENNESSEE COUNTIES: Knox

DESCRIPTION: Deciduous shrub 2 to 20 dm in height with 3-pronged thorns. Leaves alternate, ovate or elliptic to obovate. Berries scarlet, 5-7 mm long.

FLOWERING DATE: April-May

FRUITING DATE: September-October

LOCATIONS NEAR ORR: Rocky bluff along the Tennessee River in Knox Co.

COMMENTS: An immature specimen of B. canadensis or a similar species was collected on the ORR in 19?? It is not possible to postively identify the specimen collected, and in a subsequent search for B. canadensis in the area of collection no individuals were observed. The species may be present on the ORR on rocky bluffs along the Clinch River or on creek banks.

Draba ramosissima Desv.

COMMON NAME: Branching whitlow-grass

FAMILY: Brassicaceae

FEDERAL STATUS: ---

TENNESSEE STATUS: Special concern

HABITAT: Dry, usually calcareous bluffs (Wofford 1989)

HABITAT NEAR ORR: Limestone bluffs along river

RANGE: VA, WV, e. KY, NC, and TN

TENNESSEE COUNTIES: Anderson

DESCRIPTION: Mat-forming perennial. Basal rosettes with oblanceolate, toothed leaves. Petals entire, style persistent, and fruit twisted.

FLOWERING DATE: April-May

FRUITING DATE: May-July

LOCATIONS NEAR ORR: Calcareous bluff along the Clinch River at approximately river mile 51. Anderson County.

COMMENTS: The species may be present on rocky bluffs along the Clinch River on the ORR.

Gnaphalium helleri Britt.

COMMON NAME: Catfoot

FAMILY: Asteraceae

FEDERAL STATUS: ---

TENNESSEE STATUS: Special concern

HABITAT: Openings in woods and woodland borders (Radford et al 1968)

HABITAT NEAR ORR: Dry woodland edge

RANGE: ME to GA, IN, AR, and TX

TENNESSEE COUNTIES: Roane

DESCRIPTION: Annual with lanceolate leaves not decurrent on stem. Green, conspicuously hairy stem with greater than 15 leaves below the infloresence.

FLOWERING DATE: September-October

FRUITING DATE: September-October

LOCATIONS NEAR ORR: Dry, calcareous soil on Campbell Bend on the Clinch River, formerly part of the ORR, now owned by Boeing Tennessee, Inc.

COMMENTS: Specimen collected in 198? on Campbell Bend. The species may be present on the ORR on barren openings or dry woodland edges.

Liatris cylindracea Michx.

COMMON NAME: Slender blazing star

FAMILY: Asteraceae

FEDERAL STATUS: --

TENNESSEE STATUS: Endangered

HABITAT: Dry, open places (Gleason 1952)

HABITAT NEAR ORR: Open, dry, calcareous barrens

RANGE: w. NY and s. ONT to s. OH, n.IN, MI, MN, then s. to n.AR

TENNESSEE COUNTIES: Roane, Rutherford, Marion, Decatur

DESCRIPTION: Glabrous perennial with numerous stiff, linear leaves. Pink-purple, discoid flowers on stalks to 6 dm tall. Involucral bracts appressed, broadly rounded, and mucronate.

FLOWERING DATE: August-September

FRUITING DATE: September-October

LOCATIONS NEAR ORR: 1) Dry, calcareous barren at Campbell Bend on the Clinch River, locally called the Crowder Cemetary Barren. Formerly part of Research Park Natural Area 1; the land is now owned by Boeing Tennessee, Inc.. The barren is protected by an agreement between the Tennessee Department of Conservation and Boeing and is a registered Tennessee Natural Area. Last observed in 1990. Roane County.

COMMENTS: Other rare species that co-occur with L. cylindracea at the Crowder Cemetary Barren are Tomanthera auriculata, Solidago ptarmicoides, and Delphinium exaltatum. Liatris squarrosa also occurs at this site, and an apparent blending of morphological characteristics suggests that it may be hybridizing with L. cylindracea. Liatris cylindracea may be present on the ORR on barrens.

Lonicera dioica L.

COMMON NAME: Mountain honeysuckle

FAMILY: Caprifoliaceae

FEDERAL STATUS: --

TENNESSEE STATUS: Special concern

HABITAT: Woodlands and thickets (Radford et al 1968)

HABITAT NEAR ORR: Rocky river banks

RANGE: sw. ME and sw. QUE to MAN. s. to GA and MO.

TENNESSEE COUNTIES:

DESCRIPTION: Climbing vine with glabrous stems. Leaves glaucous beneath. Inflorescence a terminal spike, corollas less than 3 cm long. Ovaries not fused.

FLOWERING DATE: June-August

FRUITING DATE: August-September

LOCATIONS NEAR ORR: Rocky banks of the Emory River near Harriman

COMMENTS: The species may be present on the ORR on rocky banks and bluffs on the Clinch River and its tributaries.

Meehania cordata (Nutt.) Britt.

COMMON NAME: Heartleaf meehania

FAMILY: Lamiaceae

FEDERAL STATUS: --

TENNESSEE STATUS: Threatened

HABITAT: Rich, wooded slopes and coves (Radford et al 1968)

HABITAT NEAR ORR: Wooded, calcareous slope along a river

RANGE: sw. PA and s. OH to TN and NC; IL

TENNESSEE COUNTIES: Anderson

DESCRIPTION: Perennial herb spreading by stolons and forming carpets. Erect flowering stems to 2 dm tall. Anther-bearing stamens 4, ovary 4-parted, style basal, and flowers more than 2 cm long.

FLOWERING DATE: May-June

FRUITING DATE: June-July

LOCATIONS NEAR ORR: On a wooded slope near Norris Dam on the Clinch River. Anderson County.

COMMENTS: The species may be present on the ORR on rich wooded slopes along the Clinch River and its tributaries.

Pedicularis lanceolata Michx.

COMMON NAME: Swamp lousewort

FAMILY: Scrophulariaceae

FEDERAL STATUS: --

TENNESSEE STATUS: Threatened

HABITAT: Wet meadows on basic soils (Radford et al 1968)

HABITAT NEAR ORR: Wet meadow/seep at base of ridge

RANGE: MA to MI, MN, MAN, and ND, s. to NC, MO, and NE

TENNESSEE COUNTIES: Roane, Union

DESCRIPTION: Perennial with basal rosette. Stems to 8dm in height. Leaves sessile, lanceolate and shallowly, crenately lobed. Corolla yellow.

FLOWERING DATE: August-October

FRUITING DATE: September-October

LOCATION NEAR ORR: Wet meadow off Highway 70, south of Kingston. On private property. Last observed in 1990. Roane Co.

COMMENTS: No other listed plant species co-occur with P. lanceolata at this site. This species may be present on the ORR on wet meadows and on seeps.

Pycnanthemum verticillatum (Michx.) Pers.

COMMON NAME: Whorled mountain-mint

FAMILY: Lamiaceae

FEDERAL STATUS: --

TENNESSEE STATUS: Endangered, possibly extirpated

HABITAT: Woodlands and woodland borders (Radford et al 1968)

HABITAT NEAR ORR: Low, shaded, wet area

RANGE: VT to OH, s. to w. VA CT, MN*, NY, OH, PA, TN*, VA, WV, MA, MI, NJ, RI, VT, NC (Grant-Epling, *Edwards)

TENNESSEE COUNTIES: Anderson, Fentress, Roane

DESCRIPTION: Pubescent and canescent perennial herb to 8 dm in height. Stems branched in the upper part, pubescence spread over the stem surface and not confined to the angles of the square stem. Leaves narrowly lanceolate, leaf bases rounded. Reportedly entirely apomictic.

FLOWERING DATE: July-September

FRUITING DATE: August-October

LOCATIONS NEAR ORR: 1) Low, shaded, wet area in Oak Ridge in vicinity of the Clinch River. Specimen collected in 1961. Last observed in 1961; area may have been inundated by Melton Hill Reservoir. Anderson County.

COMMENTS: Three rare and somewhat difficult species of Pycnanthemum occur in our area: P. verticillatum, P. virginiana, and P. torrei. Pycnanthemum verticillatum has not been collected recently in Tennessee. Pycnanthemum torrei is known in Tennessee only from a recent collection at one site in Oak Ridge. Pycnanthemum virginianum is not currently listed by the state but is considered rare in Tennessee (personal communication, Paul Somers, Tennessee Department of Conservation, 1989). Further work on identification and habitats of the three species is necessary to assess their status on the ORR.

Pycnanthemum torrei Benth.

COMMON NAME: Torrey's mountain-mint

FAMILY: Lamiaceae

FEDERAL STATUS: --

TENNESSEE STATUS: not previously known to occur in Tennessee so not listed

HABITAT: Dry, upland woods (Gleason 1952)

HABITAT NEAR ORR: Dry, calcareous barren

RANGE: CT to e. PA and DE; IL, MO, and e KS; n. GA, CT, DC, DE, GA, KS, MD, MO, NC, NJ, NY, PA, SC, VW (Grant-Epling)

TENNESSEE COUNTIES: Anderson

DESCRIPTION: Perennial herb up to 8 dm in height. Upper leaf surface glabrous. Leaves linear-lanceolate, leaf bases acute to acuminate. Reproduces sexually.

FLOWERING DATE: July-September

FRUITING DATE: August-October

LOCATIONS NEAR ORR: 1) Dry, calcareous opening at the Oak Ridge Barrens, a registered Tennessee Natural Area owned by the City of Oak Ridge, next to Jefferson Junior High School. Occurs both in the opening and under sparse tree canopy at edge of the barren. Last observed in 1990. Anderson County.

COMMENTS: see comments under P. verticillatum.

Solidago ptarmicoides (Nees) Boivin

COMMON NAME: Prairie goldenrod

FAMILY: Asteraceae

FEDERAL STATUS: ---

TENNESSEE STATUS: Endangered

HABITAT: Prairies and open dry places (Gleason 1952)

HABITAT NEAR ORR: Dry, calcareous barren

RANGE: VT and w. QUE to GA, w. to SASK, WY, CO, AR; CT CO, GA, IA, IL, MA, MN, MO, NC, ND, NY, OK, PA, SD, TN*, WI, KS, WY, NE, OH, VT (Cronquist, *Edwards)

TENNESSEE COUNTIES: Anderson, Roane,

DESCRIPTION: Scabrous perennial to 7 dm tall. Leaves stiff, linear-oblanceolate to linear. Infloresence corbiform, rays and disk of flowers white.

FLOWERING DATE: July-September

FRUITING DATE: September-October

LOCATIONS NEAR ORR: 1) Dry, calcareous barren on Campbell Bend in Clinch River, locally called the Crowder Cemetary Barren. Formerly part of Research Park Natural Area 1; the land is now owned by Boeing Tennessee, Inc.. The barren is protected by an agreement between the Tennessee Department of Conservation and Boeing and is a registered Tennessee Natural Area. Last observed in 1990. Roane County.

2) Dry, calcareous opening at the Oak Ridge Barrens, a registered Tennessee Natural Area owned by the City of Oak Ridge, next to Jefferson Junior High School. Last observed in 1990. Anderson County.

COMMENTS: Other rare species that co-occur with S. ptarmicoides at sites near the ORR are Liatris cylindracea, Tomanthera auriculata, and Delphinium exaltatum. Solidago ptarmicoides may be present on the ORR on barrens.

Tomanthera auriculata (Michx.) Raf.

COMMON NAME: Earleaf foxglove

FAMILY: Scrophulariaceae

FEDERAL STATUS: Category 2

TENNESSEE STATUS: Endangered

HABITAT: Dry or moist soil, in prairies or open, upland woods (Gleason 1952)

HABITAT NEAR ORR: Calcareous barren

RANGE: OH to WI and MN, s. to MO and KS, also locally in s. states AR, PA, MO, MS, KS, IA, IL, OH, TN, SC

TENNESSEE COUNTIES: Bledsoe, Roane

DESCRIPTION: Hemiparasitic, annual herb to 8 dm in height. Foliage purple-green when in full sun. Upper leaves with divergent basal auricles. flowers sessile in leafy spikes, corolla pink with purple spots on throat.

FLOWERING DATE: August-September

FRUITING DATE: September-October

LOCATIONS NEAR ORR: 1) Bottom of gentle slope on dry, calcareous barren on Campbell Bend in Clinch River, locally called the Crowder Cemetary Barren. Formerly part of Research Park Natural Area 1; the land is now owned by Boeing Tennessee, Inc.. The barren is protected by an agreement between the Tennessee Department of Conservation and Boeing and is a registered Tennessee Natural Area. Population size estimated to be 2400. Last observed in 1990. Roane County.

COMMENTS: Tomanthera auriculata is a hemiparasite that forms haustoria on roots of Helianthus occidentalis, Solidago rigida, and Rudbeckia fulgida. In the field a host is apparently necessary for normal growth and flowering (Cunningham and Parr 1990). Other rare species that co-occur with T. auriculata at this site are Liatris cylindracea, Solidago ptarmicoides, and Delphinium exaltatum. Tomanthera auriculata may be present on the ORR on barrens.

APPENDIX 1

Explanation of Rare Plant Status Codes

Federal Status. Determined by U.S. Fish and Wildlife Service [Federal Register, 50(188):39526-39527, 27 Sept., 1985].

LE — Taxa formally listed as endangered

LT — Taxa formally listed as threatened

PE — Taxa proposed to be formally listed as endangered

PT — Taxa proposed to be formally listed as threatened

C1 — Taxa for which the Service has on filed substantial information on biological vulnerability and threat(s) to support the appropriateness to list them as endangered or threatened species. Included are those taxa whose status in recent past is known; some may have already become extinct. Such possibly extinct taxa are indicated by an asterisk (*).

C2 — Taxa for which information now in possession of the Service indicated proposing to list them as endangered or threatened is appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support a proposed rule. If a taxon is considered to be possibly extinct, this is indicated by an asterisk(*). Double asterisk(**) indicate taxa believed to be extinct in the wild, but known to be extant in cultivation.

C3 — Taxa that are no longer being considered for listing as threatened or endangered species.

The following subcategories are used to further indicate the reason(s) for removal from consideration.

3A — Taxa for which the Service has persuasive evidence of extinction or being destroyed. If rediscovered, such taxa might acquire high priority for listing.

3B — Names that on the basis of current taxonomic understanding do not represent taxa meeting the Acts definition of "species." Such proposed taxa could be reevaluated in the future on the basis of subsequent research.

3C — Taxa that have proven to be more abundant or widespread than was previously believed and/or those that are not subject to any identifiable threat.

State Status. Determined as explained in Appendix 2. Status categories and definitions adapted from Collins et al. (1978).

E — **ENDANGERED.** Species now in danger of becoming extinct in Tennessee because of:
(a) their rarity throughout their range, or
(b) their rarity in Tennessee is a result of sensitive habitat destruction or restricted area of distribution.

E* - Taxa considered to be endangered in Tennessee due to evidence of large numbers being taken from the wild and lack of commercial success with propagation or transplantation.

T — **THREATENED.** Species likely to become endangered in the immediately foreseeable future as a result of rapid habitat destruction or commercial exploitation.

S — **SPECIAL CONCERN.** Species requiring special concern because of:
(a) their rarity in Tennessee is because the State represents the limit or near-limit of their geographic range, or
(b)
their status is undetermined because of insufficient information.

P — **POSSIBLY EXTIRPATED.** Species that have not been seen in Tennessee within the past 20 years.

APPENDIX 2

TENNESSEE LAWS GOVERNING RARE PLANT SPECIES

I. A Brief History of Rare Plant Listings for Tennessee (Somers 1989)

"The first list of rare plants of Tennessee was prepared by Dr. Aaron J. Sharp (1974), based on his extensive knowledge of the state's flora. That list was utilized by the Tennessee Department of Conservation and the tennessee Valley authority's Natural Heritage Programs until Dr. Leo Collins of TVA organized an *ad hoc* committee in 1976 to systematically review the flora and issue a new list. A preliminary list resulting from their screening of herbaria records was in use in 1977. A general filter used by that committee was to include only taxa occurring in less than three counties. Exceptions were made for many cedar glade endemics and other taxa known to be genuinely rare yet more widely dispersed. Categories of rarity were 'Possibly Extirpated,' 'Endangered,' 'Threatened,' and 'Special Concern.' The results of that committee's work were published by Collins et al. (1978).

In 1980, the Department of Conservation appointed a Scientific Advisory Committee of 11 botanists to assist the department in periodic reviews of the list. Meetings of this group occurred in 1981, 1983, and 1985. One change made in 1980 was to use the 'Possibly Extirpated' designation in combination with the 'Endangered' category. This allows a species to be automatically considered as endangered should it be rediscovered in the state.

With passage of 'The Rare Plant Protection and Conservation Act of 1985,' the Department of Conservation was given the responsibility of promulgating an official state list of rare plants using the above status designations; they were also given the duty of revising the list, as needed, at least every three years. Under the state law, plant taxa listed as 'Endangered' receive protection from 'taking' (i.e., theft, destruction, etc.) without permission of the land owner or land manager, and from sale without a license from the department."

II. Harvesting and Sale of Ginseng in Tennessee

According to the "Ginseng Harvest Season Act of 1985" it is unlawful in Tennessee for any person to dig, harvest, collect or remove wild ginseng for the purpose of sale or export under the following circumstances:

a) on any date not within the ginseng harvest season (harvest season is Aug. 15 - Dec. 31)
b) plants with green berries or less than three prongs
c) failure to plant the ripened berries in approximate location harvested
d) plants that were harvested from any state other than Tennessee unless such ginseng has been approved for export by the state from which it was harvested
e) without permission of the landowner

Penalties for violation of this law, upon conviction, are a fine not to exceed $250 and forfeiture of all ginseng harvested, collected, removed or sold in violation of the law.

Ginseng dealers must be registered and obtain a permit from the Department of Conservation (DOC). Monthly records and an annual report must be filed with the DOC. Dealers exporting ginseng from Tennessee must attach a Tennessee ginseng export certificate with each sale of roots.

Appendix 3. Updated Checklist of the Vascular Flora of the Oak Ridge Reservation.

to be added

ornl

ORNL/NERP-5

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RESOURCE MANAGEMENT PLAN FOR THE OAK RIDGE RESERVATION

VOLUME 28: WETLANDS ON THE OAK RIDGE RESERVATION

Maureen Cunningham
Larry Pounds

Environmental Sciences Division
Publication No. 3765

Oak Ridge
National
Environmental
Research Park

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DEPARTMENT OF ENERGY

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ORNL/NERP-5

ENVIRONMENTAL SCIENCES DIVISION

RESOURCE MANAGEMENT PLAN FOR THE OAK RIDGE RESERVATION

VOLUME 28: WETLANDS ON THE OAK RIDGE RESERVATION

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ABSTRACT

A survey of wetlands on the Oak Ridge Reservation (ORR) was conducted in 1990. Wetlands occurring on ORR were identified using National Wetlands Inventory (NWI) maps and field surveys. More than 120 sites were visited and 90 wetlands were identified. Wetland types on ORR included emergent communities in shallow embayments on reservoirs, emergent and aquatic communities in ponds, forested wetland on low ground along major creeks, and wet meadows and marshes associated with streams and seeps. Vascular plant species occurring on sites visited were inventoried, and 57 species were added to the checklist of vascular plants on ORR. Three species listed as rare in Tennessee were discovered on ORR during the wetlands survey. The survey provided an intensive ground truth of the wetlands identified by NWI and offered an indication of wetlands that the NWI remote sensing techniques did not detect.

OBJECTIVES

The goals of the survey were as follows:

1. to identify the wetlands resource on ORR,
2. to describe the types of wetlands present,
3. to map the locations of wetlands on the ORR,
4. to inventory the vascular plant species on wetlands on ORR, and
5. to consider the potential threats to wetlands on ORR.

INTRODUCTION

Wetlands have received considerable attention in the past several years as a natural resource in need of protection. Wetlands perform a variety of important functions in the ecosystem (Sharitz and Gibbons 1989). They play a major role in the quantity and quality of water in local and regional hydrologic regimes. Floodwaters can be absorbed by wetlands, and water quality can dramatically improve after passing through a wetland. The rate of productivity in wetlands is impressively high, and wetlands provide a necessary habitat for both resident and migratory wildlife.

Wetlands vary in size from large areas such as the Everglades National Park to small riparian zones along streams. Regulations protecting wetlands have traditionally focused on relatively large wetlands and relatively large-scale disturbances. Disturbances of small wetlands and cumulative impacts from small-scale disturbances of large wetlands,

however, may also be significant and warrant attention in wetland protection.

The rate of loss of wetlands in the United States is staggering. Wetlands represent a small percentage of the land base of the United States, and in the lower forty-eight states wetland acreage is estimated to have been reduced by half over the past 200 years (Dahl 1990). Wetlands continue to annually disappear by hundreds of thousands of acres (U.S. Congress 1986). These factors have shaped a national commitment to reduce loss of wetlands in the United States.

Previous investigators on the Oak Ridge Reservation (ORR) have studied selected aquatic and riparian habitats. Loar (1984) described the aquatic habitats on ORR, DeSelm and Shanks (1967) studied vegetation development on the drained White Oak Lake bed, and Ryon and Smith (1988, 1989) and Ryon et al. (1990) have documented riparian vegetation on several areas of ORR. Prior to 1990 a systematic survey of wetlands on the reservation had not been conducted. The valuable wetland resource across ORR was not documented, and the potential impact of Department of Energy (DOE) project development on wetlands could not be assessed. Potential impacts to wetlands must be considered for compliance with floodplain/wetlands environmental review requirements issued by DOE (1979). To address this deficiency the Resource Management Organization, an ad hoc group of resource scientists and managers from the three DOE facilities on ORR, requested that a survey be conducted to identify wetlands across the reservation.

METHODS

A planning meeting to define the scope of the survey was held in January 1990 and was attended by representatives from the DOE Oak Ridge facilities (ORNL, K-25 Site, and Y-12 Plant) as well as the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service, two agencies that have responsibilities for jurisdictional wetlands. The meeting attendees and their respective organizations are listed in Table 1. At the meeting, a decision was made to use the definition of wetland contained in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation 1989). Because of the large area to be surveyed and the time frame allotted for completion, only a general survey was deemed possible. Thus the locations and descriptions of wetlands would be provided, but the lengthy task of delimiting individual wetland boundaries and other detailed descriptions would be delegated to site-specific surveys to be requested by environmental compliance staff during review of proposed projects.

Once the scope of the survey was defined, the first step was to identify potential wetland sites across ORR. National Wetlands Inventory (NWI) maps were acquired; these are prepared by the U.S. Fish and Wildlife Service using interpretation of aerial photography and overlaid on

Table 1. Participants at a planning meeting held January 1990 to define the scope of a wetlands survey of ORR

U.S. Army Corps of Engineers	Michael Bell, Brad Bishop
U.S. Fish and Wildlife Service	Robert Willis
U.S. DOE OR	David Page
Y-12 Environmental Management	Patty Phillips, Mick Wiest
K-25 Environmental Management	Bill Scheib
Martin Marietta Energy Systems, Inc., Environmental and Safety	Jim Rogers
Oak Ridge National Laboratory (ORNL) Environmental Compliance	James Hall
ORNL Environmental Sciences	Maureen Cunningham, Jim Loar, Webb Van Winkle, Pat Parr, Mike Ryon, Glenn Cada, Roger Kroodsma

U.S. Geological Survey (USGS) quadrangle maps. Aerial photographs of ORR used in the construction of the maps were taken in 1981. The NWI maps were used as base maps of wetlands on ORR, with the realization that all wetlands present would not be shown on the maps. Unique identifiers consisting of a USGS quadrangle initial and a number were added to wetland codes assigned by NWI to each mapped wetland. A wetland on the Bethel Valley quadrangle, for example, would be designated "B-NWI code-ORR number."

Additional areas not shown on the NWI maps but considered by the field investigators to be possible wetland sites were also identified and coded with a quadrangle initial and a number. These were all visited either on foot or by canoe, and data sheets were prepared for each visited site. Data collected for each site included a general description of vegetation and abundant plant species, notes on any abnormal conditions (e.g., unusual weather or a recent anthropogenic disturbance) prevailing at the time of the visit, and other comments by the field surveyors. It is important to note that the survey reports on visited sites but does not suggest that all wetlands on ORR are identified. For example, the location of wetlands on upland areas is difficult to identify from aerial photographs or to predict from topographic maps.

Three criteria must be met for an area to be considered wetland (Federal Interagency Committee for Delineating Jurisdictional Wetlands 1989). Hydric soils must be present, wetland hydrology must exist (the ground saturated or inundated for at least one week during the growing season), and hydrophytic vegetation must be dominant. If hydrophytic vegetation is dominant, it is assumed that the other criteria are met. Determining whether hydrophytic vegetation is dominant requires two time-consuming techniques, quantitative sampling and definition of the wetland boundary. Because of time constraints in this survey, dominance of hydrophytic vegetation was not determined; abundance of hydrophytic plants was used as a field indicator of wetlands. The U.S. Fish and Wildlife Service (1988) manual National List of Plant Species That Occur in Wetlands: Tennessee was used to verify hydrophytic vegetation. Thus the survey provides information on sites that have an abundance of wetland species and have a high probability of meeting the definition of wetland, at least in some portion of the site. Hydrophytic vegetation may be confined to a narrow zone or may be in discontinuous locations at the sites.

Ponds on parcel A at the ORR's extreme eastern end (Clinton quadrangle), soon to be sold to the City of Oak Ridge, were not surveyed. An environmental assessment for sale of the site has been conducted, and the status of the ponds as wetlands is described therein (DOE, June 1990).

RESULTS

Field visits to 122 possible wetland sites were completed. Of the sites visited 90 supported hydrophytic vegetation; 61 were shown on the NWI maps, and 29 sites were not. Twenty-five sites mapped by NWI as wetlands lacked hydrophytic vegetation; these were mostly farm ponds that no longer held water. Wetlands identified on NWI maps of ORR fell into one of three major categories: palustrine, lacustrine, or riverine. The vast majority of wetlands identified by NWI on ORR were palustrine; however, their combined area may not be greater than lacustrine habitat on ORR. Explanation of the hierarchical system of codes assigned by NWI to ORR wetlands is given in Fig. 1.

Definitions of the various system codes used by NWI are provided in The Classification of Wetland and Deepwater Habitats of the United States (U.S. Fish and Wildlife Service 1989) and are presented here in an abridged form (e.g., references to wetlands with ocean-derived salts are omitted).

Riverine wetlands and deepwater habitats are contained within a channel, with the exception of those dominated by trees, shrubs, or persistent emergents. A channel is "an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water" (Langbein and Iseri 1960).

Lacustrine wetlands and deepwater habitats exhibit the following characteristics: (1) location in a topographic depression or a dammed river channel; (2) lack of trees, shrubs, and persistent emergents with greater than 30% areal coverage; and (3) total area in excess of 8 ha (20 acres).

Palustrine wetlands include all nontidal wetlands dominated by trees, shrubs, or persistent emergents. Also included are wetlands lacking such characteristics but with all of the following: (1) area less than 8 ha; (2) lack of active wave-formed or bedrock shoreline features; and (3) water depth in the deepest part of the basin less than 2 m at low water.

The following section provides a brief description of the sites visited. Sites are arranged by USGS quadrangle and NWI code. Sites without an NWI code are not shown on the NWI maps for ORR. The first section under each quadrangle name describes sites that supported hydrophytic vegetation; the second lists sites that lacked wetland vegetation.[1] Tables 2, 3, and 4 list the sites visited for the Lovell, Bethel Valley, and Elverton quadrangles, respectively, and indicate whether wetland vegetation was present. Plant species commonly found on ORR wetlands are in Table 5.

[1]Each site visited is referenced to a map in the Appendix. An index map of ORR in the Appendix shows coverage of the individual maps.

Fig. 1. The hierarchical system of codes assigned by NWI to wetlands on ORR.

ORNL-DWG 91-17713

R — Riverine

- 2 — Lower Perennial
  - UB — Unconsolidated bottom
  - 3 — Mud
- 4 — Intermittent
  - SB — Streambed
  - 3 — Cobble gravel

P — Palustrine

- AB — Aquatic bed
  - 1 — Algal
- SS — Scrub shrub
  - 1 — Broadleaved deciduous
- FO — Forested
  - 1 — Broadleaved deciduous
  - 5 — Dead
- OW — Open water
  - Unknown bottom

L — Lacustrine

- 1 — Limnetic
  - OW — Open water
  - Unknown bottom
- 2 — Littoral
  - OW — Open water
  - Unknown bottom

Modifiers

- Water regime
  - A — Temporarily flooded
  - F — Semipermanently flooded
  - H — Permanently flooded
  - U — Unknown
- Special modifiers
  - h — Diked/impounded
  - r — Artificial substrate
  - x — Excavated

Table 2. Presence or absence of hydrophytic vegetation on sites in the USGS Lovell quadrangle that were visited during a wetlands survey of ORR

Hydrophytes present	Hydrophytes not present
L-L1OWHh	L-PFO1C-1
L-PFO1A-2	L-POWHh-1
L-POWHh-8	L-POWHh-2
L-POWHh-9	L-POWHh-3
L-POWHh-15	L-POWHh-10
L-POWHh-21	L-POWHh-11
L-POWHh-22	L-POWHh-16
L-POWHh-23	L-POWHx-1
L-POWHh-24	L-POWHx-3
L-POWHh-25	L-POWHx-4
L-POWHh-26	L-POWHx-7
L-POWHh-28	L-3
L-POWHh-29	
L-POWHh-31	
L-POWHh-32	
L-POWHh-33	
L-POWHh-35	
L-POWHh-36	
L-1	
L-2	

Table 3. Presence or absence of hydrophytic vegetation on sites in the USGS Bethel Valley quadrangle that were visited during a wetlands survey of ORR

Hydrophytes present		
B-L1OWHh	B-POWHh-13	B-19
B-L2OWHh-1	B-POWHx-1	B-20
B-L2OWHh-2	B-R4SB3A-1	B-21
B-PFO1Ah-5	B-R4SB3U-4	B-22
B-PFO1A-7	B-1	B-25
B-PFO1A-11	B-2	
B-PFO1A-17	B-3	
B-PFO1A-18	B-4	
B-PFO1A-19	B-5	
B-PFO1A-21	B-6	
B-PFO1A-22	B-7	
B-PFO1A-24	B-8	
B-PFO1A-27	B-9	
B-PFO1A-32	B-10	
B-PFO1A-99	B-11	
B-POWHh-1	B-12	
B-POWHh-2	B-13	
B-POWHh-3	B-14	
B-POWHh-7	B-15	
B-POWHh-8	B-16	
B-POWHh-11	B-17	
B-POWHh-12	B-18	
B-PFO1A-6		
B-PFO1A-25		
B-PFO1A-32		
B-POWHr-1		
B-POWH-2		
B-POWHh-9		
B-POWHh-10		
B-7		
B-23		
B-24		

Table 4. Presence or absence of hydrophytic vegetation on sites in the USGS Elverton quadrangle that were visited during a wetlands survey of ORR

Hydrophytes present	Hydrophytes not present
E-L1OWHh-1	E-POWHr-1
E-L1OWHh-2	E-POWHr-2
E-L2OWHh-1	E-POWHh-4
E-L2OWHh-5	E-POWHh-5
E-L2OWHh-6	E-POWHx-1
E-PAB1H-1	E-R2UB3H-1
E-PFO1A-1	E-6
E-PFO1A-2	E-7
E-PFO1A-96	E-8
E-PFOSF/SS1F	E-9
E-POWHh-1	
E-POWHh-2	
E-POWHh-3	
E-POWHh-6	
E-POWHh-97	
E-POWHx-2	
E-POWHx-3	
E-R2UB3H-99	
E-1	
E-2	
E-3	
E-4	
E-5	

Table 5. Common wetland genera and species on ORR

Trees	Herbaceous emergent
Acer negundo, boxelder	*Acorus calamus*, sweet flag
Fraxinus pennsylvanica, green ash	*Carex* sp., sedge
Platanus occidentalis, sycamore	*Juncus* sp., rush
Salix nigra, black willow	*Justicia americana*, water willow
	Eleocharis sp.
	Hibiscus sp., mallow
	Samolus parviflorus
Shrubs	*Saururus cernuus*, lizard's tail
Alnus serrulata, alder	*Sagittaria* sp.
Amorpha fruticosa, indigobush	*Typha* sp., cattail
Cephalanthus occidentalis, buttonbush	
Cornus amomum, silky dogwood	
Hypericum densiflorum	
Floating aquatics	**Submerged aquatics**
Wolffia sp.	*Elodea* sp.
Lemna sp.	*Myriophyllum* sp.
	Potamogeton sp.

Some sites on ORR shown on the NWI maps were not visited during the survey (Table 6); the majority are identified as palustrine forested or riverine and are small tributaries through upland forest, where major wetland development was not considered likely because of the steep gradient. Stream drainages and ponds with significant amounts of radioactive contaminants were not visited. The White Oak Creek floodplain and White Oak Lake have extensive wetland communities and should be surveyed by staff certified to work on contaminated sites.

Table 6. Sites on the NWI maps of ORR that were not visited during the wetlands survey

B-PFO1A-3	B-R4SB3U-1
B-PFO1A-4	B-R4SB3U-2
B-PFO1A-5	B-R4SB3U-3
B-PFO1A-9	B-R4SB3U-5
B-PFO1A-26	B-R4SB3U-6
B-PFO1A-28	B-R4SB3U-7
B-PFO1A-29	B-R4SB3U-8
B-PFO1A-30	B-R4SB3U-9
B-PFO1A-31	B-R4SB3U-10
B-PFO1A-33	B-R2UB3H-1
B-PFO1A-34	B-L2OWHh-1
B-PFO1A-35	L-R4SB5A-2
B-PFO1A-36	
B-PFO1A-37	
B-PFO1A-97	
B-PFO1A-98	
B-PFO1A-199	
B-POWH-3	
B-POWH-1	
B-POWHx-2	

LOVELL QUADRANGLE

I. Wetland vegetation is present at these sites. (Letters in parentheses refer to maps in Appendix.)

L-L1OWHh - Lowland along the Clinch River (Melton Hill Lake). Wetland shrubs and herbaceous emergent vegetation are abundant in some areas, primarily in embayments and small coves with very shallow water along the dissected shoreline. (I and J)

L-PFO1A-2 - A relatively open, flat, wet area adjoining McCoy Branch near Rogers Quarry. Black willow and cattail dominate. (I)

L-POWHh-8 - A large pond with cattail along the edges; floating and rooted aquatic plants present. (I)

L-POWHh-9 - A shallow pond covered with duckweed; emergent herbaceous species along the edge. (I)

L-POWHh-15 - Pond with a narrow zone of emergent herbaceous species at the edge. Pond is in a bowl-shaped depression; planted pine trees are on three sides. (I)

L-POWHh-21 - An embayment of Melton Hill Lake that is separated from the reservoir by Edgemoor Road except for a culvert. Emergent herbaceous vegetation dominates in some areas along the bank. (I)

L-POWHh-22 - A section of Melton Hill Lake that is isolated by Edgemoor Road. The water level follows that of the reservoir, so it is perhaps joined to it by a culvert that is not visible. Many emergent herbaceous species are along the banks of this shallow pool, and numerous wet meadow species occur back from the shoreline. (I)

L-POWHh-23 - An embayment of Melton Hill Lake that is separated from the reservoir by Edgemoor Road except for a culvert. Herbaceous emergent vegetation is along two sides of the pool. (I)

L-POWHh-24 - Two adjacent ponds near the shore of Melton Hill Lake. Aquatic plant species are present. (I)

L-POWHh-25 - An embayment of Melton Hill Lake that is impounded by a road. A culvert connects the embayment to the reservoir. A perennial stream flows into the embayment. Wetland shrubs and an abundance of emergent herbaceous species are present at the narrow end of the embayment. (I)

L-POWHh-26 - An embayment of Melton Hill Lake that is impounded by a road. A culvert connects the embayment to the reservoir. A small perennial stream flows into the site. A small wetland community is at the western end of the embayment. (I)

L-POWHh-28 - An embayment of Melton Hill Lake that is impounded by a road; a culvert connects it to the reservoir. Green ash, black alder, and black willow dominate the wetland community at the narrow end of the embayment. (J)

L-POWHh-29 - A shallow pond dominated by a hydrophytic grass. Another small pond is nearby. (J)

L-POWHh-31 - A steep-sided pond surrounded by black willow and silky dogwood. (J)

L-POWHh-32 - A small pond with emergent herbaceous species at the edges. (J)

L-POWHh-33 - A pond near Melton Hill Lake with numerous aquatic species and emergent herbaceous species along the shallow shoreline. (J)

L-POWHh-35 - A small pond with some emergent herbaceous vegetation and wetland shrubs. (I)

L-POWHh-36 - A broad shallow pond with an abundance of emergent herbaceous species. Some wetland shrubs are also present. (I)

L-POWHx-4 - A small pond with some wetland vegetation that drys out during the summer.

L-1 - A pond that has almost filled in with emergent herbaceous species; very little open water is left in the center. (I)

L-2 - East Fork Poplar Creek from Lake Reality to ORR boundary. The banks and floodplain of the creek are forested wetland dominated by sycamore, boxelder, and green ash. (I)

II. Sites that support little to no hydrophytic plants. (Letters in parentheses refer to maps in Appendix.)

L-PFO1C-1, 2, and 3 - Forested islands with a steep bank and very few emergent species at shoreline. (I)

L-POWHh-1 - An earthen dam is intact, but no water is present. ((J)

L-POWHh-2 - An earthen dam is intact, but no water is present. (J)

L-POWHh-3 - No wetland present. Perhaps a shallow pond that has dried up. (J)

L-POWHh-10 - Could not locate this pond; it must be dry. It does not appear on the most recent topographic maps for ORR. (I)

L-POWHh-11 - New Hope Pond is now drained and filled. (I)

L-POWHh-16 - This pond no longer holds water; no hydrophytic species are present. (I)

L-POWHx-1 - Rogers Quarry. A deep steep-sided rock quarry now filled with water. No hydrophytic vegetation at the edges. We did not take a boat out to look for aquatics. (I)

L-POWHx-3 - Steep sides to this now dry, and apparently consistently dry, pond. (I)

L-POWHx-7 - Two very steep-sided ponds side by side; no hydrophytic vegetation. (J)

L-3 - Headwaters of East Fork Poplar Creek to the now filled New Hope Pond. Headwaters within the Y-12 fence are mixed with a large volume of Y-12 process water and flow through a channel with rip-rap banks. Very little natural vegetation or creek bank remains. As the water flows around the old New Hope Pond area, it is contained in a cement channel and remains in the channel until it flows into Lake Reality. (I)

BETHEL VALLEY QUADRANGLE

I. Wetland vegetation is present at these sites. (Letters in parentheses refer to maps in Appendix.)

B-L1OWHh - Clinch River (Melton Hill Lake). Much of the river edge is a relatively steep bank with little wetland development, but hydrophytic vegetation occurs in some lowland areas. In these areas, particularly embayments, wetland trees, shrubs, and herbaceous emergent vegetation occur. (E,G, and H)

B-L2OWHh-1 - White Oak Creek Embayment. Only a small spur of this site was visited. The main body of the embayment is contaminated and so was not visited by canoe. The upper end of the embayment spur near the 0800 field site supported emergent wetland vegetation. (E)

B-L2OWHh-2 - White Oak Lake. From a distance, abundant emergent wetland vegetation was observed along the edges of White Oak Lake, but because of contamination we did not get a close look. (E)

B-PFO1Ah-5 - Two small impounded ponds flow into a stream with a wet floodplain. The stream flows into a small embayment of Melton Hill Lake. Black willow and sedges are abundant. (G)

B-PFO1A-7 - Wetland community development in areas where the stream crosses through a cleared power-line right-of-way. Emergent herbaceous species dominate. (D)

B-PFO1A-8 - A sedge meadow is present where the stream crosses through a cleared power-line right-of-way. (D)

B-PFO1A-11 - Floodplain of Bear Creek. Forested wetland vegetation occurs in varying width bordering the stream. A small tributary to Bear Creek flows into this area; the upstream section of the tributary flows through a power line right-of-way. In the wet opening, Platanthera peramoena, an orchid listed as threatened in Tennessee, was found. (D)

B-PFO1A-17 - Relatively little wetland species except where the stream crosses the power-line right-of-way. In this area herbaceous emergent species occur. Platanthera peramoena, a species listed as threatened in Tennessee, grows in the wet opening. (D)

B-PFO1A-18 - Forested wetland along floodplain of Bear Creek. The width of the wetland vegetation varies and is not always continuous. (F)

B-PFO1A-19 - A thicket with small areas of wetland mostly along Bear Creek. (D)

B-PFO1A-21 - Forested wetland along an unnamed tributary to Bear Creek. An interesting wetland not shown on the NWI map adjoins the tributary. It is partly forested but grades into a shrub area and then into an opening dominated by sweet flag, Acorus calamus. The open area has standing and slowly moving water fed by seeps. The site is part of a registered Tennessee Natural Area. During the wetlands survey a twayblade orchid tentatively identified as Liparis loeselii, a state endangered species, was found in the forested part of the wetland. Confirmation of identification was made in 1991. (D)

B-PFO1A-22 - Forested wetland composed of seeps, channels, swamps, low wet woods, and peaty/marshy areas. Large patches of Carex prosina with distinct boundaries. Large areas dominated by Solidago patula and Impatiens capensis. Swamp areas with standing open water and with bare soil (void of vegetation) or blackened litter; water marks on the trees. Water in channels was flowing in some places. Sparse pine throughout the maple- and ash-dominated woodland contributed a larger than expected share of litter on the forest floor. A state endangered species, Platanthera flava var. herbiola, grows in this wetland. (D)

B-PFO1A-24 - Forested wetland along East Fork Poplar Creek. Sycamore, boxelder and green ash dominate. (C and D)

B-PFO1A-27 - Forested wetland along an unnamed tributary to East Fork Poplar Creek. As stream flows through a power-line opening, a wet meadow/marshy area is developed, partly fed by seeps away from the stream channel. (C)

B-PFO1A-32 - Visited only the headwater of the stream. Seeps and springs are in the area. The stream has a gravel bottom. Exotic species dominate on one side of the stream but a wetland orchid, Platanthera clavelata, was present on the other side. Hydrophytic vegetation is confined to certain areas. (G)

B-PFO1A-99 - Area visited was relatively flat bottomland along an unnamed tributary to East Fork Poplar Creek. Herbaceous emergent vegetation is present. (F)

B-POWHh-1 - A narrow embayment separated from the reservoir by a roadbed and connected with a culvert. Strong zonation in the emergent wetland; Scirpus and Juncus at water's edge are bordered by a shrub Hypericum, and farthest from the shore were wetland dogwood, willow, and alder. (E)

B-POWHh-2 - Raccoon Creek embayment. A narrow embayment separated from the reservoir by a road. A culvert connects it to the main channel. Herbaceous and shrubby emergent/wet meadow vegetation is present on the long shoreline. (E)

B-POWHh-3 - A small embayment cut off from the reservoir by a road and connected by a culvert. There is a large area of wetland dominated by a single grass species. (E)

B-POWHh-7 - A very small pond created by Bethel Valley Road isolating a part of the Walker Branch embayment. Cattail and Myriophyllum are present. (G)

B-POWHh-8 - A pond with some emergent vegetation and Wolffia, a floating aquatic species. (F)

B-POWHh-11 - A large pond with zones of emergent vegetation around the perimeter. No aquatics observed. Slopes to the pond are not steep, but pond gets deep quickly. (F)

B-POWHh-12 - A shallow pond with many emergent species and large beds of aquatic species. (F)

B-POWHh-13 - A stream drainage feeding Bearden Creek embayment is cut off from the reservoir by a gravel road with a culvert underneath. Standing water next to the road supports herbaceous emergent vegetation. There is a dense alder thicket in the shady stream drainage. (G)

B-POWHx-1 - A group of ponds constructed and used for research. Two aquatic species, Myriophyllum and Elodea nuttallii, a state-listed aquatic species, are present. (D)

B-R4SB3A-1 - Headwaters and upper reaches of Bear Creek. Wetland vegetation varies through this highly disturbed section of the creek. It ranges from narrow strips of boxelder, sycamore, and willow along the bank to more open sections with low banks or broader channel where emergent and wet meadow vegetation are present. (F)

B-R4SB3U-4 - A wet stream bottom with hydrophytic species present, including a wetland orchid. (F)

B-1 - Low, wet drainage on south-facing slope of Pine Ridge near Y-12. This is a recently disturbed area with lots of rock fill and rip-rap on the sides. Water was standing and flowing through a culvert under Bear Creek Road. Some herbaceous emergent species are established. (F)

B-2 - A shallow pond at the edge of a woodland; standing dead trees, some with apparent nest holes. Water flows through a culvert to Bear Creek. Black willow and herbaceous emergents are present. (F)

B-3 - A pond in a disturbed area with a few emergent species present. Looks recently formed or reworked. (F)

B-4 - A broad, wet area bordering Bear Creek Road connected by a culvert to another wet area upslope. Water was flowing at the upslope location. A rich collection of mostly herbaceous emergent vegetation and wet meadow species. (F)

B-5 - A low, wet area with flowing water on the south-facing slope of Pine Ridge near Bear Creek Road. Many emergent and wet meadow species present. (F)

B-6 - A small pond in a low area along Bear Creek Road. Cattails abundant and aquatic species present also. (F)

B-8 - The Y-12 fly ash pond. This large area is a mosaic of bare ash, grasses and forbs, and black willow. In some sections hydrophytic species are clearly dominant. The ash sluice is no longer deposited in the pond, so the hydrology is altered. Judging from the downstream flow, however, there may still be enough flow from the springs feeding McCoy Branch to continue the wetland hydrology. (F)

B-9 - A series of small wetlands along the power-line right-of-way that runs parallel to Bear Creek Road. In 1989 a section of the right-of-way was turned into a haul road for trucks carrying clay to cap burial grounds at Y-12. The widening and grading of the right-of-way have reduced the extent of the wet areas at this site. (F)

B-10 - A series of marshy areas under the Bear Creek power-line right-of-way, east of the section that is used as a haul road (see B-9). Some emergent species present, along with wet meadow species and an alder thicket. (F)

B-11 - A pool that either is a natural oxbow of East Fork Poplar Creek or was cut off from the creek during construction of Highway 95. A culvert at one end may connect it to the creek; the pipe is bent, however, and may not allow flow. Area is forested. Rock outcrops are present along one side of the curved pool, and the other side is marshy. Hydrophytic species include herbaceous forest floor species and duckweed, a floating aquatic. (C)

B-12 - A forested boggy wetland near New Zion Cemetery. A unique community on ORR; cool water emerges slowly and steadily from the ground in several places. Sphagnum moss dominates in seep areas, and ferns cover the boggy forest floor. (E)

B-13 - A series of wetlands under the Bear Creek power-line right-of-way west of Highway 95. A great diversity of wet meadow species occur in these sites, including Platanthera peramoena. (D)

B-14 - Spring-fed streams with alder, spicebush, and fern nearby. (G)

B-15 - An excavated pond with a synthetic liner. Cattails are present at one end. (G)

B-16 - Wet meadows along Bethel Valley Road. Emergent and wet meadow species present. (G)

B-17 - A series of wet sites under the right-of-way corridor that runs parallel to Melton Valley Drive. Emergent and wet meadow species dominate in these areas. (G)

B-18 - Small pond at the Y-12 landfill. Eroded sides. The edges of the pond support a few emergent and wet meadow species. (F)

B-19 - An apparently perennial stream flows through forest near George Jones Cemetery. As it crosses a gas pipeline right-of-way, hydrophytic herbs and shrubs are present. (D)

B-20 - A section of the Bearden Creek embayment is separated from the reservoir by Melton Valley Drive, except for a culvert under the road. A small stream flows into the isolated section. Many emergent species are present along the shore. Water milfoil is abundant. (G)

B-21 - A spring-fed pond near ORNL. The water is clear, and Elodea nuttallii (an aquatic species listed by Tennessee as threatened) dominates the pond. (D)

B-22 - A small stream that leads to B-PSS1A-1. Several hydrophytic ferns are present in the area. (D)

II. These sites do not support hydrophytic vegetation. (Letters in parentheses refer to maps in Appendix.)

B-PFO1A-6 - Island in the Melton Hill Reservoir that does not support wetland vegetation. (G)

B-PFO1A-25 - Stream in a forested area. No wetland vegetation, even in the power-line right-of-way. (D)

B-PFO1A-32 - Stream in a forested area near Walker Branch Watershed Laboratory. Banks of the stream were steep-sided; no wetland community development. (G)

B-POWHr-1 - The settling basins have been closed and filled. No hydrophytic vegetation. (F)

B-POWH-2 - Pond no longer exists. No wetland vegetation. (F)

B-POWHh-9 - A dam was noted, but no water or hydrophytic vegetation was present. (G)

B-POWHh-10 - A dam was noted, but no water was present. (G)

B-7 - A disturbed area in the Y-12 fenced enclosure. A few cattails and a willow, but most of the vegetation is not hydrophytic. (F)

B-23 - Several sites along the power-line corridor that runs parallel to Bethel Valley Road near ORNL. Wetlands have not developed in these topographic low places along the right-of-way as they have in Bear Creek Valley. (D)

B-24 - A small unnamed tributary to East Fork Poplar Creek that is not a perennial stream. Both the forested section and the opening under the power line did not support wetland vegetation. (D)

ELVERTON QUADRANGLE

I. Wetland vegetation is present at these sites. (Letters in parentheses refer to maps in Appendix.)

E-L1OWHh-1 - Poplar Creek. Wetland vegetation exists in discontinuous bands along the creek on low ground and small islands and in shallow embayments. A wide array of forested wetland species and of herbaceous emergent species occurs primarily along the west bank of the creek. Limestone outcrops are abundant on the east bank. Aureolaria patula and Cimicifuga rubifolia, two rare plant species that are always associated with rivers and creeks, occur on the rock outcrops and adjacent forest. Two great blue heron rookeries are in the Poplar Creek drainage in ORR. (A and B)

E-L1OWHh-2 - Deepwater channel of Watts Bar Reservoir. Much of this area is upland habitat at the river bank, but sizeable areas of well-developed wetland communities are present in several shallow embayments and on lowland. Forested wetland dominates on lowland near Gallahar Bridge, and one of the largest areas of emergent vegetation on ORR is in a narrow embayment near the bridge. Emergent vegetation is also abundant just upstream and downstream of Brashear Island. Aureolaria patula, a rare plant species that is a candidate for federal listing, occurs at shoreline just downstream of K-25. (B)

E-L2OWHh-1 - A silt bar in the sharp bend of Poplar Creek before its junction with the Clinch River. Some herbaceous emergent vegetation present but far less than in the protected shallow areas along the creek. (B)

E-L2OWHh-5 - This narrow channel supports emergent species. Wet meadow species, including an uncommon orchid, Platanthera lacera, are in the power-line corridor near the channel. (B)

E-L2OWHh-6 - Roberts Branch embayment. A community of emergent wetland species occurs in the narrow end of the embayment. (B)

E-PAB1H-1 - Two small, adjacent ponds surrounded by wetland shrubs. (B)

E-PFO1A-1 AND 2 - Floodplain of East Fork Poplar Creek supports a forested wetland community. The wetland extends farther back from the creek in some areas than the NWI map shows. (A)

E-PFO1A-96 - Forested wetland on lowland along the Watts Bar Reservoir edge. (B)

E-PFOSF/SS1-1F - A pond below a water filtration plant. Effluent from the plant empties into the pond and then flows into the reservoir. Pond is surrounded by wetland shrubs and herbaceous emergent vegetation. Water level fluctuates rapidly. (B)

E-POWHh-1 - Embayment on Poplar Creek that is cut off by a road and connects to the impoundment by a culvert. Forested up to the edges. Herbaceous emergent species present. (A)

E-POWHh-2 - A large pond previously used for waste retention and disposal; a spillway allows outflow to Watts Bar Reservoir. A beaver dam on the spillway has raised the water level in the pond. Dead trees are at the edge of pond. Cattail dominates the emergent community at the northwest end where a small stream enters the pond. The wet stream drainage is dominated by black willow. Some aquatic species are present in the pond. (A and B)

E-POWHh-3 - A large pond separated from Poplar Creek by a narrow strip of land; there is apparently no culvert connecting it to the creek. Much of the pond bank is steep. A sedge meadow is developed on one edge, however, and a wetland shrub community is well-developed in a strip on one shore. (B)

E-POWHh-6 - A pond alongside Highway 58. The pond is mostly steep-sided. A stream enters the back end of the pond, and in this area there is an alder thicket. Seeps and wet areas occur along the stream drainage. (B)

E-POWHh-97 - An embayment of the Watts Bar Reservoir cut off by an old roadbed. A culvert connects it to the reservoir. An emergent wetland community occurs where a small stream enters the embayment. (B)

E-POWHx-2 - A pond that has apparently either varied in size or been altered; the small pond in this vicinity doesn't seem to be on the NWI map. Sedge meadows are near the pond. (B)

E-POWHx-3 - A pond and associated canals have wetland shrub areas on the edges. (B)

E-R2UB3H-99 - Brashear Creek drainage into the Watts Bar Reservoir. An emergent wetland community occurs where the creek enters the embayment. (B)

E-1 - Wet area on a power-line right-of-way that supports emergent wetland species, including Platanthera peramoena. (B)

E-2 - A wetland between Harrell Road and East Fork Poplar Creek. Several springs are in this area. Abundant algae in the streams from the springs. This low wet area is dominated by wetland shrubs growing in fairly dense thickets. (A)

E-3 - A pond on a power-line right-of-way near K-25. An interesting site with a diverse array of emergent species and aquatic pondweed. (B)

E-4 - Mitchell Branch inside the fence at K-25. Area bordering the stream is in wetland trees and shrubs but the extent varies. In low areas or in sections with braided channel, wetland species extend back from the banks. (A)

E-5 - Mitchell Branch outside the K-25 fence. Near Portal 6 the small stream flows through a forest with some wetland shrubs near the stream, then into an open area near a parking lot. In the opening the stream area is dominated by wetland shrubs and herbaceous emergent species. Between Portal 5 and Poplar Creek, the stream area supports emergent and wet meadow species and wetland trees and shrubs. (A)

II. These sites do not support hydrophytic vegetation. (Letters in parentheses refer to maps in Appendix.)

E-POWHr-1 AND 2 - Former waste settling ponds that have been drained and sediments removed during environmental restoration. No hydrophytic vegetation. (A)

E-POWHh-4 AND 5 - Small artificial ponds with no wetland vegetation. (B)

E-POWHx-1 - A long, narrow, steep-sided pond that is cemented in some areas. No wetland development. (B)

E-R2UB3H-1 - The channel of East Fork Poplar Creek supports virtually no hydrophytic plants. Wetlands that do exist are out of the stream channel; see E-PFO1A-1 AND 2 for a description of forested wetland on the floodplain. (A)

E-6 - A small stream flows through upland forest; there is no wetland development. (A)

E-7 - A pool of water is formed by the roadbed of Highway 58 near K-25, blocking the flow of a small stream. A very scenic area in the forest with extensive limestone outcrops. The terrain is steep, and the pond has no shallow areas that support wetland species. (B)

E-8 - Cleared areas along dirt roadways just west of K-25. No wetlands have developed in the clearings. (B)

E-9 - Openings on power-line rights-of-way west of K-25. No hydrophytic vegetation was observed. (A)

NOTEWORTHY PLANT SPECIES IN WETLANDS ON ORR

Vascular plant species occurring on sites visited were inventoried during the wetlands survey, and 57 species were added to the checklist of vascular plants on ORR (Table 7). Not all of the added species are wetland species. Plant specimens were collected for each new species. Several rare plant species not previously seen on ORR were observed in wetland habitats. Purple fringeless orchid, Platanthera peramoena, was observed in flower and positively identified. A floating aquatic species, identified as Elodea nuttallii, was found in two ponds; the species can be difficult to distinguish from the more common and variable Elodea canadensis, and the identification should be confirmed by an expert on this genus. A twayblade orchid, tentatively identified as Liparis loeselii, was observed in fruit, and on this basis the determination was made. The identification was verified in spring 1991, when the species was in flower.

Table 7. Additions to the checklist of vascular plants on ORR (not all of these are wetland species)

Genus	Species	Variety
Agalinis	fasiculata	
Ammannia	coccinea	
Aronia	arbutifolia	
Carex	blanda	
Carex	debilis	
Carex	festucacea	
Carex	gravida	
Carex	laevivaginata	
Carex	meadii	
Carex	oligocarpa	
Ceratophyllum	demersum	
Chasmanthium	laxum	
Chasmanthium	sessiliflorum	
Cyperus	brevifolioides	
Cyperus	retrofractus	
Cyperus	tenuifolius	
Elaeagnus	umbellata	
Eleocharis	palustris	
Eleocharis	quadrangulata	
Elodea	nuttallii	
Erianthus	giganteus	
Eulalia	vimineum	
Euthamia	graminifolia	
Galium	obtusum	
Galium	pedemontanum	
Gratiola	neglecta	
Hibiscus	moschuetos	palustris
Hypericum	drummondii	
Hypericum	prolificum	
Juncus	brachycarpus	
Juncus	scirpoides	
Leucospora	multifida	
Liatris	spicata	
Lotus	corniculatus	
Mosla	dianthera	

Table 7 (continued). Additions to the checklist of vascular plants on ORR (not all of these are wetland species)

Genus	Species	Variety
Najas	guadalupensis	
Platanthera	lacera	
Platanthera	peramoena	
Polygala	incarnata	
Polygonum	cespitosum	
Potamogeton	diversifolius	
Potamogeton	pusillus	
Prenanthes	trifoliata	
Ranunculus	acris	
Rapistrum	rugosum	
Rhyncospora	globularis	
Rorippa	palustris	
Rudbeckia	fulgida	sullivantii
Sagittaria	engelmanniana	
Sagittaria	engelmanniana	longirostra
Scirpus	americanus	
Scirpus	purshianus	
Scrophularia	marilandica	
Silphium	compositum	
Solidago	rugosa	
Taenidia	integerrima	
Wolffia	sp.	

DISCUSSION

The extensive survey of ORR for the presence of wetlands provides an information base for use in natural resource management and resource protection. The survey provides information on the presence of hydrophytic vegetation at the visited sites, but not every wetland on ORR was identified. The scope was to field-check sites shown on the NWI maps and other likely locations of wetlands. Upland sites may have wetlands that neither the NWI maps nor survey staff identified, and some sites on ORR were not surveyed because radioactive contaminants are present (e.g., the White Oak Creek watershed). For those concerned with environmental protection and compliance at the DOE Oak Ridge facilities, the survey may be most useful as an indication of the areas visited that do not support wetland vegetation. In addition, general knowledge of the wetland resources across ORR is essential for efficient project planning, particularly given the federal and state environmental regulations that must be addressed.

The ORR wetlands can be characterized either as (1) embayments of the Melton Hill and Watts Bar Reservoirs that border the reservation; (2) forested wetland along East Fork Poplar Creek, Poplar Creek, Bear Creek, and their tributaries; (3) ponds that are primarily remnants of previous farms; or (4) wet openings associated with streams and seeps. Most of the wetland sites visited are relatively small — less than 1 acre in size. Exceptions to this are large areas of forested wetland along East Fork Poplar Creek and the Clinch River near Gallahar Bridge. Several well-developed emergent communities in shallow embayments of the reservoirs are also greater than 1 acre in size. The emergent communities typically grade into a marsh adjoining forested wetland. Ponds on ORR vary in size and degree of wetland community development; several are large and support diverse flora and fauna. A number of wetland sites visited during the survey may be considered significant habitats because they either support rare taxa or are a unique example of a community on ORR.

The survey provided a good opportunity for field validation of the remotely sensed data used by NWI in preparing its maps and gives an indication of areas that the NWI mapping techniques missed. About one-third of the ORR wetlands identified during the survey were not shown on the NWI maps. The maps were helpful in locating ponds and pools with open water (POW code) in nonforested areas. Wet meadows and some wetlands in forests, however, were not identified on the NWI maps. The NWI maps for ORR did not include all the perennial stream channels as wetland habitat and it is not clear why. Lacustrine wetlands identified along the Melton Hill and Watts Bar Reservoirs and Poplar Creek did not show the adjoining palustrine forested wetland, which occurs extensively, though not continuously, along the shores.

Fifteen of the small ORR ponds identified by NWI no longer hold water. Eleven of these are presumably former livestock ponds that have dried up. The remaining four are now drained or filled artificial ponds that

served as settling basins for DOE activities. Many other ponds appear to be stable and have considerable wetland community development. One pond close to the reservoir's main channel was rich in aquatic plant species, perhaps because migrating birds may carry propagules on their feet that are deposited in the ponds.

Embayments of the Melton Hill and Watts Bar reservoirs are classified by NWI as palustrine if they are cut off from the reservoir by a road, or they are included in the lacustrine system if they are not separated. Embayments that support well-developed wetland communities are either very shallow or cut off by a road. In both cases protection is provided from motorboats and their wave action, and recreational-user traffic on the shore is reduced. Small streams commonly flow into the embayments and flow through a wetland community. It was evident during the survey that much of the debris and surface pollutants on the reservoirs accumulate in the narrow corners of embayments. The numerous wetland communities of varying size in embayments may be playing a role in water quality regulation through decomposition or adsorption of undesirable elements. That role may increase as the size of the wetlands grows over time; much of the existing wetland habitat associated with the reservoirs is only 30 to 40 years old. Abundance of wildlife associated with wetland habitat (e.g., herons and osprey) will likely continue to increase also.

The most surprising group of wetlands discovered on ORR are those on utility rights-of-way. These were predominantly in Bear Creek Valley and Melton Valley and occurred where small streams or moist drainages crossed the right-of-way. Although the upstream or upslope forested areas did not appear to be dominated by wetland species, wet meadow conditions prevailed in the openings. A rich variety of herbaceous wetland species were present, including an orchid listed as threatened in the state. Possible explanations for this observation are (1) the herbaceous species that develop so lushly in the openings may impede surface water and shallow groundwater flow and result in broad zones of wet soil; (2) there may a differential in the degree of substrate wetness required to support a forested wetland community versus one dominated by herbaceous species; (3) the forest canopy may be a greater evapotransportative surface than the dense herbaceous community and thus deplete soil moisture to a much greater extent; or (4) the subsurface soil may be structurally different in the right-of-way openings from forest soil because of slope location or compaction from mowing equipment.

Potential threats to the ORR wetlands include habitat loss or degradation from project development activities, extreme and sustained water level fluctuation in the reservoirs, use of herbicides on the utility rights-of-way, and use of the rights-of-way for heavy truck traffic.

RECOMMENDATIONS

Although the purpose of this survey was to identify ORR wetlands, it is appropriate to make recommendations for responsible stewardship of significant ORR wetland habitat. Several wetland sites provide habitat for state-listed rare plant species previously unknown on ORR. Platanthera peramoena grows in wet meadows in power-line rights-of-way (B-PFO1A-11, B-PFO1A-17, B-13, and E-1). Elodea nuttallii is an aquatic species that grows in ponds (B-POWHx-1 and B-21). Liparis loeselii grows in the forested edge of the Hembree Cemetery marsh (B-PFO1A-21). Sites supporting listed rare species are recognized as protected on ORR by designation as National Environmental Research Park Natural Areas (Parr and Pounds 1987). The newly discovered rare-plant sites should be thus designated.

Sites for either unique or representative plant communities on ORR warrant recognition as areas worthy of protection. A number of areas fitting this description are designated National Environmental Research Park Reference Areas (Parr and Pounds 1987). Several of the wetlands visited during the survey are unique communities either in terms of the elements present or the size or quality of the community. New Zion Cemetery wetland (B-12) is a forested, boggy area that has a unique assemblage of species. A large wetland on a shallow embayment (a section of E-L1OWHh-2) near Gallahar Bridge on State Highway 58 has extensive stands of emergent herbaceous species, shrubs, and forested wetland. Large wetlands provide habitat for some animals that cannot live in smaller patches. A well-developed pond community, including emergent and aquatic species, is present at L-POWHh-8. A smaller pond (L-POWHh-33) near the Clinch River on Freels Bend is rich in aquatic and emergent species. These wetlands should be considered candidates for Research Park Reference Areas.

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APPENDIX

APPENDIX

EXAMPLES OF MAP CODES

B-9

This is a site with code B-9 in the text. The outline indicates that the site was visited by the survey team and wetland vegetation was present. The lack of a NWI code shows that this site was not shown on the NWI maps, but identified as an additional site by the ORR wetland survey team.

POWHh-9

The NWI code POWHh indicates that this site was on the NWI maps. The outline shows that the site was visited by the wetland survey team and no significant wetland vegetation was found. References to this site in the text would be preceded with the letter indicating in which Quadrangle map the site occurs (B, E, or L).

Note that although both of these sites end with the number "9," they are different sites.

ORNL-DWG 91-17714

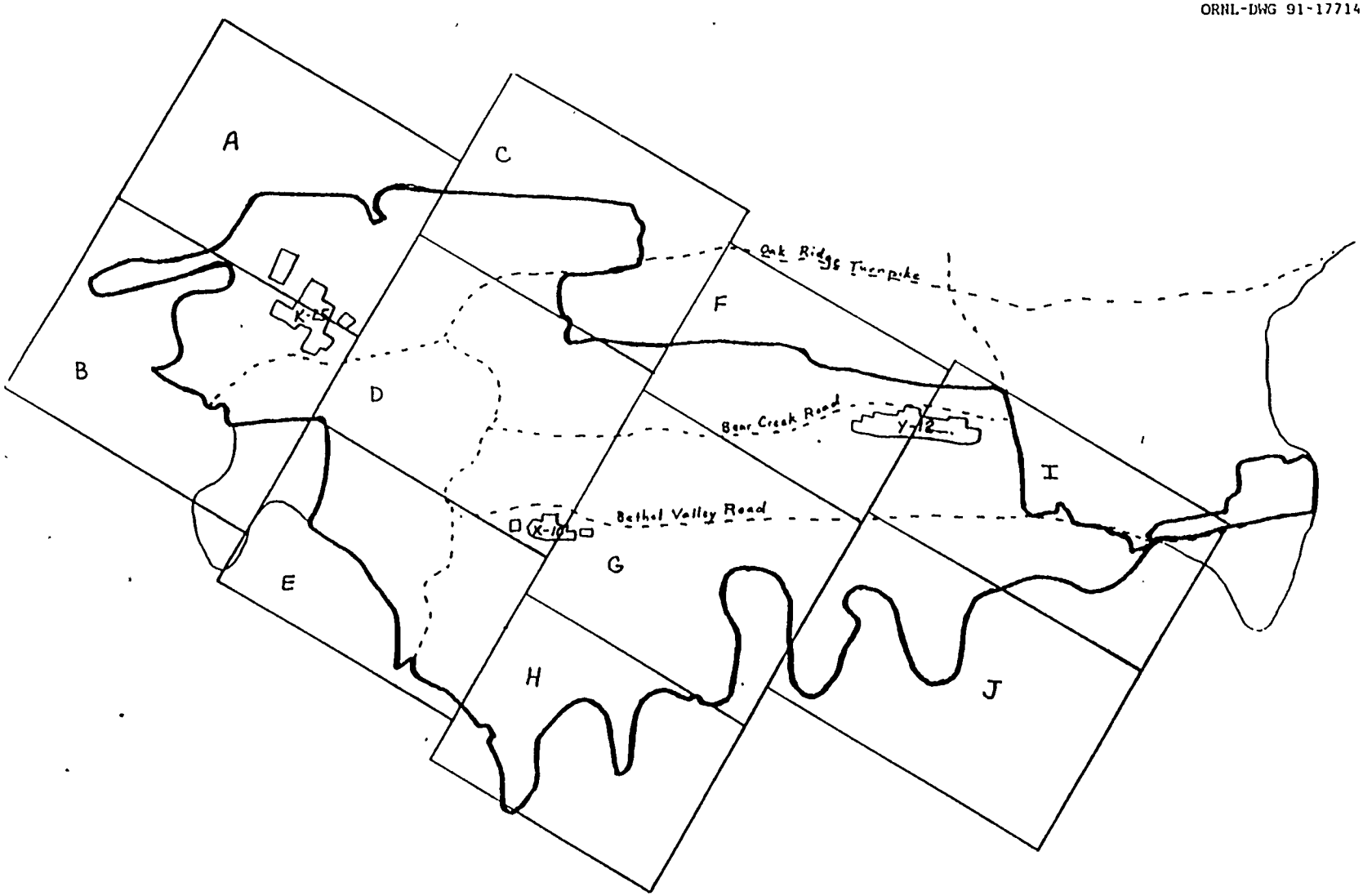
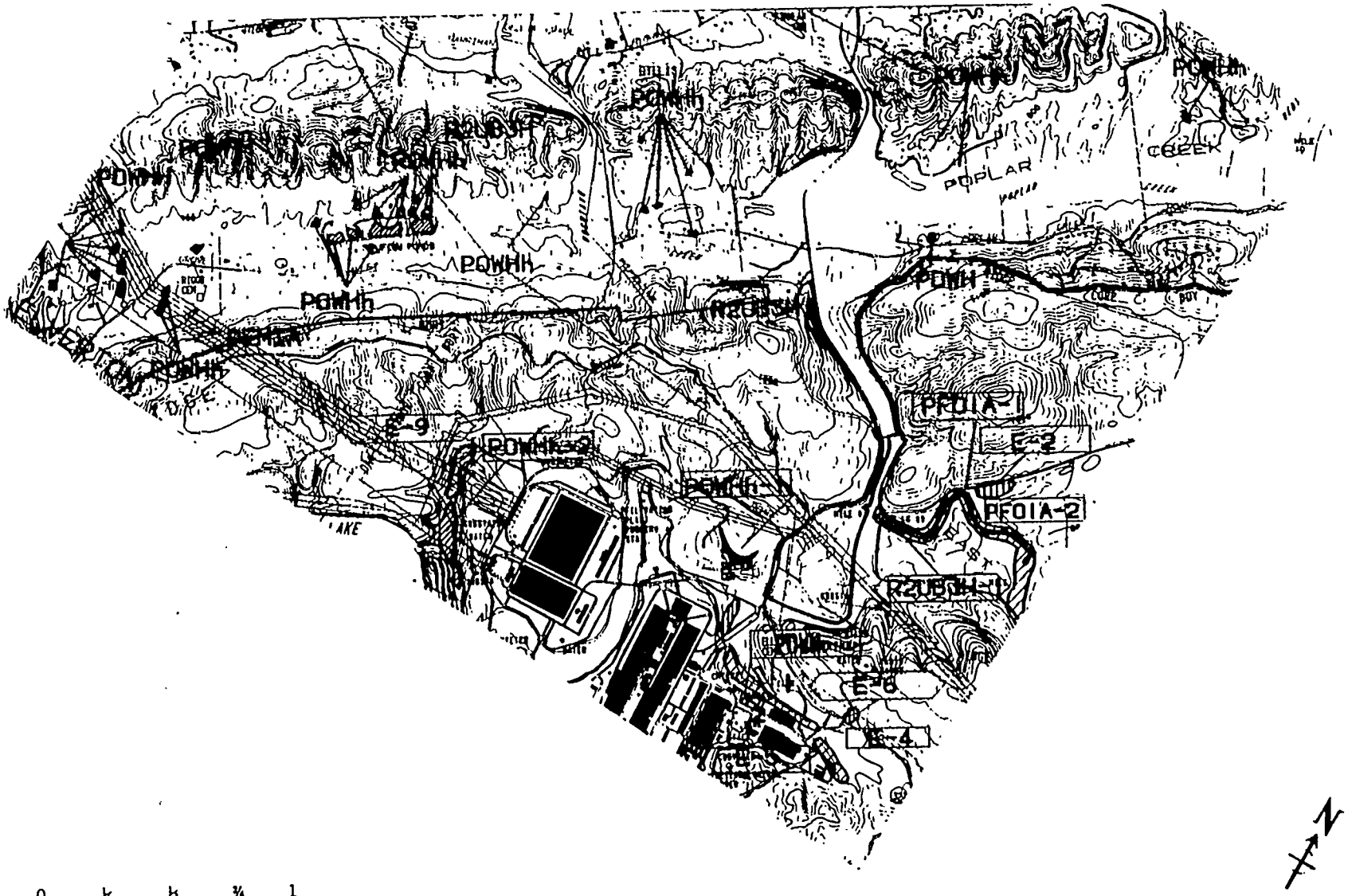


Fig. A1. Index to maps showing the location of some possible wetlands on the ORR.



0 ¼ ½ ¾ 1 - 1 mile

Map A. Elverton Quad.

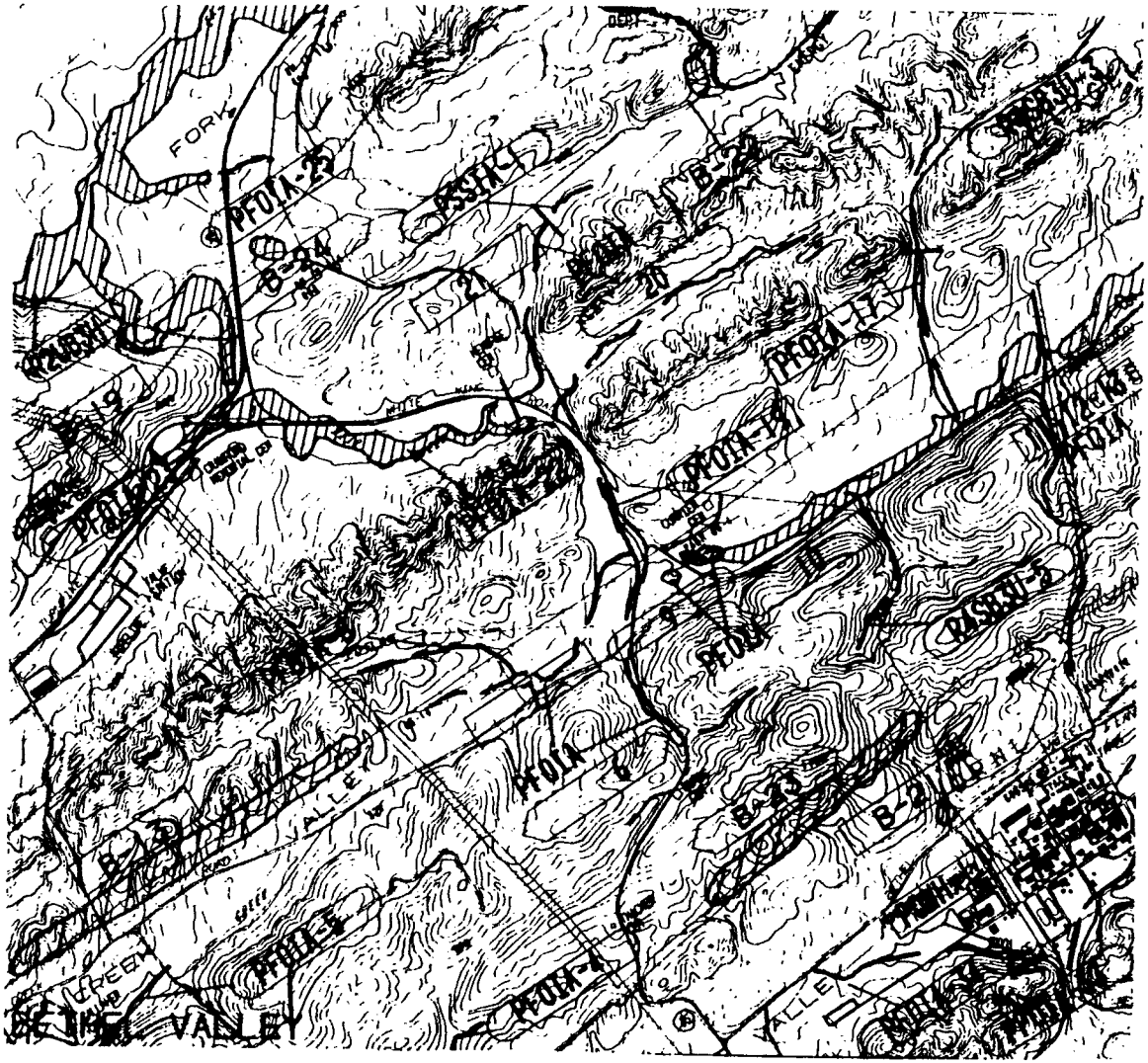
0 ¼ ½ ¾ 1 = 1 mile

Map B. Elverton Quad.

0 ¼ ½ ¾ 1 - 1 mile

Map C. Bethel Valley Quad.

N



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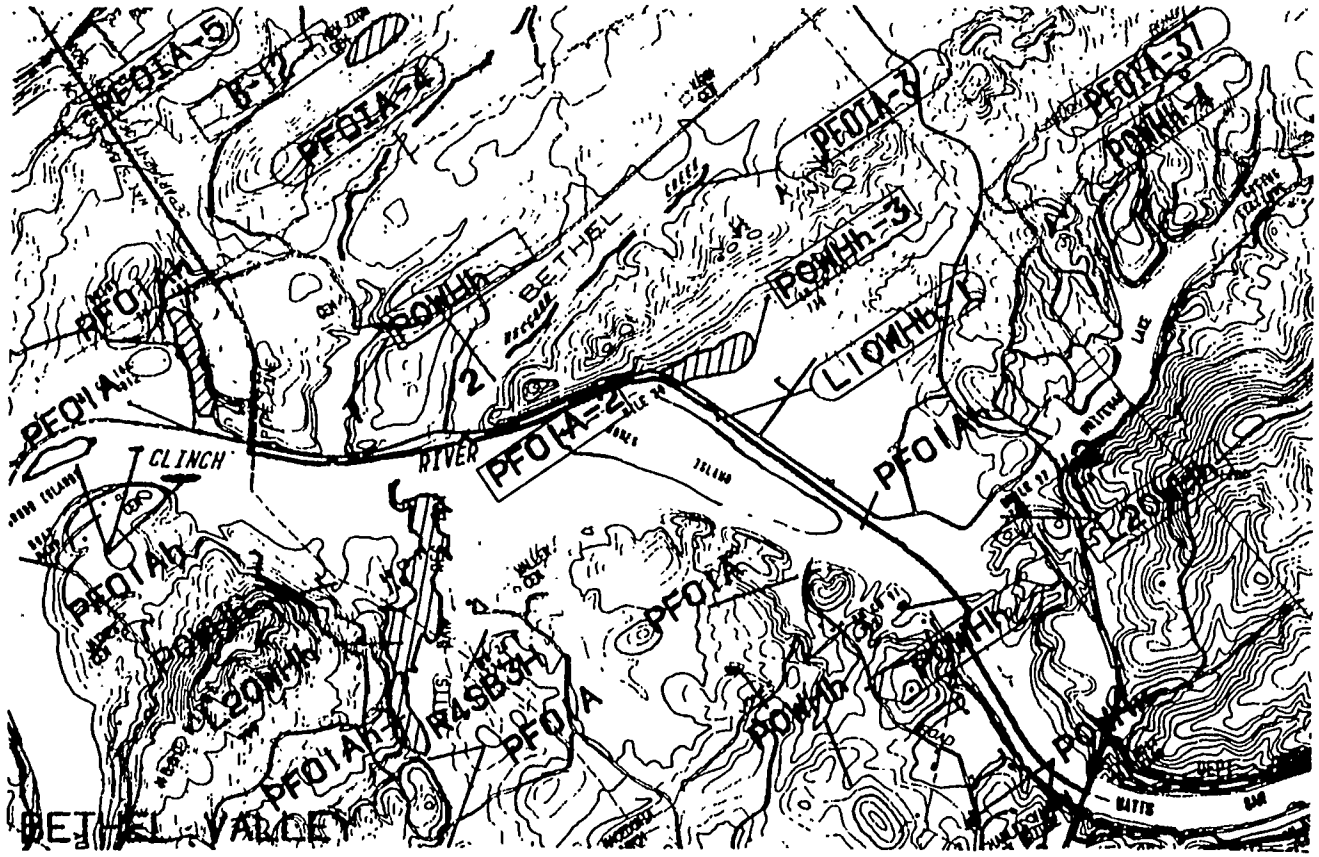

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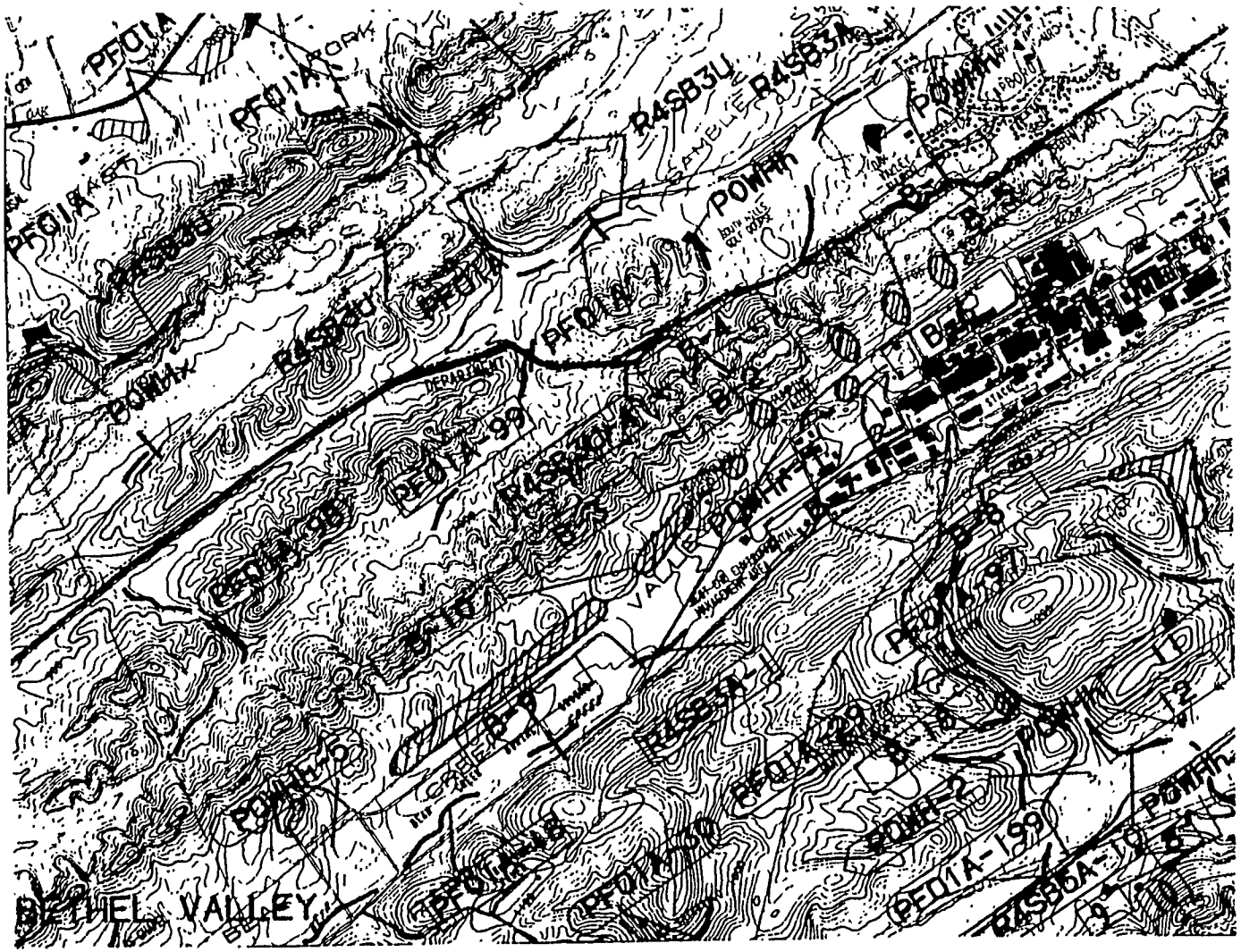

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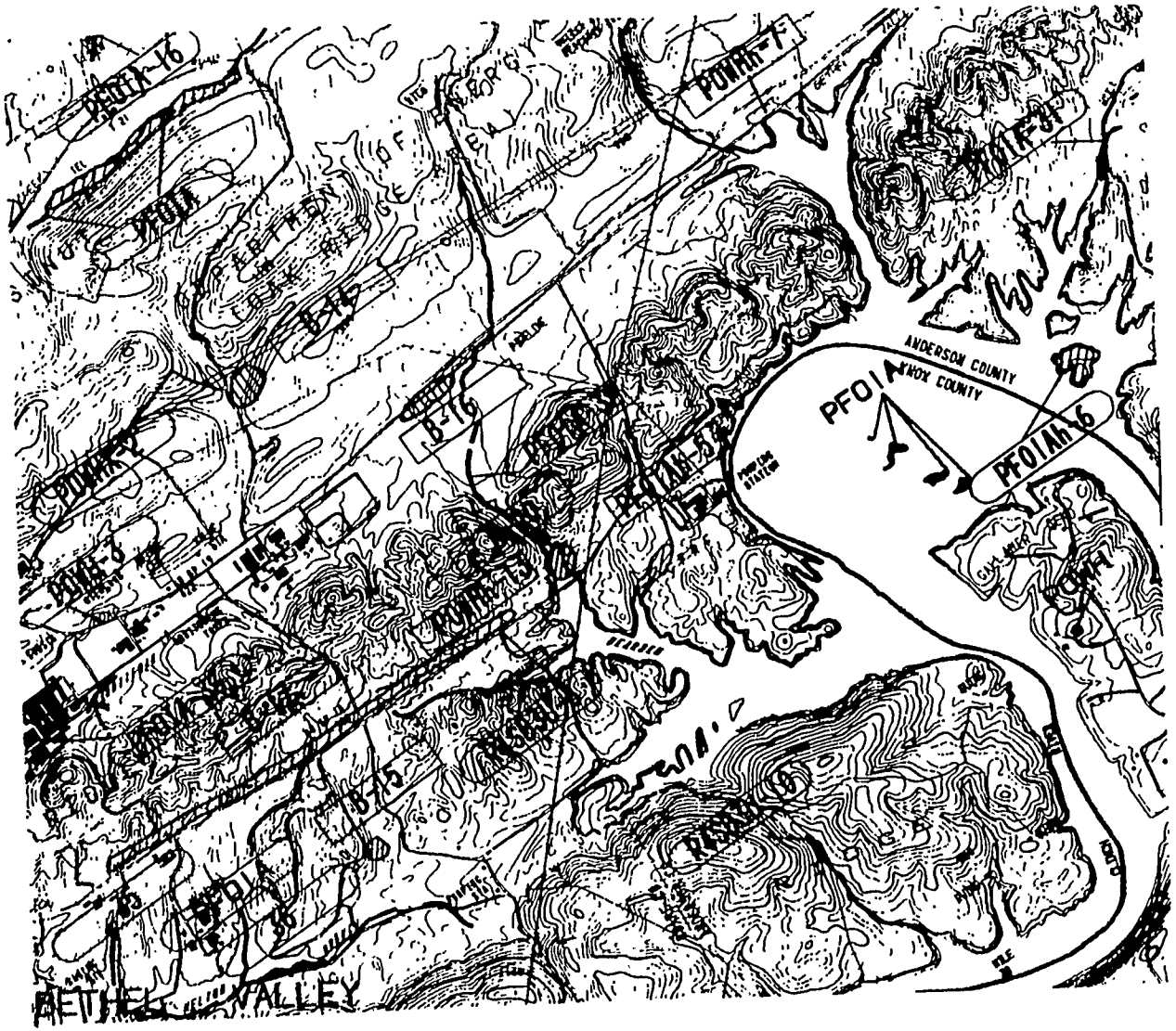
Map F. Bethel Valley Quad.



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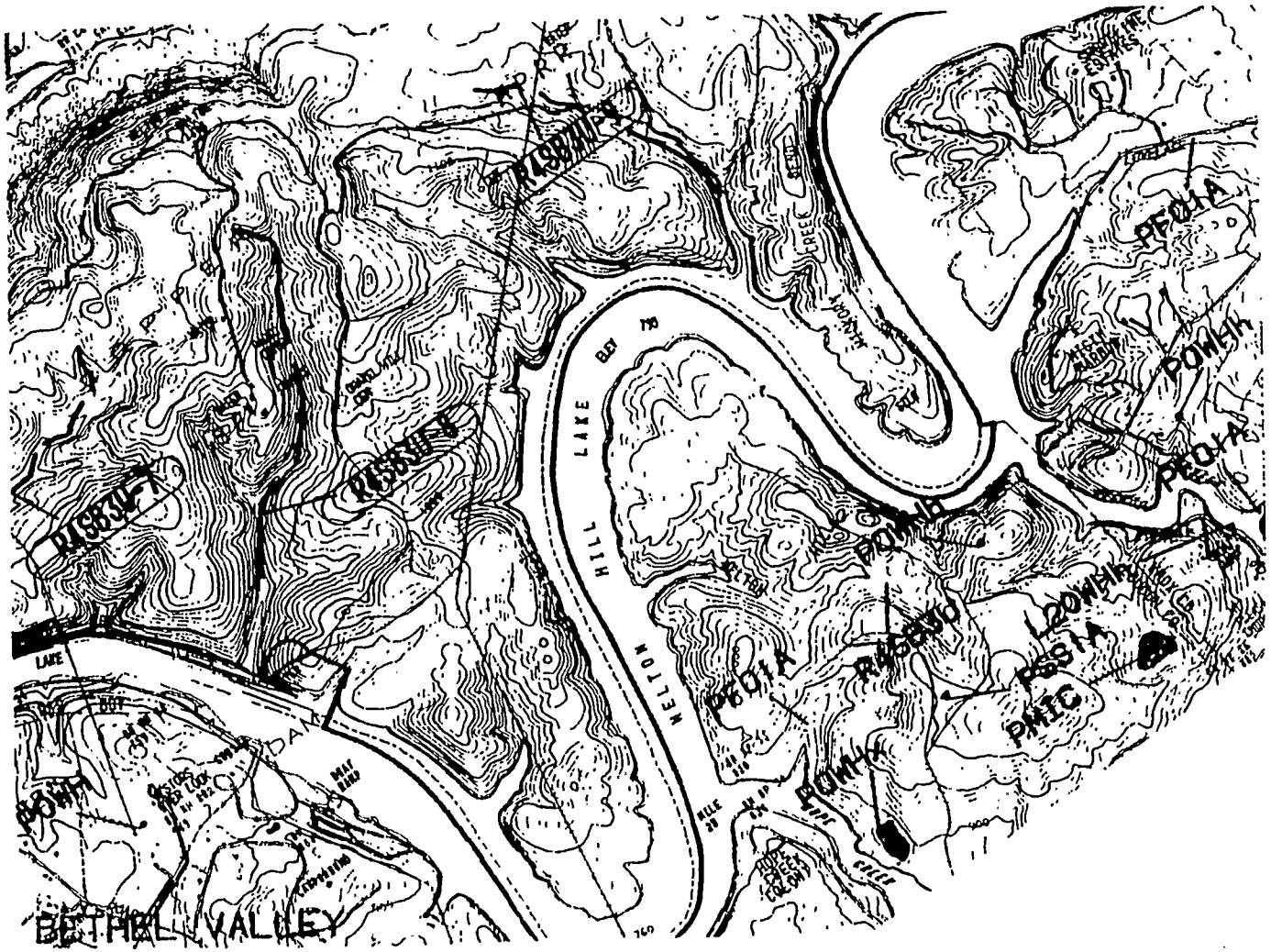
Map G. Bethel Valley Quad.



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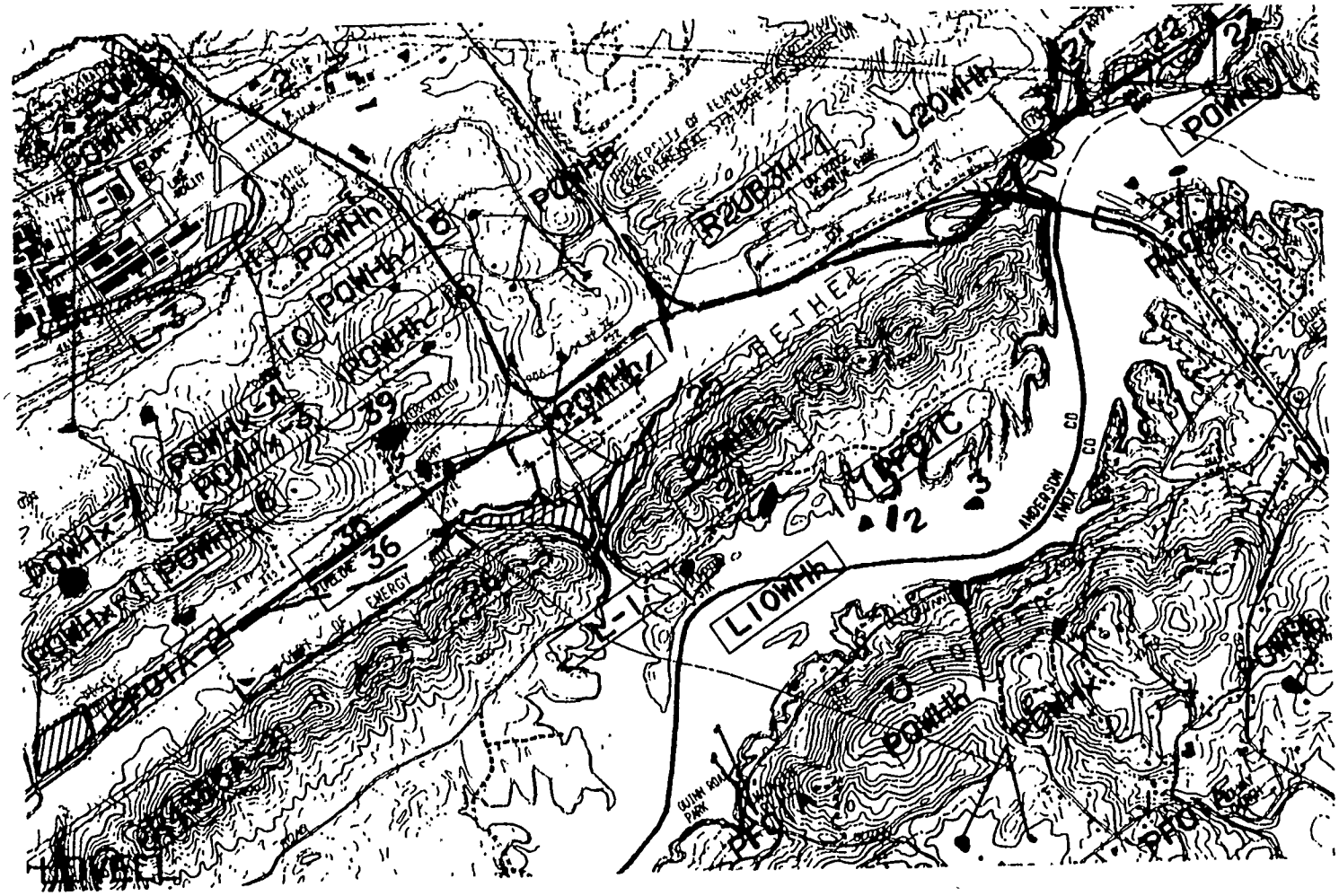

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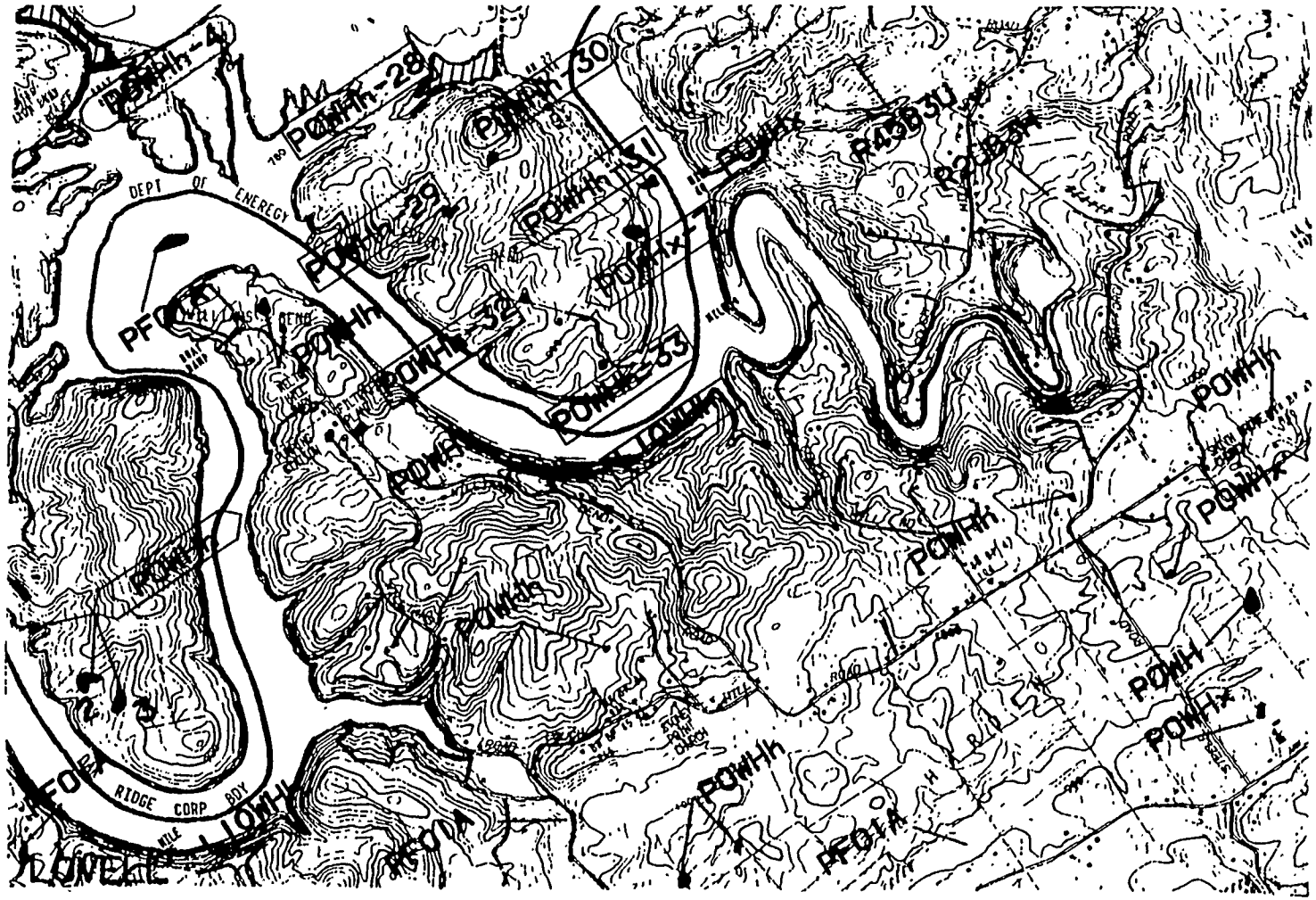
Map I. Lovell Quad.



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Map J. Lovell Quad.

N

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Appendix X

UPDATED REFERENCE AREAS (NOVEMBER 1991)

Areas on the ORR that are representative of the vegetational communities of the southern Appalachian region or that possess unique biotic features have been designated DOE-Research Park Reference Areas. These areas are important as sources of baseline information for long-term observations. They are set aside for the exclusive use of non-manipulative environmental research for definite or indefinite periods of time as stated in DOE Order 4300.1.B. Baseline information has been collected in some of the areas and other areas have been important in providing control data for ORR biological monitoring and abatement programs. Many of the original reference areas have been redesignated as DOE Research Park Natural Areas because rare plants have been found in them. Also included is a current list of Rare and Endangered plants on the Oak Ridge Reservation, which lists both state and federal status.

RA-1 Blackoak Ridge Hemlock Bluffs. This forested area is composed of eastern hemlocks (*Tsuga canadensis*) and white pine (*Pinus strobus*) overlooking Poplar Creek.

RA-2 Leatherwood Bluffs. These moist, east-facing slopes occur where Poplar Creek cuts through Blackoak Ridge. There is a great diversity of species growing there (many very uncommon on the ORR), including eastern hemlock and rhododendron (*Rhododendron sp.*).

RA-3 East Fork Floodplain. This is a typical floodplain forest of sycamore (*Platanus occidentalis*), ash (*Fraxinus* sp.), and boxelder (*Acer negundo*). This type of habitat is uncommon on the ORR; much of it has been planted in pine (*Pinus sp.*).

RA-4 Bear Creek Wetlands. This is an unusual area in a nearly flat basin with springs, seeps, and old stream beds creating a variety of wet habitats. This area surrounds on three sides the tubercled rein orchid (*Platanthera flava var herbiola*) swamp, a Research Park Natural Area. Part of this site is also registered as a State Natural Area.

RA-5 Quillwort Temporary Pond. This is a wooded wetland that appears to be flooded for part of the year. The quillworts growing here have been determined to be *Isoetes carolinia*, a recently described species (Joel Duff, University of Tennessee, personal communication). This species may be found to be rare enough for listing by the State of Tennessee. This site may be an important amphibian breeding site.

RA-6 Pink Lady Slipper Community. An unusually large population of the pink lady slipper (*Cypripedium acaule*) occurs in a Virginia pine (*Pinus virginiana*) forest. This

plant, although not rare, is subject to commercial exploitation and is listed as endangered in Tennessee.

RA-7 Bear Creek Mesic Forest. This area contains mature white pine trees (*Pinus strobus*) both on north-facing slope and in a low area with holly (*Ilex opaca*). The uncommon *Aesculus parviflora*, a shrubby buckeye, is found along Bear Creek. A large spring flows about 20 m (66 ft) into Bear Creak.

RA-8 Raccoon Creek Barren. This is a cedar barren area with few trees over a shallow limestone soil. Many interesting plants occur here: prickly pear cactus (*Opuntia humifusa*), side-oats grama (*Bouteloua curtipendula*), adder's tongue fern (*Ophioglossum engelmanni*), mild vetch (*Astragalus canadensis*) and ironwood (*Bumelia lycoides*).

RA-9 Haw Ridge Upland Hardwoods. This is a representative upland hardwoods area with primarily oaks (*Quercus* sp.) and hickories (*Carya* sp.). It is adjacent to Natural Area No. 6.

RA-10 Moss and Lichen Pine Community. This area demonstrates succession following serious soil erosion damage. The area is abundant in mosses and lichens typical of early successional stages. The dominant ground cover here is reindeer moss (*Cladonia subtenuis*), which is actually a lichen.

RA-11 Copper Ridge Area. The Copper Ridge Reference Area is a large and relatively undisturbed site that includes communities in various stages of succession. Some of the major community types include oak-hickory, pine, and cedar (*Juniperus virginiana*). The ridge section is extremely rocky, with numerous rocky sinks and several caves.

RA-12 Dry River Bluffs. This is a wooded limestone cliff area along the Clinch River. A mature oak forest is at the southern end of the area where the slope is much less rocky.

RA-13 White Pine Forest. This area contains a mesic forest with white pine and numerous small sinkholes. The upper half of the valley in the center of the area is a chain of sinkholes.

RA-14 Fanny Knob White Oak Area. This area contains a white oak community along the west and south slopes of the knob. A large number of ginseng plants (*Panax quinquefolius*) occur scattered throughout the site. This plant is state listed a threatened in Tennessee because of commercial exploitation.

RA-15 Beech-Mountain Laurel Community. This community is an unusual mixture of dry forest species and mesic species. Dry forest species include mountain laurel (*Kalmia latifolia*), Virginia pine (*Pinus virginiana*), blueberries (*Vaccinium* sp.), trailing arbutus (*Arbutus repens*), azalea (*Rhododendron* sp.), various oaks (*Quercus* sp.), and red maple (*Acer rubrum*). Mesic species, found along the stream, include beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), hydrangea (*Hydrangea arborescens*), and magnolia

(*Magnolia tripetala*). The beech extends well up the slope into the xeric forest, and the mountain laurel reaches down to the stream.

RA-16 Clinch Flood Plain Swamp. This is a wooded wetland along a stream which is entering the flood plain of the Clinch River near the 0800 area. *Carex louisianica*, a coastal plain species rare in East Tennessee, is found here.

RA-17 McKinney Ridge Hemlocks. This is the most extensive area of hemlocks and rhododendrons on the reservation. There are two small cave entrances near Poplar Creek. This site is a registered State Natural Area.

RA-18 Blackoak Ridge White Pines. This is a native white pine forest that has been disturbed by recent logging. Several white pines remain that could reestablish the stand.

RA-19 Sweet Flag Marsh. This is a large, open wetland dominated by sweet flag, *Acorus calamus*. Large (greater than 1 acre), open wetlands are rare, particularly those not controlled by the water table of TVA's lakes.

RA-20 New Zion Boggy Area (B-12 of the Draft ORR Wetlands Document). A forested, boggy wetland is located here near New Zion Cemetery. This represents a unique community on the ORR; cool water emerges steadily from the ground in several places. Sphagnum moss dominates with ferns. There is standing water during part of the year.

RA-21 Chestnut Ridge Springs Area (B-12 of the Draft ORR Wetlands Document). This is an immaturely wooded area with wetlands associated with springs, seeps, and a stream. *Bartonia paniculata*, an uncommon species in East Tennessee, is found here.

RA-22 Grassy Creek Security Site. This area contains limestone outcrops near the stream. Some of the uncommon species for the ORR found here include wild ginger (*Asarum canadensis*) and Jacob's ladder (*Polemonium reptans*). This site is adjacent to NA-3.

RA-23 Poplar Creek Rookery. This site contains a great blue heron (*Ardea herodias*) rookery--one of two known to occur on the ORR. Approximately one dozen nests in the pine stands were found occupied there in the summer of 1986. The site is located between a borrow pit area and Poplar Creek.

RA-24 Roberts Branch Wetlands Complex. This is an area of open water and wetlands along Watts Bar Reservoir northwest of Gallaher Bridge. It includes the wetlands coded as E-PFOIA-96, E-L2OWHh-6, and E-POWHh-97 in the Draft ORR Wetlands Document.

RA-25 Large Pond (L-POWHh-8 of Wetlands Document). This is one of two artificial ponds chosen for reference areas. *Sagittaria* sp. and *Wolffia* sp. are among the aquatic species present.

RA-26 Small Pond (L-POWHh-33 of Wetlands Document). This is the other artificial ponds chosen for reference areas. Several *Potamogeton* species were present, as well as emergent species.

RA-27 Old Ash Disposal Area (B-8 of Draft ORR Wetlands Document). This area was created by the flow of fly ash slurry. The flow has been turned off and area has become drier, but much of the area is still wetland. This area provides good research possibilities because the history of the site is well known. Interesting plant species are present including four species of willow (*Salix*) and two species of horsetail (*Equisetum*). A Tennessee special concern species is found here, *Siranthes ovalis.* There are two areas of open water. One was observed to dry up in the late summer. Both areas of open water have aquatic species.

RA-28 Spring Pond (B-21 of the Draft ORR Wetlands Document). This is a small spring-fed pond with unusually clear water. The pond is dominated by nutall waterweed (*Elodea nuttallii*), which is listed by the State as a species of special concern. The reference area includes the spring and a short stream that feeds the pond.

UPDATED DOE RESEARCH PARK NATURAL AREAS (NOVEMBER 1991)

The DOE Research Park Natural Areas have been established to provide protection for state and/or federally listed rare species (or species under status review for federal listing) that are known to occur on the ORR. Because the Research Park is responsible for interaction with state and federal agencies concerning our rare plant populations and unique habitats, all sites on the DOE ORR containing rare plant populations are designated DOE Research Park Natural Areas, whether or not they are actually located within National Environmental Research Park boundaries. Also included is a current list of Rare and Endangered plants on the Oak Ridge Reservation, which lists both state and federal status.

NA-1 Campbell Bend Bluffs and Forest. The river bluffs and adjacent forests provide habitat for two species under consideration for federal listing: spreading false foxglove (*Aureolaria patula*) and appalachian bugbane (*Cimicifuga rubifolia*). Both of these species are also listed as threatened on the Tennessee list of rare plants.

NA-2 East Fork Ridge Mesic Forest. This forested area consists of a moist, maturing woodland of many species, including beech (*Fagus* sp.), maple (*Acer* sp.), and basswood (*Tilia* sp.), on north- and east-facing slopes. A small creek runs through the site. The area is notable for a variety of woodland sedges and spring wildflowers. A large population of golden seal (*Hydrastis canadensis*), which is on the state list as threatened because of commercial exploitation, occurs in this area. Canada lily (*Lilium canadense*), listed by the state as threatened, has been seen here in the past ten years, but has not been located recently.

NA-3 Grassy Creek Mesic Slopes. This area, once a part of the DOE ORR, is now TVA land. It contains a population of appalachian bugbane and scattered plants of Carey's saxifrage (*Saxifraga careyana*), which is state listed as a species of special concern.

NA-4 Rein Orchid Swamp. This is a forested area with numerous wetlands around seeps and contains old stream or flood channels. The tubercled rein orchid (*Platanthera flava var herbiola*), state listed as threatened, is found here. An uncommon wetland plant, *Orontium aquaticum*, also occurs here. This site has been registered as a State Natural Area.

NA-5 Breeder Bluffs. This area, once part of the DOE ORR, is now TVA land. Carey's saxifrage occurs on the bluffs overlooking the river.

NA-6 Raccoon Creek Golden Seal Area. Golden seal occurs throughout this area. Other uncommon species that grow here are monk's hood (*Aconitum uncinatum*) and fly poison (*Amianthium muscaetoxicum*). This area also includes an interesting embayment wetland.

NA-7 Walker Branch Embayment "Barren". Tall larkspur (*Delphinium exaltatum*) is scattered throughout this site. It is state listed as endangered and is a federal candidate for listing. This site has also been registered as a State Natural Area.

NA-8 McCoy Branch Embayment "Barren". This is the largest known population of tall larkspur in the southeastern United States. This site has been registered as a State Natural Area.

NA-9 Cesium Forest Orchid Area. This is an immature, mesic forest of mainly tulip poplar (*Liriodendron tulipifera*). Several shallow sinkholes are scattered through the valley. A very small population of lesser ladies-tresses orchid (*Spiranthes ovalis*) occurs in one of the sinks. It is listed by the state as a species of special concern.

NA-10 Lazy Beaver Forest. This area is an immature mesic forest of tulip poplar. The largest known population of lesser ladies-tresses orchid on the ORR occurs here.

NA-11 Bull Bluff. This steep bluff overlooks Melton Hill Lake. The overstory consists of a full range of species from the ridge top to the lake. Rare plants occurring on this bluff include appalachian bugbane, northern bush-honeysuckle (*Diervilla lonicera*), and Carey's saxifrage. Northern bush-honeysuckle is listed by the state as threatened. This site is registered as a State Natural Area.

NA-12 Walker Branch Fothergilla Site. The only colony of mountain witch-alder (*Fothergilla major*) on the ORR grows on the west-facing slope of the Walker Branch watershed. This population of the shrub is probably one clone. The site is located at the top of a slope with heath family members (azalea and blueberry). Mountain witch-alder is state listed as Threatened.

NA-13 Pine Ridge Wetlands (in part, formerly Pine Ridge Lily Area). This area includes six wetlands and surrounding upland areas. The area includes the powerline right-of-way and some area to the north of the powerline. The wetlands are along drainages and include open areas in the right-of-way and shaded areas north of the right-of-way. The Canada lily has been seen in this area in the past. Purple fringeless orchid (*Platanthera peramoena*), state listed as threatened, is found in two of the wetlands under the powerlines. Tubercled rein-orchid is found in the shaded portions of three of the wetlands.

NA-14 White Cedar Area. White cedar (*Thuja occidentalis*) occurs here on a small, shaley cliff sloping directly into Melton Hill Lake. This species normally occurs at more northern latitudes. Also found here is northern bush-honeysuckle.

NA-15 Hickory Creek Bend Bluffs (North). This is a steep, east-facing slope with an overstory of pines and various hardwoods above Melton Hill Lake. Appalachian bugbane and Carey's saxifrage occur here.

NA-16 Hickory Creek Bend Bluffs (South). This habitat is similar to that of NA-15. Carey's saxifrage is found here.

NA-17 Tower Shielding Bluffs. This is a steep east-facing slope above Melton Hill Lake. The overstory consists of oaks (*Quercus* sp.) and hickories (*Carya* sp.), with some mesic species such as sugar maple. Spreading false foxglove and Carey's saxifrage occur here.

NA-18 Copper Ridge Outcrop. The ridge area is extremely rocky with numerous rocky sinks and cave entrances. Carey's saxifrage occurs here.

NA-19 Blackoak Ridge River Bluffs. Spreading false foxglove and appalachian bugbane occur here.

NA-20 Poplar Creek Cliffs. This site is located on a west-facing slope of the Poplar Creek gap in Blackoak Ridge. Small limestone cliffs occur near the stream. Many unusual plants for the ORR occur here, including hemlock, rhododendron, fringe tree (*Chionanthus virginicus*), spider lily (*Hymenocallis fulva*), and mock orange (*Philadelphis hirsutus*). Spreading false foxglove also occurs here. This site is registered as a State Natural Area.

NA-21 Rainy Knob Bluff, Freels Bend. This bluff provides habitat for Carey's saxifrage. There is a scenic rocky sinkhole and cave entrance here.

NA-22 Bull Bluff Road Area. Several individuals of Canada lily are scattered throughout this area. The drainages and streams are the prime sites within this area for protection.

NA-23 Solway Bend Bluffs. This area provides habitat for Carey's saxifrage. Other uncommon species occurring here include *Orobanche uniflora.*

NA-24 Hembree Marsh. This unique area is one of perhaps two marshes on the ORR not subject to the changing water levels of TVA's dams. Sweet flag (*Acorus calamus*) dominates the open wet area. Fen orchid (*Liparis loeselii*), state listed as endangered, is found here.

NA-25 Highway 95 Lily Area. Either Canada lily or Michigan lily occurs in a moist area along a wooded stream. Flowering plants will be needed to determine which species is present.

NA-26 Melton Valley Lily Area. A wooded wetland with a couple of small ponds occurs here. These may be important amphibian breeding sites. Two very immature Canada or Michigan lilies were found here.

NA-27 Fringeless Orchid Wetlands (B-13 of the Draft ORR Wetlands Document). A series of small wetlands occur under the Bear Creek powerline right-of-way west of Highway 95. A great diversity of wet meadow species occur in these sites, including purple fringeless orchid.

NA-28 Eastern Bear Creek Rein Orchid Wetland. A small wetland occurs along a stream shaded with over-arching red maple branches. There is a small population of tubercled fringeless orchid here.

NA-29 Northwest Pine Ridge Fringeless Orchid Site. A population of purple fringeless orchid is found here in a wet area in a powerline right-of-way.

Appendix XI

Maureen Cunningham

Federal Manual for Identifying and Delineating Jurisdictional Wetlands

AN INTERAGENCY COOPERATIVE PUBLICATION

Fish and Wildlife Service

Environmental Protection Agency

Department of the Army

Soil Conservation Service

January 1989

Federal Manual for Identifying and Delineating Jurisdictional Wetlands

An Interagency Cooperative Publication

U. S. Army Corps of Engineers

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

U.S.D.A. Soil Conservation Service

JANUARY 10, 1989

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Federal Manual for Identifying and Delineating Jurisdictional Wetlands

We, the undersigned, hereby adopt this Federal Manual as the technical basis for identifying and delineating jurisdictional wetlands in the United States.

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January 10, 1989

Preface

This manual describes technical criteria, field indicators and other sources of information, and methods for identifying and delineating jurisdictional wetlands in the United States. This manual is the product of many years of practical experience in wetland identification and delineation by four Federal agencies: Army Corps of Engineers (CE), Environmental Protection Agency (EPA), Fish and Wildlife Service (FWS), and Soil Conservation Service (SCS). It is the culmination of efforts to merge existing field-tested wetland delineation manuals, methods, and procedures used by these agencies. This manual draws heavily upon published manuals and methods, specifically *Corps of Engineers Wetlands Delineation Manual*, EPA's *Wetland Identification and Delineation Manual*, and SCS's *Food Security Act Manual* wetland determination procedure.

The manual has been reviewed and concurred in by an interagency committee composed of the four Federal agencies. This committee was established for purposes of reconciling differences in wetland delineation procedures and developing a single interagency manual for identification and delineation of wetlands. The committee consisted of the following individuals: Robert Pierce, Bernie Goode, and Russell Theriot of the Corps of Engineers; John Meagher, Bill Sipple, and Charles Rhodes of the Environmental Protection Agency; David Stout, Ralph Tiner, and Bill Wilen of the Fish and Wildlife Service; and Steve Brady, Maurice Mausbach, and Billy Teels of the Soil Conservation Service. The manual was prepared by Ralph Tiner based on interagency committee decisions. The negotiations were facilitated by Howard Bellman and Leah Haygood.

This report should be cited as follows:

Federal Interagency Committee for Wetland Delineation. 1989. Federal Manual for Identifying and Delineating Jurisdictional Wetlands. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C. Cooperative technical publication. 76 pp. plus appendices.

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Part I.
Introduction

Purpose

1.0. The purpose of this manual is to provide users with mandatory technical criteria, field indicators and other sources of information, and recommended methods to determine whether an area is jurisdictional wetland or not, and to delineate the upper boundary of these wetlands. The document can be used to identify jurisdictional wetlands subject to Section 404 of the Clean Water Act and to the "Swampbuster" provision of the Food Security Act, or to identify vegetated wetlands in general for the National Wetlands Inventory and other purposes. *The term "wetland" as used throughout this manual refers to jurisdictional wetlands for use by Federal agencies.* This manual, therefore, provides a single, consistent approach for identifying and delineating wetlands from a multi-agency Federal perspective.

Organization of the Manual

1.1. The manual is divided into four major parts: Part I — Introduction, Part II — Mandatory Technical Criteria for Wetland Identification, Part III — Field Indicators and Other Available Information, and Part IV — Methods for Identification and Delineation of Wetlands. References, a glossary of technical terms, and appendices are included at the back of the manual.

Use of the Manual

1.2. The manual should be used for identification and delineation of wetlands in the United States. Emphasis for delineation is on the upper boundary of wetlands (i.e., wetland-upland boundary) and not on the lower boundary between wetlands and other aquatic habitats. The technical criteria for wetland identification presented in Part II are mandatory, while the methods presented in Part IV are recommended approaches. Alternative methods are offered to provide users with a selection of methods that range from office determinations to detailed field determinations. If the user departs from these methods, the reasons for doing so should be documented.

Background

1.3. At the Federal level, four agencies are principally involved with wetland identification and delineation: Army Corps of Engineers (CE), Environmental Protection Agency (EPA), Fish and Wildlife Service (FWS), and Soil Conservation Service (SCS). Each of these agencies have developed techniques for identifying the limits of wetlands for various purposes.

1.4. The CE and EPA are responsible for making jurisdictional determinations of wetlands regulated under Section 404 of the Clean Water Act (formerly known as the Federal Water Pollution Control Act, 33 U.S.C. 1344). The CE also makes jurisdictional determinations under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). Under Section 404, the Secretary of the Army, acting through the Chief of Engineers, is authorized to issue permits for the discharge of dredged or fill materials into the waters of the United States, including wetlands, with program oversight by EPA. The EPA has the authority to make final determinations on the extent of Clean Water Act jurisdiction. The CE also issues permits for filling, dredging, and other construction in certain wetlands under Section 10. Under authority of the Fish and Wildlife Coordination Act, the FWS and the National Marine Fisheries Service review applications for these Federal permits and provide comments to the CE on the environmental impacts of proposed work. In addition, the FWS is conducting an inventory of the Nation's wetlands and is producing a series of National Wetlands Inventory maps for the entire country. While the SCS has been involved in wetland identification since 1956, it has recently become more deeply involved in wetland determinations through the "Swampbuster" provision of the Food Security Act of 1985.

1.5. The CE and EPA have developed technical manuals for identifying and delineating wetlands subject to Section 404 (Environmental Laboratory 1987 and Sipple 1988, respectively). The SCS has developed procedures for identifying wetlands for

compliance with "Swampbuster." While it has no formal method for delineating wetland boundaries, the FWS has established guidelines for identifying wetlands in the form of its official wetland classification system report (Cowardin, et al. 1979).

1.6. In early 1988, the CE and EPA resumed previous discussions on the possibilities of merging their manuals into a single document, since both manuals were produced in support of Section 404 of the Clean Water Act. At that time, it was recommended that the FWS and SCS be invited to participate in the talks to take advantage of their technical expertise in wetlands and to discuss the possibilities of a joint interagency wetland identification manual. On May 19-20, 1988, the first meeting was held in Washington, D.C., to discuss technical differences between the CE and EPA manuals. After the meeting, it was decided that a second meeting should be held to resolve technical issues and to attempt to merge the two manuals and possibly develop an interagency manual for the four agencies. This meeting was held on August 29-31, 1988, at Harpers Ferry, West Virginia. Each of the four Federal agencies (CE, EPA, FWS, and SCS) was represented by three persons, with outside facilitators moderating the session. During the three-day meeting, the four agencies reached agreement on the technical criteria for identifying and delineating wetlands and agreed to merge the existing published methods (CE, EPA, and SCS) into a single wetland delineation manual. A draft combined manual was prepared, and then reviewed by the interagency group. On January 10, 1989, the manual was formally adopted by the four agencies as the recommended manual for identifying and delineating wetlands in the United States.

Federal Wetland Definitions

1.7. Several definitions have been formulated at the Federal level to define "wetland" for various laws, regulations, and programs. These major Federal definitions are cited below in reference to their guiding document along with a few comments on their key elements.

Section 404 of the Clean Water Act

1.8. The following definition of wetland is the regulatory definition used by the EPA and CE for administering the Section 404 permit program:

> Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

(EPA, 40 CFR 230.3 and CE, 33 CFR 328.3)

1.9. This definition emphasizes hydrology, vegetation, and saturated soils. The Section 404 regulations also deal with other "waters of the United States" such as open water areas, mud flats, coral reefs, riffle and pool complexes, vegetated shallows, and other aquatic habitats.

Food Security Act of 1985

1.10. The following wetland definition is used by the SCS for identifying wetlands on agricultural land in assessing farmer eligibility for U.S. Department of Agriculture program benefits under the "Swampbuster" provision of this Act:

> Wetlands are defined as areas that have a predominance of hydric soils and that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions, except lands in Alaska identified as having a high potential for agricultural development and a predominance of permafrost soils.*

(National Food Security Act Manual, 1988)

**Special Note*: The Emergency Wetlands Resources Act of 1986 also contains this definition, but without the exception for Alaska.

1.11. This definition specifies hydrology, hydrophytic vegetation, and hydric soils. Any area that meets the hydric soil criteria (defined by the National Technical Committee for Hydric Soils) is considered to have a predominance of hydric soils. The definition also makes a geographic exclusion for Alaska, so that wetlands in Alaska with a high potential for agricultural development and a predominance of permafrost soils are exempt from the requirements of the Act.

Fish and Wildlife Service's Wetland Classification System

1.12. The FWS in cooperation with other Federal agencies, State agencies, and private organizations and individuals developed a wetland definition for conducting an inventory of the Nation's wetlands. This definition was published in the FWS's publication "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin, et al. 1979):

> Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

1.13. This definition includes both vegetated and nonvegetated wetlands, recognizing that some types of wetlands lack vegetation (e.g., mud flats, sand flats, rocky shores, gravel beaches, and sand bars). The classification system also defines "deepwater habitats" as "permanently flooded lands lying below the deepwater boundary of wetlands." Deepwater habitats include estuarine and marine aquatic beds (similar to "vegetated shallows" of Section 404). Open waters below extreme low water at spring tides in salt and brackish tidal areas and usually below 6.6 feet in inland areas and freshwater tidal areas are also included in deepwater habitats.

Summary of Federal Definitions

1.14. The CE, EPA, and SCS wetland definitions include only areas that are vegetated under normal circumstances, while the FWS definition encompasses both vegetated and nonvegetated areas. Except for the FWS inclusion of nonvegetated areas as wetlands and the exemption for Alaska in the SCS definition, all four wetland definitions are conceptually the same; they all include three basic elements - hydrology, vegetation, and soils - for identifying wetlands.

Part II.

Mandatory Technical Criteria for Wetland Identification

2.0. Wetlands possess three essential characteristics: (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland hydrology, which is the driving force creating all wetlands. These characteristics and their technical criteria for identification purposes are described in the following sections. The three technical criteria specified are mandatory and must all be met for an area to be identified as wetland. Therefore, areas that meet these criteria are wetlands.

Hydrophytic Vegetation

2.1. For purposes of this manual, hydrophytic vegetation is defined as macrophytic plant life growing in water, soil or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content. Nearly 7,000 vascular plant species have been found growing in U.S. wetlands (Reed 1988). Out of these, only about 27 percent are "obligate wetland" species that nearly always occur in wetlands under natural conditions. This means that the majority of plant species growing in wetlands also grow in nonwetlands in varying degrees.

2.2. The FWS in cooperation with CE, EPA, and SCS has published the "National List of Plant Species That Occur in Wetlands" from a review of the scientific literature and review by wetland experts and botanists (Reed 1988). The list separates vascular plants into four basic groups, commonly called "wetland indicator status," based on a plant species' frequency of occurrence in wetlands: (1) *obligate wetland plants* (OBL) that occur almost always (estimated probability >99%) in wetlands under natural conditions; (2) *facultative wetland plants* (FACW) that usually occur in wetlands (estimated probability 67-99%), but occasionally are found in nonwetlands; (3) *facultative plants* (FAC) that are equally likely to occur in wetlands or nonwetlands (estimated probability 34-66%); and (4) *facultative upland plants* (FACU) that usually occur in nonwetlands (estimated probability 67-99%), but occasionally are found in wetlands (estimated probability 1-33%). If a species occurs almost always (estimated probability >99%) in nonwetlands under natural conditions, it is considered an *obligate upland plant* (UPL). These latter plants do not usually appear on the wetland plant list; they are listed only when found in wetlands with a higher probability in one region of the country. If a species is not on the list, it is presumed to be an obligate upland plant. The "National List of Plant Species That Occur in Wetlands" has been subdivided into regional and state lists. There is a formal procedure to petition the interagency plant review committee for making additions, deletions, and changes in indicator status. Since the lists are periodically updated, the U.S. Fish and Wildlife Service should be contacted to be sure that the most current version is being used for wetland determinations. The appropriate plant list for a specific geographic region should be used when making a wetland determination and evaluating whether the following hydrophytic vegetation criterion is satisfied.

Hydrophytic Vegetation Criterion

2.3. An area has hydrophytic vegetation when, under normal circumstances: (1) more than 50 percent of the composition of the dominant species from all strata are obligate wetland (OBL), facultative wetland (FACW), and/or facultative (FAC) species, or (2) a frequency analysis of all species within the community yields a prevalence index value of less than 3.0 (where OBL = 1.0, FACW = 2.0, FAC = 3.0, FACU = 4.0, and UPL = 5.0). *CAUTION*: When a plant community has less than or equal to 50 percent of the dominant species from all strata represented by OBL, FACW, and/or FAC species, or a frequency analysis of all species within the community yields a prevalence index value of greater than or equal to 3.0, *and* hydric soils and wetland hydrology are present, the area also has hydrophytic vegetation. (*Note*: These areas are considered problem area wetlands.)

2.4. For each stratum (e.g., tree, shrub, and herb) in the plant community, dominant species are the most abundant plant species (when ranked in descending order

of abundance and cumulatively totaled) that immediately exceed 50 percent of the total dominance measure (e.g., basal area or areal coverage) for the stratum, plus any additional species comprising 20 percent or more of the total dominance measure for the stratum. All dominants are treated equally in determining the presence of hydrophytic vegetation.

2.5. (*Note*: The "National List of Plant Species that Occur in Wetlands" uses a plus (+) sign or a minus (-) sign to specify a higher or lower portion of a particular wetland indicator frequency for the three facultative-type indicators; for purposes of identifying hydrophytic vegetation according to this manual, however, FACW+, FACW-, FAC+, and FAC are included as FACW and FAC, respectively, in the hydrophytic vegetation criterion.)

Hydric Soils

2.6. Hydric soils are defined as soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part (U.S.D.A. Soil Conservation Service 1987). In general, hydric soils are flooded, ponded, or saturated for usually one week or more during the period when soil temperatures are above biologic zero 41° F as defined by "Soil Taxonomy" (U.S.D.A. Soil Survey Staff 1975). These soils usually support hydrophytic vegetation. The National Technical Committee for Hydric Soils has developed criteria for hydric soils and a list of the Nation's hydric soils (U.S.D.A. Soil Conservation Service 1987). (*Note*: Caution must be exercised in using the hydric soils list for determining the presence of hydric soil at specific sites; see p. 12.)

Hydric Soil Criterion

2.7. An area has hydric soils when the National Technical Committee for Hydric Soils (NTCHS) criteria for hydric soils are met.

NTCHS Criteria for Hydric Soils (U.S.D.A. Soil Conservation Service 1987):

"1. All Histosols except Folists; or

2. Soils in Aquic suborders, Aquic subgroups, Albolls suborder, Salorthids great group, or Pell great groups of Vertisols that are:

a. somewhat poorly drained and have water table less than 0.5 feet from the surface for a significant period (usually a week or more) during the growing season, or

b. poorly drained or very poorly drained and have either:

(1) water table at less than 1.0 feet from the surface for a significant period (usually a week or more) during the growing season if permeability is equal to or greater than 6.0 inches/hour in all layers within 20 inches, or

(2) water table at less than 1.5 feet from the surface for a significant period (usually a week or more) during the growing season if permeability is less than 6.0 inches/hour in any layer within 20 inches; or

3. Soils that are ponded for long duration or very long duration during the growing season; or

4. Soils that are frequently flooded for long duration or very long duration during the growing season."

(*Note*: Long duration is defined as inundation for a single event that ranges from seven days to one month; very long duration is defined as inundation for a single event that is greater than one month; frequently flooded is defined as flooding likely to occur often under usual weather conditions - more than 50 percent chance of flooding in any year or more than 50 times in 100 years. Other technical terms in the NTCHS criteria for hydric soils are generally defined in the glossary.)

Wetland Hydrology

2.8. Permanent or periodic inundation, or soil saturation to the surface, at least seasonally, are the driving forces behind wetland formation. The presence of water for a week or more during the growing season typically creates anaerobic conditions in the soil, which affect the types of plants that can grow and the types of soils that develop. Numerous factors influence the wetness of an area, including precipitation, stratigraphy, topography, soil permeability, and plant cover. All wetlands usually have at least a seasonal abundance of water. This water may come from direct precipitation, overbank flooding, surface water runoff due to precipitation or snow melt, ground water discharge, or tidal flooding. The frequency and duration of inundation and soil saturation vary widely from permanent flooding or saturation to irregular flooding or saturation. Of the three technical criteria for wetland identification, wetland hydrology is often the least exact and most difficult to establish in the field, due largely to annual, seasonal, and daily fluctuations.

Wetland Hydrology Criterion

2.9. An area has wetland hydrology when saturated to the surface or inundated at some point in time during an average rainfall year, as defined below:

1. **Saturation to the surface normally occurs when soils in the following natural drainage classes meet the following conditions:**

   A. **In somewhat poorly drained mineral soils, the water table is less than 0.5 feet from the surface for usually one week or more during the growing season; or**

   B. **In low permeability (<6.0 inches/hour), poorly drained or very poorly drained mineral soils, the water table is less than 1.5 feet from the surface for usually one week or more during the growing season; or**

   C. **In more permeable (≥ 6.0 inches/hour), poorly drained or very poorly drained mineral soils, the water table is less than 1.0 feet from the surface for usually one week or more during the growing season; or**

   D. **In poorly drained or very poorly drained organic soils, the water table is usually at a depth where saturation to the surface occurs more than rarely. (*Note*: Organic soils that are cropped are often drained, yet the water table is closely managed to minimize oxidation of organic matter; these soils often retain their hydric characteristics and if so, meet the wetland hydrology criterion.)**

2. **An area is inundated at some time if ponded or frequently flooded with surface water for one week or more during the growing season.**

(*Note*: An area saturated for a week during the growing season, especially early in the growing season, is not necessarily a wetland. However, in the vast majority of cases, an area that meets the NTCHS criteria for hydric soil is a wetland.)

Summary

2.10. The technical criteria are mandatory and must be satisfied in making a wetland determination. Areas that meet the NTCHS hydric soil criteria and under normal circumstances support hydrophytic vegetation are wetlands. Field indicators and other information provide direct and indirect evidence for determining whether or not each of the three criteria are met. Sound professional judgement should be used in interpreting these data to make a wetland determination. It must be kept in mind that exceptional and rare cases are possibilities that may call any generally sound principle into question.

Part III.
Field Indicators and Other Available Information

3.0. When conducting a field inspection to make a wetland determination, the three identification criteria, listed in Part II of this manual, alone may not provide enough information for users to document whether or not the criteria themselves (i.e., hydrophytic vegetation, hydric soils, and wetland hydrology) are met. Various physical properties or other signs can be readily observed in the field to determine whether the three wetland identification criteria are satisfied. Besides these field indicators, good baseline information may be available from site-specific studies, published reports, or other written material on wetlands. In the following sections, field indicators and primary sources of information for each of the three criteria are presented to help the user identify wetlands.

Hydrophytic Vegetation

3.1. All plants growing in wetlands have adapted in one way or another to life in permanently or periodically inundated or saturated soils. Some plants have developed structural or morphological adaptations to inundation or saturation. These features, while indicative of hydrophytic vegetation, are used as indicators of wetland hydrology in this manual, since they are a response to inundation and soil saturation. Probably all plants growing in wetlands possess physiological mechanisms to cope with prolonged periods of anaerobic soil conditions. Because they are not observable in the field, physiological and reproductive adaptations are not included in this manual.

3.2. Persons making wetland determinations should be able to identify at least the dominant wetland plants in each stratum (layer of vegetation) of a plant community. Plant identification requires use of field guides or more technical taxonomic manuals (see Appendix A for sample list). When necessary, seek help in identifying difficult species. Once a plant is identified to genus and species, one should then consult the appropriate Federal list of plants that occur in wetlands to determine the "wetland indicator status" of the plant (see p. 5). This information will be used to help determine if hydrophytic vegetation is present.

Dominant Vegetation

3.3. Dominance as used in this manual refers strictly to the spatial extent of a species that is directly discernable or measurable in the field. When identifying dominant vegetation within a given plant community, one should consider dominance within each stratum. All dominants are treated equally in characterizing the plant community to determine whether hydrophytic vegetation is present. The most abundant plant species (when ranked in descending order of abundance and cumulatively totaled) that immediately exceed 50 percent of the total dominance measure for a given stratum, plus any additional species comprising 20 percent or more of the total dominance measure for that stratum are considered dominant species for the stratum. Dominance measures include percent areal coverage and basal area, for example.

3.4. Vegetative strata for which dominants should be determined may include: (1) tree (≥5.0 inches diameter at breast height (dbh) and 20 feet or taller); (2) sapling (0.4 to <5.0 inches dbh and 20 feet or taller); (3) shrub (usually 3 to 20 feet tall including multi-stemmed, bushy shrubs and small trees and saplings); (4) woody vine; and (5) herb (herbaceous plants including graminoids, forbs, ferns, fern allies, herbaceous vines, and tree seedlings). Bryophytes (mosses, horned liverworts, and true liverworts) should be sampled as a separate stratum in certain wetlands, including shrub bogs, moss-lichen wetlands, and wooded swamps where bryophytes are abundant and represent an important component of the community; in most other wetlands, bryophytes should be included within the herb stratum due to their scarcity.

3.5. There are many ways to quantify dominance measures; Part IV provides recommended approaches. Alternatively, one may wish to visually estimate percent coverage when possible or perform a frequency analysis of all species within a

given plant community. These are accepted methods for evaluating plant communities.

Field Indicators

3.6. Having established the community dominants for each stratum or performed a frequency analysis, hydrophytic vegetation is considered present if:

1) OBL species comprise all dominants in the plant community (*Note*: In these cases, the area can be considered wetland without detailed examination of soils and hydrology, provided significant hydrologic modifications are not evident); or

2) OBL species do not dominate each stratum, but more than 50 percent of the dominants of all strata are OBL, FACW, or FAC species (including FACW+, FACW-, FAC+, and FAC-); or

3) A plant community has a visually estimated percent coverage of OBL and FACW species that exceed the coverage of FACU and UPL species; or

4) A frequency analysis of all species within the community yields a prevalence index value of less than 3.0 (where OBL = 1.0, FACW = 2.0, FAC = 3.0, FACU = 4.0, and UPL = 5.0); or

5) A plant community has less than or equal to 50 percent of the dominant species from all strata represented by OBL, FACW, and/or FAC species, *or* a frequency analysis for all species within the community yields a prevalence index value greater than or equal to 3.0, *and* hydric soils and wetland hydrology are present. (*Note*: In other words, if the hydric soil and wetland hydrology criteria are met, then the vegetation is considered hydrophytic. For purposes of this manual, these situations are treated as disturbed or problem area wetlands because these plant communities are usually nonwetlands.)

Other Sources of Information

3.7. Besides learning the field indicators of hydrophytic vegetation presented above, one should also become familiar with the technical literature on wetlands, especially for one's geographic region. Sources of available literature include: taxonomic plant manuals and field guides; scientific journals dealing with botany, ecology, and wetlands in particular; technical government reports on wetlands; proceedings of wetland workshops, conferences, and symposia; and the FWS's national wetland plant database, which contains habitat information on about 7,000 plant species. Appendix A presents examples of the first four sources of information. In addition, the FWS's National Wetlands Inventory (NWI) maps provide information on locations of hydrophytic plant communities that may be studied in the field to improve one's knowledge of such communities in particular regions.

Hydric Soils

3.8. Due to their wetness during the growing season, hydric soils usually develop certain morphological properties that can be readily observed in the field. Prolonged anaerobic soil conditions typically lower the soil redox potential and causes a chemical reduction of some soil components, mainly iron oxides and manganese oxides. This reduction affects solubility, movement, and aggregation of these oxides which is reflected in the soil color and other physical characteristics that are usually indicative of hydric soils. (*Note*: Much of the background material for this section was taken from "Hydric Soils of New England" [Tiner and Veneman 1987].)

3.9. Soils are separated into two major types on the basis of material composition: organic soil and mineral soil. In general, soils with at least 18 inches of organic material in the upper part of the soil profile and soils with organic material resting on bedrock are considered organic soils (Histosols). Soils largely composed of sand, silt, and/or clay are mineral soils. (For technical definitions, see "Soil Taxonomy", U.S.D.A. Soil Survey Staff 1975).

3.10. Accumulation of organic matter in most organic soils results from prolonged anaerobic soil conditions associated with long periods of submergence or soil saturation during the growing season. These saturated conditions impede aerobic decomposition (oxidation) of the bulk organic materials such as leaves, stems, and roots, and encourage their accumulation over time as peat or muck. Consequently, most organic soils are characterized as very poorly drained soils. Organic soils typically form in waterlogged depressions, and peat or muck deposits may range from about two feet to more

than 30 feet deep. Organic soils also develop in low-lying areas along coastal waters where tidal flooding is frequent.

3.11. Hydric organic soils are subdivided into three groups based on the presence of identifiable plant material: (1) muck (Saprists) in which two-thirds or more of the material is decomposed and less than one-third of the plant fibers are identifiable; (2) peat (Fibrists) in which less than one-third of the material is decomposed and more than two-thirds of the plant fibers are still identifiable; and (3) mucky peat or peaty muck (Hemists) in which the ratio of decomposed to identifiable plant matter is more nearly even (U.S.D.A. Soil Survey Staff 1975). A fourth group of organic soils (Folists) exists in tropical and boreal mountainous areas where precipitation exceeds the evapotranspiration rate, but these soils are never saturated for more than a few days after heavy rains and thus do not develop under hydric conditions. All organic soils, with the exception of the Folists, are hydric soils.

3.12. When less organic material accumulates in soil, the soil is classified as mineral soil. Some mineral soils may have thick organic surface layers due to heavy seasonal rainfall or a high water table, yet they are still composed largely of mineral matter (Ponnamperuma 1972). Mineral soils that are covered with moving (flooded) or standing (ponded) water for significant periods or are saturated for extended periods during the growing season are classified as hydric mineral soils. Soil saturation may result from low-lying topographic position, groundwater seepage, or the presence of a slowly permeable layer (e.g., clay, confining bedrock, or hardpan).

3.13. The duration and depth of soil saturation are essential criteria for identifying hydric soils and wetlands. Soil morphological features are commonly used to indicate long-term soil moisture regimes (Bouma 1983). The two most widely recognized features that reflect wetness in mineral soils are gleying and mottling.

3.14. Simply described, gleyed soils are predominantly neutral gray in color and occasionally greenish or bluish gray. In gleyed soils, the distinctive colors result from a process known as gleization. Prolonged saturation of mineral soil converts iron from its oxidized (ferric) form to its reduced (ferrous) state. These reduced compounds may be completely removed from the soil, resulting in gleying (Veneman, *et al.* 1976). Mineral soils that are always saturated are uniformly gleyed throughout the saturated area. Soils gleyed to the surface layer are hydric soils. These soils often show evidence of oxidizing conditions only along root channels. Some nonhydric soils have gray layers (E-horizons) immediately below the surface layer that are gray for reasons other than saturation (e.g., leaching due to organic acids). These soils often have brighter (e.g., brownish or reddish) layers below the gray layer and can be recognized as nonhydric on that basis.

3.15. Mineral soils that are alternately saturated and oxidized (aerated) during the year are usually mottled in the part of the soil that is seasonally wet. Mottles are spots or blotches of different colors or shades of colors interspersed with the dominant (matrix) color. The abundance, size, and color of the mottles usually reflect the duration of the saturation period and indicate whether or not the soil is hydric. Mineral soils that are predominantly grayish with brown or yellow mottles are usually saturated for long periods during the growing season and are classified as hydric. Soils that are predominantly brown or yellow with gray mottles are saturated for shorter periods and may not be hydric. Mineral soils that are never saturated are usually bright-colored and are not mottled. Realize, however, that in some hydric soils, mottles may not be visible due to masking by organic matter (Parker, *et al.* 1984).

3.16. It is important to note that the gleization and mottle formation processes are strongly influenced by the activity of certain soil microorganisms. These microorganisms reduce iron when the soil environment is anaerobic, that is, when virtually no free oxygen is present, and when the soil contains organic matter. If the soil conditions are such that free oxygen is present, organic matter is absent, or temperatures are too low (below 41°F) to sustain microbial activity, gleization will not proceed and mottles will not form, even though the soil may be saturated for prolonged periods of time (Diers and Anderson 1984).

Soil Colors

3.17. Soil colors often reveal much about a soil's wetness, that is, whether the soil is hydric or nonhydric. Scientists and others examining the soil can determine the approximate soil color by comparing

the soil sample with a Munsell soil color chart. The standardized Munsell soil colors are identified by three components: hue, value, and chroma. The hue is related to one of the main spectral colors: red, yellow, green, blue, or purple, or various mixtures of these principal colors. The value refers to the degree of lightness, while the chroma notation indicates the color strength or purity. In the Munsell soil color book, each individual hue has its own page, each of which is further subdivided into units for value (on the vertical axis) and chroma (horizontal axis). Although theoretically each soil color represents a unique combination of hues, values, and chromas, the number of combinations common in the soil environment usually is limited. Because of this situation and the fact that accurate reproduction of each soil color is expensive, the Munsell soil color book contains a limited number of combinations of hues, values, and chromas. The color of the soil matrix or a mottle is determined by comparing a soil sample with the individual color chips in the soil color book. The appropriate Munsell color name can be read from the facing page in the "Munsell Soil Color Charts" (Kollmorgen Corporation 1975). Chromas of 2 or less are considered low chromas and are often diagnostic of hydric soils. Low chroma colors include black, various shades of gray, and the darker shades of brown and red.

Hydric Organic Soils

3.18. Hydric organic soils can be easily recognized as black-colored muck and/or as black to dark brown-colored peat. Distinguishing mucks from peats based on the relative degree of decomposition is fairly simple. In mucks (Saprists), almost all of the plant remains have been decomposed beyond recognition. When rubbed, mucks feel greasy and leave hands dirty. In contrast, the plant remains in peats (Fibrists) show very little decomposition and the original constituent plants can be recognized fairly easily. When the organic material is rubbed between the fingers, most plant fibers will remain identifiable, leaving hands relatively clean. Between the extremes of mucks and peats, organic soils with partially decomposed plant fibers (Hemists) can be recognized. In peaty mucks up to two-thirds of the plant fibers can be destroyed by rubbing the materials between the fingers, while in mucky peats up to two-thirds of the plant remains are still recognizable after rubbing.

3.19. Besides the dominance of organic matter, many organic soils (especially in tidal marshes) also emit an odor of rotten eggs when hydrogen sulfide is present. Sulfides are produced only in a strongly reducing environment.

Hydric Mineral Soils

3.20. Hydric mineral soils are often more difficult to identify than hydric organic soils because most organic soils are hydric, while most mineral soils are not. A thick dark surface layer, grayish subsurface and subsoil colors, the presence of orange or reddish brown (iron) and/or dark reddish brown or black (manganese) mottles or concretions near the surface, and the wet condition of the soil may help identify the hydric character of many mineral soils. The grayish subsurface and subsoil colors and thick, dark surface layers are the best indicators of current wetness, since the orange-colored mottles are very insoluble and once formed may remain indefinitely as relict mottles of former wetness (Diers and Anderson 1984).

National and State Hydric Soils Lists

3.21. The SCS in cooperation with the National Technical Committee for Hydric Soils (NTCHS) has prepared a list of the Nation's hydric soils. State lists have also been prepared for statewide use. The national and State lists identify those soil series that meet the hydric soil criteria according to available soil interpretation records in SCS's soils database. These lists are periodically updated, so make sure the list being used is the current list. The lists facilitate use of SCS county soil surveys for identifying potential wetlands. One must be careful, however, in using the soil survey, because a soil map unit of an upland (nonwetland) soil may have inclusions of hydric soil that were not delineated on the map or vice versa. Also, some map units (e.g., alluvial land, swamp, tidal marsh, muck and peat) may be hydric soil areas, but are not on the hydric soils lists because they were not given a series name at the time of mapping.

3.22. Because of these limitations of the national and State lists, the SCS also maintains lists of hydric soil map units for each county in the United States. These lists may be obtained from local SCS district offices and are the preferred lists to be used when locating areas of hydric soils. The hydric soil

map units lists identify all map units that are either named by a hydric soil or that have a potential of having hydric soil inclusions. The lists provide the map unit symbol, the name of the hydric soil part or parts of the map unit, information on the hydric soil composition of the map unit, and probable landscape position of hydric soils in the map unit delineation. The county lists also include map units named by miscellaneous land types or higher levels in "Soil Taxonomy" that meet hydric soil criteria.

Soil Surveys

3.23. The SCS publishes county soil surveys for areas where soil mapping is completed. Soil surveys that meet standards of the National Cooperative Soil Survey (NCSS) are used to identify delineations of hydric soils. These soil surveys may be published (completed) or unpublished (on file at local SCS district offices). Published soil surveys of an area may be obtained from the local SCS district office or the Agricultural Extension Service office. Unpublished maps may be obtained from the local SCS district office.

3.24. The NCSS maps four kind of map units: (1) consociations, (2) complexes, (3) associations, and (4) undifferentiated groups. *Consociations* are soil map units named for a single kind of soil (taxon) or miscellaneous area. Seventy-five percent of the area is similar to the taxon for which the unit is named. When named by a hydric soil, the map unit is considered a hydric soil map unit for wetland determinations. However, small areas within these map units may not be hydric and should be excluded in delineating wetlands.

3.25. *Complexes and associations* are soil map units named by two or more kinds of soils (taxa) or miscellaneous areas. If all taxa for which these map units are named are hydric, the soil map unit may be considered a hydric soil map unit for wetland determinations. If only part of the map unit is made up of hydric soils, only those portions of the map unit that are hydric are considered in wetland determinations.

3.26. *Undifferentiated groups* are soil map units named by two or more kinds of soils or miscellaneous areas. These units are distinguished from the others in that "and" is used as a conjunction in the name, while dashes are used for complexes and associations. If all components are hydric, the map unit may be considered a hydric soil map unit. If one or more of the soils for which the unit is named are nonhydric, each area must be examined for the presence of hydric soils.

Use of the Hydric Soils List and Soil Surveys

3.27. The hydric soils list and county soil surveys may be used to help determine if the hydric soil criterion is met in a given area. When making a wetland determination, one should first locate the area of concern on a soil survey map and identify the soil map units for the area. The list of hydric soils should be consulted to determine whether the soil map units are hydric. If hydric soil map units are noted, then one should examine the soil in the field and compare its morphology with the corresponding hydric soil description in the soil survey report. If the soil's characteristics match those described for hydric soil, then the hydric soil criterion is met, unless the soil has been effectively drained (see disturbed areas section, p. 50). In the absence of site-specific information, hydric soils also may be recognized by field indicators.

Field Indicators

3.28. Several field indicators are available for determining whether a given soil meets the definition and criteria for hydric soils. Other factors to consider in recognizing hydric soils include obligate wetland plants, topography, observed or recorded inundation or soil saturation, and evidence of human alterations, e.g., drainage and filling. Any one of the following may indicate that hydric soils are present:

1) *Organic Soils* – Various peats and mucks are easily recognized as hydric soils. Organic soils that are cropped are often drained, yet the water table is closely managed to minimize oxidation of organic matter. These soils often retain their hydric soil characteristics and, if so, meet the wetland hydrology criterion.

2) *Histic epipedons* – A histic epipedon (organic surface layer) is an 8- to 16-inch organic layer at or near the surface of a hydric mineral soil that is saturated with water for 30 consecutive days or more in most years. It contains a minimum of 20 percent organic matter when no clay is present or a

minimum of 30 percent organic matter when clay content is 60 percent or greater. Soils with histic epipedons are inundated or saturated for sufficient periods to greatly retard aerobic decomposition of organic matter, and are considered hydric soils. In general, a histic epipedon is a thin surface layer of peat or muck if the soil has not been plowed (U.S.D.A. Soil Survey Staff 1975). Histic epipedons are technically classified as Oa, Oe, or Oi surface layers, and in some cases the terms "mucky" or "peaty" are used as modifiers to the mineral soil texture term, e.g., mucky loam.

3) *Sulfidic material* – When soils emit an odor of rotten eggs, hydrogen sulfide is present. Such odors are only detected in waterlogged soils that are essentially permanently saturated and have sulfidic material within a few inches of the soil surface. Sulfides are produced only in reducing environment. Under saturated conditions, the sulfates in water are biologically reduced to sulfides as the organic materials accumulate.

4) *Aquic or peraquic moisture regime* – An *aquic* moisture regime is a reducing one, i.e., it is virtually free of dissolved oxygen, because the soil is saturated by ground water or by water of the capillary fringe (U.S.D.A. Soil Survey Staff 1975). The soil is considered saturated if water stands in an unlined borehole at a shallow enough depth that the capillary fringe reaches the soil surface, except in noncapillary pores. Because dissolved oxygen is removed from ground water by respiration of microorganisms, roots, and soil fauna, it is also implicit that the soil temperature be above biologic zero (41°F) at some time while the soil is saturated. Soils with *peraquic* moisture regimes are characterized by the presence of ground water always at or near the soil surface. Examples include soils of tidal marshes and soils of closed, landlocked depressions that are fed by permanent streams. Soils with peraquic moisture regimes are always hydric under natural conditions. Soils with aquic moisture regimes are usually hydric, but the NTCHS hydric soil criteria should be verified in the field.

5) *Direct observations of reducing soil conditions* – Soils saturated for long or very long duration will usually exhibit reducing conditions at the time of saturation. Under such conditions, ions of iron are transformed from a ferric (oxidized) state to a ferrous (reduced) state. This reduced condition can often be detected in the field by use of a colorimetric field test kit. When a soil extract changes to a pink color upon addition of a-a-dipyridil, ferrous iron is present, which indicates a reducing soil environment at the time of the test. A negative result (no pink color) only indicates that the soil is not reduced at this moment; it does not imply that the soil is not reduced during the growing season. Furthermore, the test is subject to error due to the rapid change of ferrous iron to ferric iron when the soil is exposed to air and should only be used by experienced technicians. (*CAUTION*: This test cannot be used in hydric mineral soils having low iron content or in organic soils. Also it does not determine the duration of reduced conditions.)

6) *Gleyed, low chroma, and low chroma/mottled soils* – The colors of various soil components are often the most diagnostic indicator of hydric soils. Colors of these components are strongly influenced by the frequency and duration of soil saturation which leads to reducing soil conditions. Hydric mineral soils will be either gleyed or will have low chroma matrix with or without bright mottles.

A) *Gleyed soils* – Gleying (bluish, greenish, or grayish colors) immediately below the A-horizon is an indication of a markedly reduced soil, and gleyed soils are hydric soils. Gleying can occur in both mottled and unmottled soils. Gleyed soil conditions can be determined by using the gley page of the "Munsell Soil Color Charts" (Kollmorgen Corporation 1975). (*CAUTION*: Gleyed conditions normally extend throughout saturated soils. Beware of soils with gray E-horizons due to leaching and not to saturation; these latter soils can often be recognized by bright-colored layers below the E-horizon.)

B) *Other low chroma soils and mottled soils (i.e., soils with low matrix chroma and with or without bright mottles)* – Hydric mineral soils that are saturated for substantial periods of the growing season, but are unsaturated for some time, commonly develop mottles. Soils that have bright colored mottles and a low chroma matrix are indicative of a fluctuating water table. Hydric mineral soils usually have one of the following color features in the horizon immediately below the A-horizon:

(1) Matrix chroma of 2 or less in mottled soils, or
(2) Matrix chroma of 1 or less in unmottled soils.

(*Note*: See p. 59 for mollisols exception.)

Colors should be determined in soils that are or have been moistened. The chroma requirements above are for soils in a moistened condition. Colors noted for dry (unmoistened) soils should be clearly stated as such. The colors of the topsoil are often not indicative of the hydrologic situation because cultivation and soil enrichment affect the original soil color. Hence, the soil colors below the A-horizon (usually below 10 inches) often must be examined.

(*CAUTION*: Beware of problematic hydric soils that have colors other than those described above; see problem area wetlands section, p. 55.)

7) *Iron and manganese concretions* – During the oxidation-reduction process, iron and manganese in suspension are sometimes segregated as oxides into concretions or soft masses. Concretions are local concentrations of chemical compounds (e.g., iron oxide) in the form of a grain or nodule of varying size, shape, hardness, and color (Buckman and Brady 1969). Manganese concretions are usually black or dark brown, while iron concretions are usually yellow, orange or reddish brown. In hydric soils, these concretions are also usually accompanied by soil colors described above.

8) *Coarse-textured or sandy hydric soils* – Many of the indicators listed above cannot be applied to sandy soils. *In particular, soil color should not be used as an indicator in most sandy soils* (see problem area wetlands section, p. 55). However, three soil features may be used as indicators of hydric sandy soils:

A) *High organic matter content in the surface horizon* – Organic matter tends to accumulate above or in the surface horizon of sandy soils that are inundated or saturated to the surface for a significant portion of the growing season. The mineral surface layer generally appears darker than the mineral material immediately below it due to organic matter interspersed among or adhering to sand particles. (*Note*: Because organic matter also accumulates on upland soils, in some instances it may be difficult to distinguish a surface organic layer associated with a wetland site from litter and duff associated with an upland site unless the species composition of the organic materials is determined.)

B) *Dark vertical streaking of subsurface horizons by organic matter* – Organic matter is moved downward through sand as the water table fluctuates. This often occurs more rapidly and to a greater degree in some vertical sections of a sandy soil containing high content of organic matter than in others. Thus, the sandy soil appears vertically streaked with darker areas. When soil from a darker area is rubbed between the fingers, the dark organic matter stains the fingers.

C) *Wet Spodosols* – As organic matter is moved downward through some sandy soils, it may accumulate at the point representing the most commonly occurring depth to the water table. This organic matter may become slightly cemented with aluminum. Spodic horizons often occur at depths of 12 to 30 inches below the mineral surface. Wet spodosols (formerly called "groundwater podzolic soils") usually have thick dark surface horizons that are high in organic matter with thick, dull gray E-horizons above a very dark-colored (black) spodic horizon. (*CAUTION*: Not all soils with spodic horizons meet the hydric soil criterion; see p. 58.)

(*Note*: In recently deposited sandy material, such as accreting sand bars, it may be impossible to find any of the above indicators. Such cases are considered natural, problem area wetlands and the determination of hydric soil should be based on knowledge of local hydrology. See p. 57-58).

Wetland Hydrology

3.29. The driving force creating wetlands is "wetland hydrology", that is, permanent or periodic inundation, or soil saturation for a significant period (usually a week or more) during the growing season. All wetlands are, therefore, at least periodically wet. Many wetlands are found along rivers, lakes, and estuaries where flooding is likely to occur, while other wetlands form in isolated depressions surrounded by upland where surface water collects. Still others develop on slopes of varying steepness, in surface water drainageways or where ground water discharges to the land surface in spring or seepage areas.

3.30. Numerous factors influence the wetness of an area, including precipitation, stratigraphy, topography, soil permeability, and plant cover. The

frequency and duration of inundation or soil saturation are important in separating wetlands from nonwetlands. Duration usually is the more important factor. Areas of lower elevation in a floodplain or marsh have longer duration of inundation and saturation and often more frequent periods of these conditions than most areas at higher levels. Floodplain configuration may significantly affect the duration of inundation by facilitating rapid runoff or by causing poor drainage. Soil permeability related to the texture of the soil also influences the duration of inundation or soil saturation. For example, clayey soils absorb water more slowly than sandy or loamy soils, and therefore have slower permeability and remain saturated much longer. Type and amount of plant cover affect both degree of inundation and duration of saturated soil conditions. Excess water drains more slowly in areas of abundant plant cover, thereby increasing duration of inundation or soil saturation. On the other hand, transpiration rates are higher in areas of abundant plant cover, which may reduce the duration of soil saturation.

3.31. To determine whether the wetland hydrology criterion is met, one should consider recorded data, aerial photographs, and field indicators that provide direct or indirect evidence of inundation or soil saturation.

Recorded Data

3.32. Recorded hydrologic data usually provides both short- and long-term information on the frequency and duration of flooding, but little or no information on soil saturation periods. Recorded data include stream gauge data, lake gauge data, tidal gauge data, flood predictions, and historical flood records. Use of these data is commonly limited to areas adjacent to streams and other similar areas. Recorded data may be available from the following sources:

1) CE district offices (data for major waterbodies and for site-specific areas from planning and design documents)

2) U.S. Geological Survey (stream and tidal gauge data)

3) National Oceanic and Atmospheric Administration (tidal gauge data)

4) State, county and local agencies (flood data)

5) SCS state offices (small watershed projects data)

6) private developers or landowners (site-specific hydrologic data, which may include water table or groundwater well data).

Aerial Photographs

3.33. Aerial photographs may provide direct evidence of inundation or soil saturation in an area. Inundation (flooding or ponding) is best observed during the early spring in temperate and boreal regions when snow and ice are gone and leaves of deciduous trees and shrubs are not yet present. This allows detection of wet soil conditions that would be obscured by the tree or shrub canopy at full leaf-out. For marshes, this season of photography is also desirable, except in regions characterized by distinct dry and rainy seasons, such as southern Florida and California. Wetland hydrology would be best observed during the wet season in these latter areas.

3.34. It is most desirable to examine several consecutive years of early spring or wet season aerial photographs to document evidence of wetland inundation or soil saturation. In this way, the effects of abnormally dry springs, for example, may be minimized. In interpreting aerial photographs, it is important to know the antecedent weather conditions. This will help eliminate potential misinterpretations caused by abnormally wet or dry periods. Contact the U.S. Weather Service for historical weather records. Aerial photographs for agricultural regions of the country are often available at county offices of the Agricultural Stabilization and Conservation Service.

Field Indicators

3.35. At certain times of the year in most wetlands, and in certain types of wetlands at most times, wetland hydrology is quite evident, since surface water or saturated soils (e.g., soggy or wetter underfoot) may be observed. Yet in many instances, especially along the uppermost boundary of wetlands, hydrology is not readily apparent. Consequently, the wetland hydrology criterion is

often impracticable for delineating precise wetland boundaries. Despite this limitation, hydrologic indicators can be useful for confirming that a site with hydrophytic vegetation and hydric soils still exhibits wetland hydrology and that the hydrology has not been significantly modified to the extent that the area is now effectively drained. In other words, while hydrologic indicators are sometimes diagnostic of the presence of wetlands, they are generally either operationally impracticable (e.g., in the case of recorded data) or technically inaccurate (e.g., in the case of some field indicators) for delineating wetland boundaries. In the former case, surveying the wetland boundary according to elevation data related to recorded flood data, for example, is generally too time-consuming and may not actually be a true correlation. In the latter case, it should be quite obvious that indicators of flooding often extend well beyond the wetland boundary into low-lying upland areas that were flooded by an infrequent flood. Consequently the emphasis on delineating wetland boundaries should be placed on hydrophytic vegetation and hydric soils in the absence of significant hydrologic modification, although wetland hydrology should always be considered.

3.36. If significant drainage or groundwater alteration has taken place, then it is necessary to determine whether the area in question is effectively drained and is now nonwetland or is only partly drained and remains wetland despite some hydrologic modification. Guidance for determining whether an area is effectively drained is presented in the section on disturbed areas (p. 50). In the absence of visible evidence of significant hydrologic modification, wetland hydrology is presumed to occur in an area having hydrophytic vegetation and hydric soils.

3.37. The following hydrologic indicators can be assessed quickly in the field. Although some are not necessarily indicative of hydrologic events during the growing season or in wetlands alone, they do provide evidence that inundation or soil saturation have occurred at some time. One should use good professional judgement in deciding whether the hydrologic indicators demonstrate that the wetland hydrology criterion has been satisfied. When considering these indicators, it is important to be aware of recent extreme flooding events and heavy rainfall periods that could cause low-lying nonwetlands to exhibit some of these signs. It is, therefore, best to avoid, if possible, field inspections during and immediately after these events. If not possible, then these events must be considered in making a wetland determination. Also, remember that hydrology varies seasonally and annually as well as daily, and that at significant times of the year (e.g., late summer for most of the country) the water tables are at their lowest points. At these low water periods, signs of soil saturation and flooding may be difficult to find in many wetlands.

1) *Visual observation of inundation* – The most obvious and revealing hydrologic indicator may be simply observing the areal extent of inundation. However, both seasonal conditions and recent weather conditions should be considered when observing an area because they can affect whether surface water is present on a nonwetland site.

2) *Visual observation of soil saturation* – In some cases, saturated soils are obvious, since the ground surface is soggy or mucky under foot. In many cases, however, examination of this indicator requires digging a hole to a depth of 18 inches and observing the level at which water stands in the hole after sufficient time has been allowed for water to drain into the hole. The required time will vary depending on soil texture. In some cases, the upper level at which water is flowing into the hole can be observed by examining the wall of the hole. This level represents the depth to the water table. The depth to saturated soils will always be nearer the surface due to a capillary fringe. In some heavy clay soils, water may not rapidly accumulate in the hole even when the soil is saturated. If water is observed at the bottom of the hole but has not filled to the 12-inch depth, examine the sides of the hole and determine the shallowest depth at which water is entering the hole. Saturated soils may also be detected by a "squeeze test," which involves taking a soil sample within 18 inches (actual depth depends on soil permeability) and squeezing the sample. If free water can be extracted, the soil is saturated at the depth of the sample at this point in time. When applying the soil saturation indicator, both the season of the year and the preceding weather conditions must be considered. (*Note*: It is not necessary to directly demonstrate soil saturation at the time of inspection. If the NTCHS criteria for hydric soil are met, it can be assumed that an area is saturated to the surface or inundated at some point in time during an average rainfall year.)

3) *Oxidized channels (rhizospheres) associated with living roots and rhizomes* – Some plants are

able to survive saturated soil conditions (i.e., a reducing environment) because they can transport oxygen to their root zone. Look for iron oxide concretions (orangish or reddish brown in color) forming along the channels of living roots and rhizomes as evidence of soil saturation (anaerobic conditions) for a significant period during the growing season.

4) *Water marks* – Water marks are found most commonly on woody vegetation but may also be observed on other vegetation. They often occur as stains on bark or other fixed objects (e.g., bridge pillars, buildings, and fences). When several water marks are present, the highest usually reflects the maximum extent of recent inundation.

5) *Drift lines* – This indicator is typically found adjacent to streams or other sources of water flow in wetlands and often occurs in tidal marshes. Evidence consists of deposition of debris in a line on the wetland surface or debris entangled in aboveground vegetation or other fixed objects. Debris usually consists of remnants of vegetation (branches, stems, and leaves), sediment, litter, and other water-borne materials deposited more or less parallel to the direction of water flow. Drift lines provide an indication of the minimum portion of the area inundated during a flooding event; the maximum level of inundation is generally at a higher elevation than that indicated by a drift line.

6) *Water-borne sediment deposits* – Plants and other vertical objects often have thin layers, coatings, or depositions of mineral or organic matter on them after inundation. This evidence may remain for a considerable period before it is removed by precipitation or subsequent inundation. Sediment deposition on vegetation and other objects provides an indication of the minimum inundation level. When sediments are primarily organic (e.g., fine organic material and algae), the detritus may become encrusted on or slightly above the soil surface after dewatering occurs.

7) *Water-stained leaves* – Forested wetlands that are inundated earlier in the year will frequently have water-stained leaves on the forest floor. These leaves are generally grayish or blackish in appearance, darkened from being underwater for significant periods.

8) *Surface scoured areas* – Surface scouring occurs along floodplains where overbank flooding erodes sediments (e.g., at the bases of trees). The absence of leaf litter from the soil surface is also sometimes an indication of surface scouring. Forested wetlands that contain standing waters for relatively long duration will occasionally have areas of bare or essentially bare soil, sometimes associated with local depressions.

9) *Wetland drainage patterns* – Many wetlands (e.g., tidal marshes and floodplain wetlands) have characteristic meandering or braided drainage patterns that are readily recognized in the field or on aerial photographs and occasionally on topographic maps. (*CAUTION*: Drainage patterns also occur in upland areas after periods of considerable precipitation; therefore, topographic position also must be considered when applying this indicator.)

10) *Morphological plant adaptations* – Many plants growing in wetlands have developed morphological adaptations in response to inundation or soil saturation. Examples include pneumatophores, buttressed tree trunks, multiple trunks, adventitious roots, shallow root systems, floating stems, floating leaves, polymorphic leaves, hypertrophied lenticels, inflated leaves, stems or roots, and aerenchyma (air-filled) tissue in roots and stems (see Table 1 for examples). As long as there is no evidence of significant hydrologic modification, these adaptations can be used as hydrologic indicators. Moreover, when these features are observed in young plants, they provide good evidence that recent wetland hydrology exists. (*Note*: While some people may consider these morphological adaptations as indicators of hydrophytic vegetation, for purposes of this manual, they are treated as indicators of wetland hydrology because they typically develop in response to permanent or periodic inundation or soil saturation.)

11) *Hydric soil characteristics* – In the absence of the above indicators, if an area meets the field indicators for hydric soils and there is no indication of significant hydrologic modification, then it can be assumed that the area meets the wetland hydrology criterion. If the area has been significantly disturbed hydrologically, refer to the section on disturbed areas (p. 50). (*CAUTION*: Listing of a soil on the NTCHS list of hydric soils does not necessarily mean the wetland hydrology criterion is met, nor does exclusion of a soil from the list demonstrate that the wetland hydrology criterion has not been met. However, soils on the NTCHS list represent those soils which typically meet the wetland hydrology criterion, unless effectively drained or otherwise altered.)

Table 1. Morphological or structural adaptations of plants for growing in permanently or periodically flooded or saturated soils.

Adaptations	Examples of Plants Possessing Adaptation
Buttressed (swollen) Tree Trunk	Bald Cypress (*Taxodium distichum*), Black Gum (Nyssa sylvatica var. *biflora*), Green Ash (*Fraxinus pennsylvanica* var. *subintegerima*), Water Gum (*Nyssa aquatica*), and Ogechee Tupelo (*Nyssa ogechee*)
Multiple Trunks	Red Maple (*Acer rubrum*), Silver maple (*Acer saccharinum*), Swamp Privet (*Forestiera acuminata*), and Ogechee Tupelo
Pneumataphores	Bald Cypress, Water Gum, and Black Mangrove (*Rhizophora mangle*)
Adventitious Roots (arising from stem above ground)	Box Elder (*Acer negundo*), Sycamore (*Platanus occidentalis*), Pin Oak (*Quercus palustris*), Black Willow (*Salix nigra*), Green Ash, Alligatorweed (*Alternanthera philoxeroides*), Water Primroses (*Ludwigia* spp.), Water Gum, Eastern Cottonwood (*Populus deltoides*), and Willows (*Salix* spp.)
Shallow Roots (often exposed to ground surface)	Red Maple and Laurel Oak (*Quercus laurifolia*)
Hypertrophied Lenticels	Red Maple, Silver Maple, Willows, Black Mangrove, Water Locust (*Gleditsia aquatica*), and Sweet Gale (*Myrica gale*)
Aerenchyma (air-filled tissue) in Roots & Stems	Eastern Bur-reed (*Sparganium americanum*), Soft Rush (*Juncus effusus*), Soft-stemmed Bulrush (*Scirpus validus*), Water Shield (*Brasenia schreberi*), Umbrella Sedges (*Cyperus* spp.), other Rushes (*Juncus* spp.), Spike-rushes (*Eleocharis* spp.), Twig-rush (*Cladium mariscoides*), Buckbean (*Menyanthes trifoliata*), Giant Bur-reed (*Sparganium eurycarpum*), and Cattails (*Typha* spp.)
Polymorphic Leaves	Arrowheads (*Sagittaria* spp.) and Water Parsnip (*Sium suave*)
Floating Leaves	Water Shield, Spatterdock Lily (*Nuphar luteum*), and White Water Lily (*Nymphaea odorata*)

Sources: Environmental Laboratory (1987) and Tiner (1988).

Part IV.

Methods for Identification and Delineation of Wetlands

4.0. Four basic approaches for identifying and delineating wetlands have been developed to cover situations ranging from desk-top or office determinations to highly complex field determinations for regulatory purposes. These methods are the recommended approaches and the reasons for departing from them should be documented. Remember, however, that any method for making a wetland determination must consider the three technical criteria (i.e., hydrophytic vegetation, hydric soils, and wetland hydrology) listed in Part II of this manual. These criteria must be met in order to identify a wetland. In applying all methods, relevant available information on wetlands in the area of concern should be collected and reviewed. Table 2 lists primary data sources.

Selection of a Method

4.1. The wetland delineation methods presented in this manual can be grouped into two general types: (1) offsite procedures and (2) onsite procedures. The offsite procedures are designed for use in the office, while onsite procedures are developed for use in the field. When an onsite inspection is unnecessary or cannot be undertaken for various reasons, available information can be reviewed in the office to make a wetland determination. If available information is insufficient to make a wetland determination or if a precise wetland boundary must be established, an onsite inspection should be conducted. Depending on the field information needed or the complexity of the area, one of three basic onsite methods may be employed: (1) routine, (2) intermediate-level, or (3) comprehensive.

4.2. The routine method is designed for areas equal to or less than five acres in size or larger areas with homogeneous vegetation. For areas greater than five acres in size or other areas of any size that are highly diverse in vegetation, the intermediate-level method or the comprehensive method should be applied, as necessary. The comprehensive method is applied to situations requiring detailed documentation of vegetation, soils, and hydrology. Assessments of significantly disturbed sites will often require intermediate-level or comprehensive determinations as well as some special procedures. In other cases where natural conditions make wetland identification difficult, special procedures for problem area wetland determinations have been developed. These procedures are subroutines of the three onsite determination methods. In making wetland determinations, one should select the appropriate method for each individual unit within the area of concern and not necessarily employ one method for the entire site. Thus, a combination of determination methods may be used for a given site.

4.3. Regardless of the method used, the desired outcome or final product is a wetland/nonwetland determination. Depending on one's expertise, available information, and individual or agency preference, there are two basic approaches to delineating wetland boundaries. The first approach involves characterizing plant communities in the area, identifying hydrophytic plant communities, examining the soils in these areas to confirm the presence of hydric soil, and finally looking for evidence of wetland hydrology. This approach has been widely used by the CE and EPA and to a large extent by the FWS. A second approach involves first delineating the boundary of hydric soils, and then verifying the presence of hydrophytic vegetation and looking for signs of wetland hydrology. This type of approach has been employed by the SCS and to a limited extent by the FWS. Since these approaches yield the same result, this manual incorporates both approaches into most of the methods presented.

Table 2. Primary sources of information that may be helpful in making a wetland determination.

Data Name	Source
Topographic Maps (mostly 1:24,000; 1:63,350 for Alaska)	U.S. Geological Survey (USGS) (Call 1-800-USA-MAPS)
National Wetlands Inventory Maps (mostly 1:24,000; 1:63,350 for Alaska)	U.S. Fish and Wildlife Service (FWS) (Call 1-800-USA-MAPS)
County Soil Survey Reports	U.S.D.A. Soil Conservation Service (SCS) District Offices (Unpublished reports--local district offices)
National Hydric Soils List	SCS National Office
State Hydric Soils List	SCS State Offices
County Hydric Soil Map Unit List	SCS District Offices
National Insurance Agency Flood Maps	Federal Emergency Management Agency
Local Wetland Maps	State and local agencies
Land Use and Land Cover Maps	USGS (1-800-USA-MAPS)
Aerial Photographs	Various sources--USGS, U.S.D.A. Agricultural Stabilization and Conservation Service, other Federal and State agencies, and private sources
Satellite Imagery	EOSAT Corporation, SPOT Corporation, and others
National List of Plant Species That Occur in Wetlands (Stock No. 024-010-00682-0)	Government Printing Office Superintendent of Documents Washington, DC 20402
Regional Lists of Plants that Occur in Wetlands	National Technical Information Service 5285 Port Royal Head Springfield, VA 22161 (703) 487-4650
National Wetland Plant Database	FWS
Stream Gauge Data	CE District Offices and USGS
Soil Drainage Guides	SCS District Offices
Environmental Impact Statements and Assessments	Various Federal and State agencies
Published Reports	Federal and States agencies, universities, and others
Local Expertise	Universities, consultants, and others
Site-specific Plans and Engineering Designs	Private developers

Description of Methods

Offsite Determinations

4.4. When an onsite inspection is not necessary because information on hydrology, hydric soils, and hydrophytic vegetation is known or an inspection is not possible due to time constraints or other reasons, a wetland determination can be made in the office. This approach provides a best approximation of the presence of wetland and its boundaries based on available information. The accuracy of the determination depends on the quality of the information used and on one's ability and experience in an area to interpret these data. Where reliable, site-specific data have been previously collected, the wetland determination should be reasonably accurate. Where these data do not exist, more generalized information may be used to make a preliminary wetland determination. In either case, however, if a more accurate delineation is required, then onsite procedures must be employed.

Offsite Determination Method

4.5. The following steps are recommended for conducting an offsite wetland determination:

Step 1. *Locate the area of interest on a U.S.Geological Survey topographic map and delineate the approximate subject area boundary on the map.* Note whether marsh or swamp symbols or lakes, ponds, rivers, and other waterbodies are present within the area. If they are, then there is a good likelihood that wetland is present. Proceed to Step 2.

Step 2. *Review appropriate National Wetlands Inventory (NWI) maps, State wetland maps, or local wetland maps, where available.* If these maps designate wetlands in the subject area, there is a high probability that wetlands are present unless there is evidence on hand that the wetlands have been effectively drained, filled, excavated, impounded, or otherwise significantly altered since the effective date of the maps. Proceed to Step 3.

Step 3. *Review SCS soil survey maps where available.* In the area of interest, are there any map units listed on the county list of hydric soil map units or are there any soil map units with significant hydric soil inclusions? If *YES*, then assume that at least a portion of the project area may be wetland. If this area is also shown as a wetland on NWI or other wetland maps, then there is a high probability that the area is wetland unless it has been recently altered (check recent aerial photos, Step 4). Areas without hydric soils or hydric soil inclusions should in most cases be eliminated from further review, but aerial photos still should be examined for small wetlands to be more certain. This is especially true if wetlands have been designated on the National Wetlands Inventory or other wetland maps. Proceed to Step 4.

Step 4. *Review recent aerial photos of the project area.* Before reviewing aerial photos, evaluate climatological data to determine whether the photo year had normal or abnormal (high or low) precipitation two to three months, for example, prior to the date of the photo. This will help provide a useful perspective or frame-of-reference for doing photo interpretation. In some cases, aerial photos covering a multi-year period (e.g., 5-7 years) should be reviewed, especially where recent climatic conditions have been abnormal.

During photo interpretation, look for one or more signs of wetlands. For example:

1) hydrophytic vegetation;
2) surface water;
3) saturated soils;
4) flooded or drowned out crops;
5) stressed crops due to wetness;
6) greener crops in dry years;
7) differences in vegetation patterns due to different planting dates.

If signs of wetland are observed, proceed to Step 5 when site-specific data are available; if site-specific data are not available, proceed to Step 6.

(*CAUTION*: Accurate photo interpretation of certain wetland types requires considerable expertise. Evergreen forested wetlands and temporarily flooded wetlands, in general, may present considerable difficulty. If not proficient in wetland photo interpretation, then one can rely more on the findings of other sources, such as NWI maps and soil surveys, or seek help in photo interpretation.)

Step 5. *Review available site-specific information.* In some cases, information on vegetation, soils, and hydrology for the project area has been collected during previous visits to the area by agency personnel, environmental consultants or others.

Moreover, individuals or experts having firsthand knowledge of the project site should be contacted for information whenever possible. Be sure, however, to know the reliability of these sources. After reviewing this information, proceed to Step 6.

Step 6. *Determine whether wetlands exist in the subject area.* Based on a review of existing information, wetlands can be assumed to exist if:

1) Wetlands are shown on NWI or other wetland maps, and hydric soil or a soil with hydric soil inclusions is shown on the soil survey; or

2) Hydric soil or soil with hydric soil inclusions is shown on the soil survey, and

A) site-specific information confirms hydrophytic vegetation, hydric soils, and/or wetland hydrology, or

B) signs of wetland are detected by reviewing aerial photos; or

3) Any combination of the above or parts thereof (e.g., vegetated wetland on NWI maps and signs of wetland on aerial photos).

If after examining the available reference material one is still unsure whether wetland occurs in the area, then a field inspection should be conducted, whenever possible. Alternatively, more detailed information on the site characteristics may be sought from the project sponsor, if applicable, to help make the determination.

4.6. Offsite procedures are dependent on the availability of information for making a wetland determination, the quality of this information, and one's ability and experience to interpret these data. In most cases, therefore, the offsite procedure yields a preliminary determination. For more accurate results, one must conduct an onsite inspection.

Onsite Determinations

4.7. When an onsite inspection is necessary, be sure to review pertinent background information (e.g., NWI maps, soil surveys, and site plans) before going to the subject site. This information will be helpful in determining what type of field method should be employed. Also, read the sections of this manual that discuss disturbed and problem area wetlands before conducting field work (see p. 50-59). Recommended equipment and materials for conducting onsite determinations are listed in Table 3.

Figures 1, 2, and 3 show the conceptual approaches for making onsite wetland determinations. These figures are *NOT* decision matrices for making wetland determinations.

Table 3. Recommended equipment and materials for onsite determinations.

Equipment	Materials
Soil auger, probe, or spade	Data sheets and clipboard
Sighting compass	Field notebook
Pen or pencil	Base (topographic) map
Penknife	Aerial photograph
Hand lens	National Wetlands Inventory map
Vegetation sampling frame*	Soil survey or other soil map
Camera/Film	Appropriate Federal interagency wetland plants list
Binoculars	County hydric soil map unit list
Tape measure	Munsell scoil color book
Prism or angle gauge	Plant identification field guides/manuals
Diameter tape*	*National List of Scientific Plant Names*
Vasculum (for plant collection)	Flagging tape/wire flags/wooden stakes
Calculator*	Plastic bags (for collecting plants and soil samples as needed)
Dissecting kit	

* Needed for comprehensive determination

4.8. For every upcoming field inspection, the following pre-inspection steps should be undertaken:

Step 1. *Locate the project area on a map (e.g., U.S. Geological Survey topographic map or SCS soil survey map) or on an aerial photograph and determine the limits of the area of concern.* Proceed to Step 2.

Step 2. *Estimate the size of the subject area.* Proceed to Step 3.

Step 3. *Review existing background information and determine, to the extent possible, the site's geomorphological setting (e.g., floodplain, isolated depression, or ridge and swale complex), its habitat or vegetative complexity (i.e., the range of habitat or vegetation types), and its soils.* (*Note*: Depending on available information, it may not be possible to determine the habitat complexity without going on the site; if necessary, do a field reconnaissance.) Proceed to Step 4.

Step 4. *Determine whether a disturbed condition exists.* Examine available information and determine whether there is evidence of sufficient natural or human-induced alteration to significantly modify all or a portion of the area's vegetation, soils, and/or hydrology. If such disturbance is noted, identify the limits of affected areas for they should be evaluated separately for wetland determination purposes (usually after evaluating undisturbed areas). The presence of disturbed areas within the subject area should be considered when selecting an onsite determination method. (*Note*: It may be possible that at any time during this determination, one or more of the three characteristics may be found to be significantly altered. If this happens, follow the disturbed area wetland determination procedures, as necessary, noted on p. 50.) Proceed to Step 5.

Step 5. *Determine the field determination method to be used.* Considering the size and complexity of the area, determine whether a routine, intermediate-level, or comprehensive field determination method should be used. When the area is equal to or less than five acres in size or is larger and appears to be relatively homogeneous with respect to vegetation, soils, and/or hydrology, use the routine method (see below). When the area is greater than five acres in size, or is smaller but appears to be highly diverse with respect to vegetation, use the intermediate-level method (p. 35). When detailed quantification of plant communitie and more extensive documentation of other factors (soils and hydrology) are required, use the comprehensive method regardless of the wetland's size (p. 39.) Significantly disturbed sites (e.g., sites that have been filled, hydrologically modified, cleared of vegetation, or had their soils altered) will generally require intermediate-level or comprehensive methods. In these disturbed areas, it usually will be necessary to follow a set of subroutines to determine whether the altered characteristic met the applicable criterion prior to its modification; in the case of altered wetland hydrology, it may be necessary to determine whether the area is effectively drained. Because a large area may include a diversity of smaller areas ranging from simple wetlands to vegetatively complex areas, one may use a combination of the onsite determination methods, as appropriate.

Routine Onsite Determination Method

4.9. For most cases, wetland determinations can be made in the field without rigorous sampling of vegetation and soils. Two approaches for routine determinations are presented: (1) hydric soil assessment procedure, and (2) plant community assessment procedure. In the former approach, areas that meet or may meet the hydric soil criterion are first delineated and then dominant vegetation is visually estimated to determine if hydrophytic vegetation is obvious. If so, the area is designated as wetland. If not, then the site must undergo a more rigorous evaluation following one of the other onsite determination methods presented in the manual. The second routine approach requires initial identification of representative plant community types in the subject area and then characterization of vegetation, soils, and hydrology for each type. After identifying wetland and nonwetland communities, the wetland boundary is delineated. All pertinent observations on the three mandatory wetland criteria should be recorded on an appropriate data sheet.

4.10. Hydric Soil Assessment Procedure

Step 1. *Identify the approximate limits of areas that may meet the hydric soil criterion within the area of concern and sketch limits on an aerial photograph.* To help identify these limits use sources of information such as Agricultural Stabili-

zation and Conservation slides, soil surveys, NWI maps, and other maps and photographs. (*Note*: This step is more convenient to perform offsite, but may be done onsite.) Proceed to Step 2.

Step 2. *Scan the areas that may meet the hydric soil criterion and determine if disturbed conditions exist.* Are any significantly disturbed areas present? If *YES*, identify their limits for they should be evaluated separately for wetland determination purposes (usually after evaluating undisturbed areas). Refer to the section on disturbed areas (p. 50), if necessary, to evaluate the altered characteristic(s) (vegetation, soils, or hydrology); then return to this method and continue evaluating characteristics not altered. (*Note*: Prior experience with disturbed sites may allow one to easily evaluate an altered characteristic, such as when vegetation is not present in a farmed wetland due to cultivation.) Keep in mind that if at any time during this determination, one or more of these three characteristics are found to have been significantly altered, the disturbed area determination procedures should be followed. If the area is not significantly disturbed, proceed to Step 3.

Step 3. *Scan the areas that may meet the hydric soil criterion and determine if obvious signs of wetland hydrology are present.* The wetland hydrology criterion is met for any area or portion thereof where it is obvious or known that the area is frequently inundated or saturated to the surface during the growing season. If the above condition exists, the hydric soil criterion is met for the subject area and the area is considered wetland. If necessary, confirm the presence of hydric soil by examining the soil for appropriate field indicators. (*Note*: Hydrophytic vegetation is assumed to be present under these conditions, i.e., undrained hydric soil, so vegetation does not need to be examined. Moreover, hydrophytic vegetation should be obvious in these situations.) Areas lacking obvious indicators of wetland hydrology must be further examined, so proceed to Step 4.

Step 4. *Refine the boundary of areas that meet the hydric soil criterion.* Verify the presence of hydric soil within the appropriate map units by digging a number of holes at least 18 inches deep along the boundary (interface) between hydric soil units and nonhydric soil units. Compare soil samples with descriptions in the soil survey report to see if they are properly mapped and look for hydric soil characteristics or indicators. In this way, the boundary of areas meeting the hydric soil criterion is further refined by field observations. In map units where only part of the unit is hydric (e.g., complexes, associations, and inclusions), locate hydric soil areas on the ground by considering landscape position and evaluating soil characteristics for hydric soil properties (indicators). (*Note*: Some hydric soils, especially organic soils, have not been given a series name and are referred to by common names, such as peat, muck, swamp, marsh, wet alluvial land, tidal marsh, sulfaquents, and sulfihemists. These areas are also considered hydric soil map units. Certain hydric soils are mapped with nonhydric soils as an association or complex, while other hydric soils occur as inclusions in nonhydric map units. Only the hydric soil portion of these map units should be evaluated for hydrophytic vegetation in Step 7.) If the area meets the hydric soil criterion, proceed to Step 5. (*Note*: These areas are also considered to have met the wetland hydrology criterion.)

Step 5. *Determine whether normal environmental conditions are present.* Determine whether normal environmental conditions are present by considering the following:

1) Is the area presently lacking hydrophytic vegetation or hydrologic indicators due to annual, seasonal or longterm fluctuations in precipitation, surface water, or ground-water levels?

2) Are hydrophytic vegetation indicators lacking due to seasonal fluctuation in temperature (e.g., seasonality of plant growth)?

If the answer to either of these questions is *YES* or uncertain, proceed to the section on problem area wetland determinations (p. 55). If the answer to both questions is *NO*, normal conditions are assumed to be present, so proceed to Step 6.

Step 6. *Select representative observation area(s).* Identify one or more observation areas that represent the area(s) meeting the hydric soil criterion. A representative observation area is one in which the apparent characteristics (determined visually) best represent characteristics of the entire community. Mark the approximate location of the observation area(s) on the aerial photo. Proceed to Step 7.

Step 7. *Characterize the plant community within the area(s) meeting the hydric soil criterion.* Visually estimate the percent areal cover of dominant species for the entire plant community. (*Note*: Dominant species are the most abundant species in each stratum, see p. 9.) If dominant species are not obvious, use one of the other onsite methods. Proceed to Step 8 or to another method, as appropriate.

Step 8. *Record the indicator status of dominant species within each area meeting the hydric soil criterion.* Indicator status is obtained from the interagency Federal list of plants occurring in wetlands for the appropriate geographic region. Record information on an appropriate data form. Proceed to Step 9.

Step 9. *Determine whether wetland is present or additional analysis is required.* If the estimated percent areal cover of OBL and FACW species exceeds that of FACU and UPL species, the area is considered wetland and the wetland-nonwetland boundary is the line delineated in Step 3. If not, then the point intercept or other sampling procedures should be performed to do a more rigorous analysis of site characteristics.

4.11. Plant Community Assessment Procedure

Step 1. *Scan the entire project area, if possible, or walk, if necessary, and identify plant community types present.* In identifying communities, pay particular attention to changes in elevation throughout the site. (*CAUTION*: In highly variable sites, such as ridge and swale complexes, be sure to stratify properly.) If possible, sketch the approximate location of each plant community on a base map, an aerial photograph of the project area, or a county soil survey map and label each community with an appropriate name. (*Note*: For large homogeneous wetlands, especially marshes dominated by herbaceous plants and shrub bogs dominated by low-growing shrubs, it is usually not necessary to walk the entire project area. In these cases, one can often see for long distances and many have organic mucky soils that can be extremely difficult to walk on. Forested areas, however, will usually require a walk through the entire project area.)

In examining the project area, are any significantly disturbed areas observed? If *YES*, identify their limits for they should be evaluated separately f wetland determination purpose (usually after evaluating undisturbed areas). Refer to the section on disturbed areas (p. 50) to evaluate the altered characteristic(s) (i.e., vegetation, soils, or hydrology); then return to this method to continue evaluating characteristics not altered. Keep in mind that if at any time during this determination one or more of these three characteristics are found to have been significantly altered, the disturbed area procedures should be followed. If the area is not significantly disturbed, proceed to Step 2.

Step 2. *Determine whether normal environmental conditions are present.* Determine whether normal environmental conditions are present for each plant community by considering the following:

1) Is the area presently lacking hydrophytic vegetation or hydrologic indicators due to annual, seasonal or long-term fluctuations in precipitation, surface water, or ground-water levels?

2) Are hydrophytic vegetation indicators lacking due to seasonal fluctuations in temperature (e.g., seasonality of plant growth)?

If the answer to either of these questions is *YES* or uncertain, proceed to the section on problem area wetland determinations (p. 55). If the answer to both questions is *NO*, normal conditions are assumed to be present, so proceed to Step 3.

Step 3. *Select representative observation area(s).* Select one or more representative observation areas within each community type. A representative observation area is one in which the apparent characteristics (determined visually) best represent characteristics of the entire community. Mark the approximate location of the observation areas on the base map or photo. Proceed to Step 4.

Step 4. *Characterize each plant community in the project area.* Within each plant community identified in Step 1, visually estimate the dominant plant species for each vegetative stratum in the representative observation areas and record them on an appropriate data form. Vegetative strata may include tree, sapling, shrub, herb, woody vine, and bryophyte strata (see glossary for definitions). A separate form must be completed for each plan community identified for wetland determination

purposes. (*Note*: Dominant species are those species in each stratum that, when ranked in decreasing order of abundance and cumulatively totaled, immediately exceed 50 percent of the total dominance measure for that stratum, plus any additional plant species comprising 20 percent or more of the total dominance measure for the stratum.) After identifying dominants within each vegetative stratum, proceed to Step 5.

Step 5. *Record the indicator status of dominant species in all strata.* Indicator status is obtained from the interagency Federal list of plants occurring in wetlands for the appropriate geographic region. Record indicator status for all dominant plant species on a data form. Proceed to Step 6.

Step 6. *Determine whether the hydrophytic vegetation criterion is met.* When more than 50 percent of the dominant species in each community type have an indicator status of OBL, FACW, and/or FAC, the vegetation is hydrophytic. Complete the vegetation section of the data form. Portions of the project area failing this test are usually not wetlands, although under certain circumstances they may have hydrophytic vegetation (follow the problem area wetland determination procedures on p. 55). If hydrophytic vegetation is present, proceed to Step 7.

Step 7. *Determine whether soils must be characterized.* Examine vegetative data collected for each plant community (in Steps 5 and 6) and identify any plant community where: (1) all dominant species have an indicator status of OBL, or (2) all dominant species have an indicator status of OBL and FACW and the wetland boundary is abrupt. For these communities, hydric soils are assumed to be present and do not need to be examined; proceed to Step 9. Plant communities lacking the above characteristics must have soils examined; proceed to Step 8.

Step 8. *Determine whether the hydric soil criterion is met.* Locate the observation area on a county soil survey map, if possible, and determine the soil map unit delineation for the area. Using a soil auger, probe, or spade, make a hole at least 18 inches deep at the representative location in each plant community type. Examine soil characteristics and compare if possible to soil descriptions in the county soil survey report. If soil colors match those described for hydric soil, then record data and proceed to Step 9. If not, then check for hydric soil indicators below the A-horizon (surface layer) and within 18 inches for organic soils and for mineral soils with low permeability rates (<6.0 inches/hour), within 12 inches for coarse-textured (sandy) mineral soils with high permeability rates (≥6.0 inches/hour), and within 6 inches for somewhat poorly drained soils. (*Note*: If the A-horizon extends below the designated depth, look immediately below the A-horizon for signs of hydric soil.) Are hydric soil indicators present (see pp. 13-15)? If so, list indicators present on an appropriate data form and proceed to Step 9. If soil has been plowed or otherwise altered, which may have eliminated these indicators, proceed to the section on disturbed areas (p. 50). If field indicators are not present, but available information verifies that the hydric soil criterion is met, then the soil is hydric. Complete the soils section on the appropriate data sheet. (*CAUTION*: Become familiar with problematic hydric soils that do not possess good hydric field indicators, such as red parent material soils, some sandy soils, and some floodplain soils, so that these hydric soils are not misidentified as nonhydric soils; see the problem area wetlands discussion on p. 55.)

Step 9. *Determine whether the wetland hydrology criterion is met.* Examine the area of each plant community type for indicators of wetland hydrology (see pp. 17-19). The wetland hydrology criterion is met when:

1) one or more field indicators are present; or

2) available hydrologic records provide sufficient evidence; or

3) the plant community is dominated by OBL, FACW and/or FAC species or has a prevalence index of less than 3.0, and the area has not been hydrologically disturbed.

If the area is hydrologically disturbed, proceed to the section on disturbed areas (p. 50). Record observations and other evidence on the appropriate data form. Proceed to Step 10.

Step 10. *Make the wetland determination.* Examine data forms for each plant community identified in the project area. Each community meeting the hydrophytic vegetation, hydric soil, and wetland hydrology criteria is considered wetland. If all communities meet these three criteria,

then the entire project area is a wetland. If only a portion of the project area is wetland, then the wetland-nonwetland boundary must be established. Proceed to Step 11.

Step 11. *Determine the wetland-nonwetland boundary*. Where a base map or annotated photo was prepared, mark each plant community type on the map or photo with a "W" if wetland or an "N" if nonwetland. Combine all "W" types into a single mapping unit, if possible, and all "N" types into another mapping unit. On the map or photo, the wetland boundary will be represented by the interface of these mapping units. If flagging the boundary on the ground, the boundary is established by determining the location where hydrophytic vegetation and hydric soils give way to nonhydrophytic vegetation and nonhydric soils. This will often require sampling a few more holes to better define the limits of the hydric soils and thereby establish the limits of hydrophytic vegetation.

Intermediate-level Onsite Determination Method

4.12. On occasion, a more rigorous sampling method is required than the routine method to determine whether hydrophytic vegetation is present at a given site, especially where the boundary between wetland and nonwetland is gradual or indistinct. This circumstance requires more intensive sampling of vegetation and soils than presented in the routine determination method. This method also may be used for areas greater than five acres in size or other areas that are highly diverse in vegetation.

4.13. The intermediate-level onsite determination method has been developed to provide for more intensive vegetation sampling than the routine method. Two optional approaches are presented: (1) quadrat transect sampling procedure, and (2) vegetation unit sampling procedure. The former procedure involves establishing transects within the project area and sampling plant communities along the transect within sample quadrats, with soils and hydrology also assessed as needed in each sample plot. In contrast, the vegetation unit sampling procedure offers a different approach for analyzing the vegetation. First, vegetation units are designated in the project area and then a meander survey is conducted in each unit where visual estimates of percent areal coverage by plant species are made. Soil and hydrology observations also are made as necessary. Boundaries between wetland and nonwetland are established by examining the transitional gradient between them.

4.14. The following steps should be completed:

Step 1. *Locate the limits of the project area in the field and conduct a general reconnaissance of the area*. Previously the project boundary should have been determined on aerial photos or maps. Now appropriate ground reference points need to be located to insure that sampling will be conducted in the proper area. In examining the project area, were any significantly disturbed areas observed? If YES, identify their limits for they should be evaluated separately for wetland determination purposes (usually after evaluating undisturbed areas). Refer to the section on disturbed areas (p. 50) to evaluate the altered characteristic(s) (i.e., vegetation, soils, or hydrology); then return to this method to continue evaluating the characteristics not altered. Keep in mind that if at any time during this determination, one or more of these three characteristics is found to have been significantly altered, the disturbed areas procedures should be followed. If the area is not significantly disturbed, proceed with Step 2.

Step 2. *Decide how to analyze plant communities within the project area: (1) by selecting representative plant communities (vegetation units), or (2) by sampling along a transect*. Discrete vegetation units may be identified on aerial photographs, topographic and other maps, and/or by field inspection. These units will be evaluated for hydrophytic vegetation and also for hydric soils and wetland hydrology, as necessary. *If the vegetation unit approach is selected, proceed to Step 3*. An alternative approach is to establish transects for identifying plant communities, sampling vegetation and evaluating other criteria, as appropriate. *If the transect approach is chosen, proceed to Step 4*.

Step 3. *Identifying vegetation units for sampling*. Vegetation units are identified by examining aerial photographs, topographic maps, NWI maps, or other materials or, by direct field inspection. All of the different vegetation units present in the project area should be identified. The subject area should be traversed and different vegetation units specifically located prior to conducting the sampling.

Field inspection may refine previously identified vegetation units, as appropriate. It may be advisable to divide large vegetation units into subunits for independent analysis. (*CAUTION*: In highly variable terrain, such as ridge and swale complexes, be sure to stratify properly.) Decide which plant community to sample first and proceed to Step 7.

Step 4. *Establish a baseline for locating sampling transects.* Select as a baseline one project boundary or a conspicuous feature, such as road, in the project area. The baseline should be more or less parallel to the major watercourse through the area, if present, or perpendicular to the hydrologic gradient (see Figure 4). Determine the approximate baseline length. Proceed to Step 5.

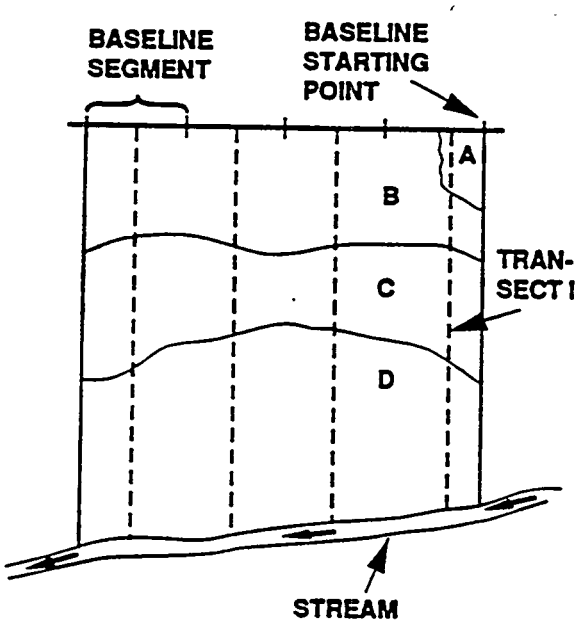

Figure 4. General orientation of baseline and transects (dashed lines) in a hypothetical project area. The letters "A", "B", "C" and "D" represent different plant communities. All transects start at the midpoint of a baseline segment except the first, which was repositioned to include community type A.

Step 5. *Determine the required number and position of transects.* Use the following to determine the required number and position of transects (specific site conditions may necessitate changes in intervals):

Divide the baseline length by the number of required transects to establish baseline segments for sampling. Establish one transect in each resulting baseline segment (see Figure 4). Use the midpoint of each baseline segment as a transect starting point. For example, if the baseline is 1,200 feet in length, three transects would be established: one at 200 feet, one at 600 feet, and one at 1,000 feet from the baseline starting point. *Make sure that all plant community types are included within the transects; this may necessitate relocation of one or more transect lines or establishing more transects.* Each transect should extend perpendicular to the baseline (see Figure 4). Once positions of transect lines are established, go to the beginning of the first transect and proceed to Step 6.

Baseline length	Number of Transects
Less than one mile	3
One mile to two miles	3-5
Two miles to four miles	5-8
Four miles or longer	8 or more*

*Transect intervals should not exceed 0.5 mile.

Step 6. *Locate sample plots along the transect.* Along each transect, sample plots are established within each plant community encountered to assess vegetation, soils, and hydrology. When identifying these sample plots, two approaches may be followed: (1) walk the entire length of the transect, taking note of the number, type, and location of plant communities present (flag the location, if necessary), and on the way back to the baseline, identify plots and perform sampling, or (2) identify plant communities as the transect is walked and sample the plot at that time ("sample as you go"). The sample plot should be located so it is representative of the plant community type. When the plant community type is large and covers a significant distance along the transect, select an area that is no closer than 300 feet to a perceptible change in plant community type; mark the center of this area on the base map or photo and flag the location in the field, if necessary. (*CAUTION*: In highly variable terrain, such as ridge and swale complexes, be sure to stratify properly to ensure best results.) At each plant community, proceed to Step 7.

Step 7. *Determine whether normal environmental conditions are present.* Determine whether normal environmental conditions are present by considering the following:

1) Is the area presently lacking hydrophytic vegetation or hydrologic indicators due to annual, seasonal, or long-term fluctuations in precipitation, surface water, or ground-water levels?

2) Are hydrophytic vegetation indicators lacking due to seasonal fluctuations in temperature (e.g., seasonality of plant growth)?

If the answer to either of these questions is *YES* or uncertain, proceed to the section on problem area wetland determinations (p. 55), then return to this method and continue the wetland determination. If the answer to both questions is *NO*, normal conditions are assumed to be present, so proceed to Step 8.

Step 8. *Characterize the vegetation of the vegetation unit or the plant community along the transect.*

If analyzing vegetation units, meander through the unit making visual estimates of the percent area covered for each species in the herb, shrub, sapling, woody vine, and tree strata; alternatively, for the tree stratum determine basal area using the Bitterlich method (Dilworth and Bell 1978; Avery and Burkhart 1983). Then:

1) Within each stratum determine and record the cover class of each species and its corresponding midpoint. The cover classes (and midpoints) are: T = <1% (none); 1 = 1-5% (3.0); 2 = 6-15% (10.5); 3 = 16-25% (20.5); 4 = 26-50% (38.0); 5 = 51-75% (63.0); 6 = 76-95% (85.5); 7 = 96-100% (98.0).

2) Rank the species within each stratum according to their midpoints. (*Note*: If two or more species have the same midpoints and the same or essentially the same recorded percent areal cover, rank them equal; use absolute areal cover values as a tie-breaker only if they are obviously different.)

3) Sum the midpoint values of all species within each stratum.

4) Multiply the total midpoint values for each stratum by 50 percent. (*Note*: This number represents the dominance threshold number and is used to determine dominant species.)

5) Compile the cumulative total of the ranked species in each stratum until 50 percent of the sum of the midpoints (i.e., the dominanc threshold number), for the herb, woody vine, shrub, sapling, and tree strata (or alternatively basal area for trees) is immediately exceeded. All species contributing areal cover or basal area to the 50 percent threshold are considered dominants, plus any additional species representing 20 percent or more of the total cover class midpoint values for each stratum or the basal area for tree stratum. (*Note*: If the threshold is reached by two or more equally ranked species, consider them all dominants, along with any higher ranked species. If all species are equally ranked, consider them all dominants.)

6) Record all dominant species on an appropriate data sheet and list indicator status of each. Proceed to Step 9.

If using the transect approach, sample vegetation in each stratum (e.g., tree, shrub, herb, etc.) occurring in the sample plots using the following quadrat sizes: (1) a 5-foot radius for bryophytes and herbs, and (2) a 30-foot radius for trees, saplings, shrubs, and woody vines. Plot size and shape may be changed as necessary to meet site conditions. Determine dominant species for each stratum by estimating one or more of the following as appropriate: (1) relative basal area (trees); (2) areal cover (trees, saplings, shrubs, herbs, woody vines, and bryophytes); or (3) stem density (shrubs, saplings, herbs, and woody vines). (*Note*: Dominant species within each stratum are the most abundant plant species that when ranked in descending order of abundance and cumulatively totaled immediately exceed 50 percent of the total dominance measure for the stratum, plus any additional species comprising 20 percent or more of the total dominance measure.) Record all dominant species on an appropriate data sheet and list the indicator status of each. Proceed to Step 9.

Step 9. *Determine whether the hydrophytic vegetation criterion is met.* When more than 50 percent of the dominant species in the vegetation unit or sample plot have an indicator status of OBL, FACW, and/or FAC, hydrophytic vegetation is present. If the vegetation fails to be dominated by these types of species, the unit or plot is usually not wetland. However, this vegetation unit or plot may constitute hydrophytic vegetation under certain circumstances (refer to the disturbed areas or problem area wetland determination sections on pp. 50-59). If hydrophytic vegetation is present, proceed

to Step 10 after completing the vegetation section of the data sheet.

Step 10. *Determine whether soils must be characterized.* Examine vegetative data collected for the vegetation unit or plot (in Steps 8 and 9) and identify any units or plots where: (1) all dominant species have an indicator status of OBL, or (2) all dominant species have an indicator status of OBL and FACW, and the wetland boundary is abrupt. For these units or plots, hydric soils are assumed to be present and do not need to be examined; proceed to Step 12. Vegetation units or plots lacking the above characteristics must have soils examined; proceed to Step 11.

Step 11. *Determine whether the hydric soil criterion is met.* Locate the sample plot or vegetation unit on a county soil survey map if possible, and determine the soil map unit delineation for the area. Using a soil auger, probe, or spade, make a hole at least 18 inches deep in the area. (*Note*: In applying the vegetation unit approach, one or more soil samples should be taken.) Examine soil characteristics in the sample plot or vegetative unit and if possible compare them to soil descriptions in the county soil survey report. If soil colors match those described for hydric soil in the report, then record data and proceed to Step 12. If not, then check for hydric soil indicators below the A-horizon (surface layer) and within 18 inches for organic soils and poorly and very poorly drained mineral soils with low permeability rates (<6.0 inches/hour), within 12 inches for poorly and very poorly drained, coarse-textured (sandy) mineral soils with high permeability rates (≥6.0 inches/hour), and within 6 inches for somewhat poorly drained soils. (*Note*: If the A-horizon extends below the designated depth, look immediately below the A-horizon for signs of hydric soil.) Are hydric soil indicators present (see pp. 13-15)? If so, list indicators present on data form and proceed to Step 12. If soil has been plowed or otherwise altered which may have eliminated these indicators, proceed to the section on disturbed areas (p. 50), then return to this method to continue the wetland determination. If field indicators are not present, but available information verifies that the hydric soil criterion is met, then the soil is hydric. Complete the soils section on an appropriate data sheet. Proceed to Step 12. (*CAUTION*: Become familiar with problematic hydric soils that do not possess good hydric field indicators, such as red parent material soils, some sandy soils, and some floodplain soils, so that these hydric soils are not misidentified as nonhydric soils; see the section on problem area wetlands, p.55.)

Step 12. *Determine whether the wetland hydrology criterion is met.* Examine the sample plot or vegetation unit for indicators of wetland hydrology (see pp. 17-19) and review available recorded hydrologic information. The wetland hydrology criteria is met when:

1) one or more field indicators are materially present; or

2) available hydrologic records provide necessary evidence; or

3) the plant community is dominated by OBL, FACW, and/or FAC species, *and* the area's hydrology is not significantly disturbed.

If the area's hydrology is significantly disturbed, proceed to the section on disturbed areas (p. 50). Record observations and other evidence on an appropriate data form. Proceed to Step 13.

Step 13. *Make the wetland determination for the plant community or vegetation unit.* Examine the data forms for the plant community (sample plot) or vegetation unit. When the community or unit meets the hydrophytic vegetation, hydric soil, and wetland hydrology criteria, the area is considered wetland. Complete the summary data sheet; proceed to Step 14 when continuing to sample the transect or other vegetation units, or to Step 15 when determining a boundary between wetland and nonwetland plant communities or units. (*Note*: Before going on, double check all data sheets to ensure that the forms are completed properly.)

Step 14. *Sample other plant communities along the transect or other vegetation units.* Repeat Steps 6 through 13 for all remaining plant communities along the transect if following transect approach, or repeat Steps 7 through 13 at the next vegetation unit. When sampling is completed for this transect, proceed to Step 15, or when sampling is completed for all vegetation units, proceed to Step 16.

Step 15. *Determine the wetland-nonwetland boundary point along the transect.* When the transect contains both wetland and nonwetland plant communities, then a boundary must be established.

Proceed along the transect from the wetland plot toward the nonwetland plot. Look for the occurrence of UPL species, the appearance of nonhydric soil types, subtle changes in hydrologic indicators, and/or slight changes in topography. When such features are noted, establish a new sample plot and repeat Steps 8 through 13. (*Note*: New data sheets must be completed for this new plot.) If this area is a nonwetland, move halfway back along the transect toward the last documented wetland plot and repeat Steps 8 through 13, varying plot size as appropriate. Continue this procedure until the wetland-nonwetland boundary point is found. It is not necessary to complete new data sheets for all intermediate points, but data sheets should be completed for each plot immediately adjacent to the wetland-nonwetland boundary point (i.e., data sheets for each side of the boundary). Mark the position of the wetland boundary point on the base map or photo and stake or flag the boundary in the field, as necessary. Continue along the transect until the boundary points between all wetland and nonwetland plots have been established. (*CAUTION*: In areas with a high interspersion of wetland and nonwetland plant communities, several boundary determinations will be required.) When all wetland determinations along this transect have been completed, proceed to Step 17.

Step 16. *Determine the wetland-nonwetland boundary between adjacent vegetation units.* Review all completed copies of the data sheets for each vegetation unit. Identify each unit as either wetland (W) or nonwetland (N). When adjacent vegetation units contain both wetland and nonwetland communities, a boundary must be established. Walk the interface between the two units from the wetland unit toward the nonwetland unit and look for changes in vegetation, soils, hydrologic indicators, and/or elevation. As a general rule, at 100-foot intervals or whenever changes in the vegetation unit's characteristics are noted, establish a new observation area and repeat Steps 8 through 13. (*Note*: New data sheets must be completed for this new area.) If this area is nonwetland, move back down the gradient about halfway back toward the wetland unit and make additional observations along the interface until wetland is identified. (*Note*: Soils often are more useful than vegetation in establishing the wetland-nonwetland boundary, particularly if there is no obvious vegetation break or when FAC plant species dominate two adjacent vegetation units.) At each designated boundary point, complete data sheets for areas immediately upslope and downslope of the wetland-nonwetlar boundary (i.e., one set for the wetland unit and one for the nonwetland unit), record the distance and compass directions between the boundary points and their respective pair of soil samples. Mark the position of the wetland boundary point on the base map or photo and stake or flag the boundary in the field, as necessary. Based on observations along the interface, identify a host of boundary points between each wetland unit and nonwetland unit. Repeat this step for all adjacent vegetation units of wetland and nonwetland. When wetland boundary points between all adjacent wetland and nonwetland units have been established, proceed to Step 18.

Step 17. *Sample other transects and make wetland determinations along each.* Repeat Steps 5 through 15 for each remaining transect. When wetland boundary points for all transects have been established, proceed to Step 18.

Step 18. *Determine the wetland-nonwetland boundary for the entire project area.* Examine all completed copies of the data sheets, and mark the location of each plant community type along the transect on the base map or photo, when used. (*Note*: This has already been done for the vegetation unit approach.) Identify each plant community as either wetland (W) or nonwetland (N), if it has not been done previously. If all plant communities are wetlands, then the entire project area is wetland. If all communities are nonwetlands, then the entire project area is nonwetland. If both wetlands and nonwetlands are present, identify the boundary points on the base map and connect these points on the map by generally following contour lines to separate wetlands from nonwetlands. Confirm this boundary by walking the contour lines between the transects or vegetation units, as appropriate. Should anomalies be encountered, it will be necessary to establish short transects in these areas to refine the boundary; make any necessary adjustments to the boundary on the base map and/or on the ground. It also may be worthwhile to flag these boundary points, especially when marking the boundary for subsequent surveying by engineers..

Comprehensive Onsite Determination Method

4.15. The comprehensive determination method is the most detailed, complex, and labor-intensive

approach of the three recommended types of onsite determinations. It is usually reserved for highly complicated and/or large project areas, and/or when the determination requires rigorous documentation. Due to the latter situation, this type of onsite determination may be used for areas of any size.

4.16. In applying this method, a team of experts, including a wetland ecologist and a qualified soil scientist, is often needed, especially when rigorous documentation of plants and soils are required. It is, possible, however, for a highly trained wetland boundary specialist to singly apply this method.

4.17. Two alternative approaches of the comprehensive onsite determination method are presented: (1) quadrat sampling procedure and (2) point intercept sampling procedure. The former approach establishes quadrats or sampling areas in the project site along transects, while the latter approach involves a frequency analysis of vegetation at sampling points along transects. The point intercept sampling procedure requires that the limits of hydric soils be established prior to evaluating the vegetation. In many cases, soil maps are available to meet this requirement, but in other cases a qualified soil scientist may need to inventory the soils before applying this method. The quadrat sampling procedure, which involves identifying plant communities along transects and analyzing vegetation, soils, and hydrology within sample plots (quadrats), may be the preferred approach when soil maps are unavailable or the individual is more familiar with plant identification.

Quadrat Sampling Procedure

4.18. Prior to implementing this determination procedure, read the sections of this manual that discuss disturbed area and problem area wetland determination procedures (pp. 50-59); this information is often relevant to project areas requiring a comprehensive determination.

Step 1. *Locate the limits of the project area in the field.* Previously, the project boundary should have been determined on aerial photos or maps. Now appropriate ground reference points need to be located to ensure that sampling will be conducted in the proper area. Proceed to Step 2.

Step 2. *Stratify the project area into different plant community types.* Delineate the locations of these types on aerial photos or base maps and label each community with an appropriate name. (*CAUTION*: In highly variable terrain, such as ridge and swale complexes, be sure to stratify properly to ensure best results.) In evaluating the subject area, were any significantly disturbed areas observed? If *YES*, identify their limits for they should be evaluated separately for wetland determination purposes (usually after evaluating undisturbed areas). Refer to the section on disturbed areas (p. 50) to evaluate the altered characteristic(s) (i.e., vegetation, soils, and/or hydrology); then return to this method to continue evaluating the characteristics not altered. Keep in mind that if at any time during this determination, it is found that one or more or these three characteristics have been significantly altered, the disturbed areas wetland determination procedures should be followed. If the area is not significantly disturbed, proceed to Step 3.

Step 3. *Establish a baseline for locating sampling transects.* Select as a baseline one project boundary or a conspicuous feature, such as a road, in the project area. The baseline ideally should be more or less parallel to the major watercourse through the area, if present, or perpendicular to the hydrologic gradient (see Figure 5). Determine the approximate baseline length and record its origin, length, and compass heading in a field notebook. When a limited number of transects are planned, a baseline may not be necessary provided there are sufficient fixed points (e.g., buildings, walls, and fences) to serve as starting points for the transects. Proceed to Step 4.

Step 4. *Determine the required number and position of transects.* The number of transects necessary to adequately characterize the site will vary due to the area's size and complexity of habitats. In general, it is best to divide the baseline into a number of equal segments and randomly select a point within each segment to begin a transect (see Figure 5).

Use the following as a guide to determine the appropriate number of baseline segments:

Baseline Length (ft)	Number of Segments	Baseline Segment (ft)
<1,000	3	18 – 333
≥1,000 – 5,000	5	200 – 1,000
≥5,000 – 10,000	7	700 – 1,400
>10,000*	variable	2,000

*If the baseline exceeds five miles, baseline segments should be 0.5 mile in length.

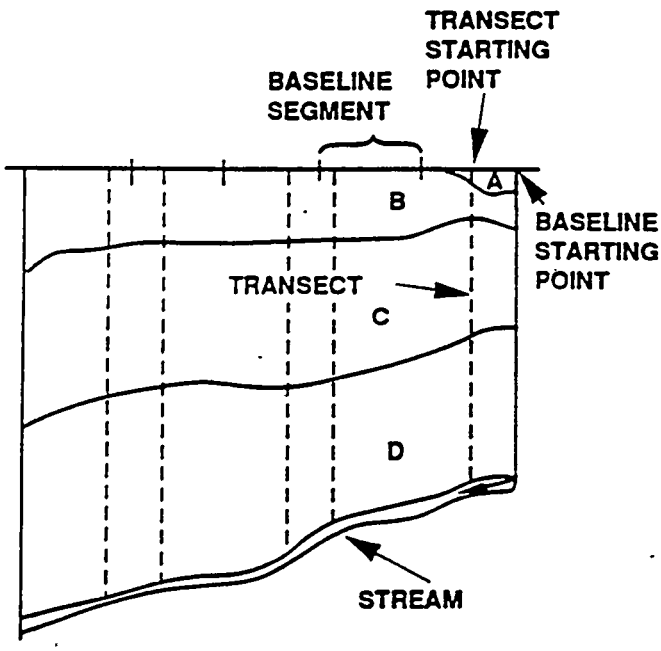

Figure 5. General orientation of baseline and transects in a hypothetical project area. The letters "A", "B", "C", and "D" represent different plant communities. Transect positions were determined using a random numbers table.

Use a random numbers table or a calculator with a random numbers generation feature to determine the position of a transect starting point within each baseline segment. For example, when the baseline is 4,000 feet, the number of baseline segments will be five, and each baseline segment length will be 800 feet (4,000/5). Locate the first transect within the first 800 feet of the baseline. If the random numbers table yields 264 as the distance from the baseline starting point, measure 264 feet from the baseline starting point and establish the starting point of the first transect. If the second random number selected is 530, the starting point of the second transect will be located at a distance of 1,330 feet (800 + 530) from the baseline starting point. Record the location of each transect in a field notebook. When a fixed point such as a stone wall is used as a starting point, be sure to record its position also. *Make sure that each plant community type is included in at least one transect; if not, modify the sampling design accordingly.* When the starting points for all required transects have been located, go to the beginning of the first transect and proceed to Step 5.

Step 5. *Identify sample plots along the transect.* Along each transect, sample plots may be established in two ways: (1) within each plant community encountered (*the plant community transect sampling approach*); or (2) at fixed intervals (*the fixed interval transect sampling approach*); these plots will be used to assess vegetation, soils, and hydrology.

When employing the plant community transect sampling approach, two techniques for identifying sample plots may be followed: (1) walk the entire length of the transect, taking note of the number, type, and location of plant communities present (flag the locations, if necessary) and on the way back to the baseline, record the length of the transect, identify sample plots and perform sampling; or (2) identify plant communities as the transect is walked, sample the plot at that time ("sample as you go"), and record the length of the transect.

When conducting the fixed interval transect sampling approach, establish sample plots along each transect using the following as a guide:

Transect Length (feet)	Number of Sample Plots	Interval Between the Center of Sample Plots (feet)
<1,000	<10	100
1,000 – <10,000	10	100 – 1,000 (based on length of transect)
≥10,000	>10	1,000

The first sample plot should be established at a distance of 50 feet from the baseline. When obvious nonwetlands occupy a long segment of the transect

from the baseline, begin the first plot in the nonwetland at approximately 300 feet from the point where the nonwetland begins to intergrade into a potential wetland community type. Keep in mind that additional plots will be required to determine the wetland-nonwetland boundary between fixed points. In large areas having a mosaic of plant communities, one transect may contain several wetland boundaries.

If obstacles such as a body of water or impenetrable thicket prevent access through the length of the transect, access from the opposite side of the project area may be necessary to complete the transect; take appropriate compass reading and location data. At each sample plot (i.e., plant community or fixed interval area), proceed to Step 6.

Step 6. *Determine whether normal environmental conditions are present.* Determine whether normal environmental conditions are present by considering the following:

1) Is the area presently lacking hydrophytic vegetation or hydrologic indicators due to annual, seasonal or long-term fluctuations in precipitation, surface water, or ground-water levels?

2) Are hydrophytic vegetation indicators lacking due to seasonal fluctuations in temperature (e.g., seasonality of plant growth)?

If the answer to either of these questions is *YES* or uncertain, proceed to the section on problem area wetland determinations (p. 55). If the answer to both questions is *NO*, normal conditions are assumed to be present. Proceed to Step 7 when following the plant community transect approach. If following the fixed interval approach, go to the appropriate fixed point along the transect and proceed to Step 8.

Step 7. *Locate a sample plot in the plant community type encountered.* Choose a representative location along the transect in this plant community. Select an area that is no closer than 50 feet from the baseline or from any perceptible change in the plant community type. Mark the center of the sample plot on the base map or photo and flag the point in the field. Additional sample plots should be established within the plant community at 300-foot intervals along the transect or sooner if a different plant community is encountered. (*Note*: In large-sized plant communities, a sampling interval larger than 300 feet may be appropriate, but try to use 300-foot intervals first.) Proceed to Step 8.

Step 8. *Lay out the boundary of the sample plot.* A circular sample plot with a 30-foot radius should be established. (*Note* The size and shape of the plot may be changed to match local conditions.) At the flagged center of the plot, use a compass to divide the circular plot into four equal sampling units at 90°, 180°, 270°, and 360°. Mark the outer points of the plot with flagging. Proceed to Step 9.

Step 9. *Characterize the vegetation and determine dominant species within the sample plot.* Sample the vegetation in each layer or stratum (i.e., tree, sapling, shrub, herb, woody vine, and bryophyte) within the plot using the following procedures for each vegetative stratum and enter data on appropriate data sheet (see Appendix B for examples of data sheet):

1) *Herb stratum*

A) Sample this stratum using corresponding approach:

(1) Plant community transect sampling approach:

(a) Select one of the following designs:

(i) Eight (8) - 8" x 20" sample quadrats (two for each sampling unit within the circular plot); or

(ii) Four (4) - 20" x 20" sample quadrats (one for each sample unit within the plot); or

(iii) Four (4) - 40" x 40" sample quadrats (one for each sample unit).

(*Note*: Alternate shapes of sample quadrats are acceptable provided they are similar in area to those listed above.)

(b) Randomly toss the quadrat frame into the understory of the appropriate sample unit of the plot.

(c) Record percent areal cover of each plant species.

(d) Repeat (b) and (c) as required by the sampling scheme.

(e) Construct a species area curve (see example, Appendix C) for the plot to determine whether the number of quadrats sampled sufficiently represent the vegetation in the stratum; the number of samples necessary corresponds to the point at which the curve levels off horizontally; if necessary, sample additional quadrats within the plot until the curve levels off.

(f) For each plant species sampled, determine the average percent areal cover by summing the percent areal cover for all sample quadrats within the plot and dividing by the total number of quadrats (see example, Appendix C). Proceed to substep B below.

(2) *Fixed interval sampling approach:*

(a) Place one (1) - 40" x 40" sample quadrat centered on the transect point.

(b) Determine percent areal coverage for each species. Proceed to substep B below.

B) Rank plant species by their average percent areal cover, beginning with the most abundant species.

C) Sum the percent cover (fixed interval sampling approach) or average percent cover (plant community transect sampling approach).

D) Determine the dominance threshold number - the number at which 50 percent of the total dominance measure (i.e., total cover) for the stratum is represented by one or more plant species when ranked in descending order of abundance (i.e., from most to least abundant).

E) Sum the cover values for the ranked plant species beginning with the most abundant until the dominance threshold number is immediately exceeded; these species contributing to surpassing the threshold number are considered dominants, *plus* any additional species representing 20 percent or more of the total cover of the stratum; denote dominant species with an asterisk on the appropriate data form.

F) Designate the indicator status of each dominant.

2) *Bryophyte stratum* (mosses, horned liverworts, and true liverworts): Bryophytes may be sampled as a separate stratum in certain wetlands, such as shrub bogs, moss-lichen wetlands, and the wetter wooded swamps, where they are abundant and represent an important component of the plant community. If treated as a separate stratum, follow the same procedures as listed for herb stratum. In many wetlands, however, bryophytes are not abundant and should be included as part of the herb stratum.

3) *Shrub stratum* (woody plants usually between 3 and 20 feet tall, including multi-stemmed, bushy shrubs and small trees below 20 feet):

A) Determine the percent areal cover of shrub species within the entire plot by walking through the plot, listing all shrub species and estimating the percent areal cover of each species.

B) Indicate the appropriate cover class (T and 1 through 7) and its corresponding midpoints (shown in parentheses) for each species: T = <1% cover (None); 1 = 1-5% (3.0); 2 = 6-15% (10.5); 3 = 16-25% (20.5); 4 = 26-50% (38.0); 5 = 51-75% (63.0); 6 = 76-95% (85.5); 7 = 96-100% (98.0).

C) Rank shrub species according to their midpoints, from highest to lowest midpoint;

D) Sum the midpoint values of all shrub species.

E) Determine the dominance threshold number - the number at which 50 percent of the total dominance measure (i.e., cover class midpoints) for the stratum is represented by one or more plant species when ranked in descending order of abundance (i.e., from most to least abundant).

F) Sum the midpoint values for the ranked shrub species, beginning with the most abundant, until the dominance threshold number is immediately exceeded; these species are considered dominants, *plus* any additional species representing 20 percent or more of the total midpoint values of the stratum; identify dominant species (e.g., with an asterisk) on the appropriate data form.

G) Designate the indicator status of each dominant.

4) *Sapling stratum* (young or small trees greater than or equal to 20 feet tall *and* with a diameter at breast height less than 5 inches): Follow the same procedures as listed for the shrub stratum or the tree stratum (i.e., plot sampling technique), whichever is preferred.

5) *Woody vine stratum* (climbing or twining woody plants): Follow the same procedures as listed for the shrub stratum.

6) *Tree stratum* (woody plants greater than or equal to 20 feet tall *and* with a diameter at breast height equal to or greater than 5 inches). Two alternative approaches are offered for characterizing the tree stratum:

A) *Plot sampling technique*

This technique involves establishing a sample unit within the 30-foot radius sample plot and determining the basal area of the trees by individual and by species. Basal area for individual trees can be measured directly by using a basal area tape or indirectly by measuring diameter at breast height (dbh) with a diameter tape and converting diameter to basal area using the formula $A = \pi d^2/4$ (where A = basal area, $\pi = 3.1416$, and d = dbh). This technique may be preferred to the plotless technique if only one person is performing a comprehensive determination.

The plot technique involves the following steps:

(1) Locate and mark, if necessary, a sample unit (plot) with a radius of 30 feet, or change the shape of the plot to match topography. (*Note*: A larger sampling unit may be required when trees are large and widely spaced.)

(2) Identify each tree, within the plot, measure its basal area (using a basal area tape) or measure its dbh (using a diameter tape) and compute its basal area, then record data on the data form.

(3) Calculate the total basal area for each tree species by summing the basal area values of all individual trees of each species.

(4) Rank species according to their total basal area, in descending order from largest basal area to lowest.

(5) Calculate the total basal area value of all trees in the plot by summing the total basal area for all species.

(6) Determine the dominant trees species; dominant species are those species (when ranked in descending order and cumulatively totaled) that immediately exceed 50 percent of the total basal area value for the plot, plus any additional species comprising 20 percent or more of the total basal area of the plot; record the dominant species on the appropriate data form.

(7) Designate the indicator status of each dominant (i.e., OBL, FACW, FAC, FACU, or UPL).

B) *Plotless Sampling Technique*

This technique involves determining basal area by using a basal area factor (BAF) prism (e.g., BAF 10 for the East) or an angle gauge to identify individual trees to measure diameter at breast height (dbh) or basal area. This approach is plotless in that trees within and beyond the 30-foot radius plot are recorded depending on their dbh and distance from the sampling point.

(1) Standing near the center of the 30-foot radius plot, hold the prism or angle gauge directly over the center of the plot at a constant distance from the eye and record all trees by species that are "sighted in," while rotating 360° in one direction. (*Note*: Trees with multiple trunks below 4.5 feet should be counted as two or more trees if all trunks are "sighted in." If trunks split above 4.5 feet, count as one tree if "sighted in." Sighting level should approximate 4.5 feet above the ground. With borderline trees, every other tree of a given species should be tallied.)

(2) Measure the dbh of all "sighted in" trees. (*Note:* This should be done as trees are sighted.)

(3) Compute basal area for each tree. (*Note*: When dbh was measured, apply the formula $A = \pi d^2/4$, where A = basal area, $\pi = 3.1416$, and d = dbh. To expedite this calculation, use a hand calculator into which the following conversion factor is

stored - 0.005454 for diameter data in inches or 0.78535 in feet. Basal area in square feet of an individual tree can be obtained by squaring the tree diameter and multiplying by the stored conversion factor.)

(4) Sum the basal areas for individual trees by species, then rank tree species by their total basal area values.

(5) Determine the dominance threshold number by summing the basal areas of all tree species (total basal area for the "plot") and multiplying by 50 percent.

(6) Sum the basal area values for the ranked tree species, beginning with the largest value, until the dominance threshold number is immediately exceeded; all species contributing to surpassing the threshold number are considered dominants, plus any species representing 20 percent or more of the total basal area for the "plot." (*Note*: If it is felt that a representative sample of the trees has not been obtained from one tally, additional tallies can be obtained by moving perpendicular from the center of the plot to another area.) Denote dominant species with an asterisk on the appropriate data form.

(7) Designate the indicator status of each dominant (i.e., OBL, FACW, FAC, FACU, or UPL).

After determining the dominants for each stratum, proceed to Step 10.

Step 10. *Determine whether the hydrophytic vegetation criterion is met.* When more than 50 percent of the dominant species in the sample plot have an indicator status of OBL, FACW, and/or FAC, hydrophytic vegetation is present. Complete the vegetation section of the summary data sheet. If the vegetation fails to be dominated by these types of species, the plot is usually not a wetland, however, it may constitute hydrophytic vegetation under certain circumstances (see the problem area wetland discussion, p. 55). If hydrophytic vegetation is present, proceed to Step 11.

Step 11. *Determine whether the hydric soil criterion is met.* Locate the sample plot on a county soil survey map, if possible, and determine the soil map unit delineation for the plot. Using a soil auger, probe, or spade, make a soil hole at least 18 inches deep (2-3 feet to best characterize most soils) in the sample plot. Examine the soil characteristics and compare if possible to soil descriptions in the soil survey report. If soil colors match those described for hydric soil in the report, then record data and proceed to Step 12. If not, then check for hydric soil indicators below the A-horizon (surface layer) and within 18 inches for organic soils and poorly drained and very poorly drained mineral soils with low permeability rates (<6.0 inches/hour), within 12 inches for coarse-textured poorly drained and very poorly drained mineral soils with high permeability rates (≥6.0 inches/hour) and within 6 inches for somewhat poorly drained soils. (*Note*: If the A-horizon extends below the designated depth, look immediately below the A-horizon for signs of hydric soil.) If hydric soil indicators are present (see pp. 13-15), list indicators present on data form and proceed to Step 12. If the soil has been plowed or otherwise altered, which may have eliminated these indicators, proceed to the section on disturbed areas (p. 50). If field indicators are not present, but available information verifies that the hydric soil criterion is met, then the soil is hydric.

Complete the soils section on an appropriate data sheet. (*CAUTION*: Become familiar with problematic hydric soils that do not possess good hydric field indicators, such as red parent material soils, some sandy soils, and some floodplain soils, so that these hydric soils are not misidentified as nonhydric soils; see the section on problem area wetlands, p. 55.)

Step 12. *Determine whether the wetland hydrology criterion is met.* Examine the sample plot for indicators of wetland hydrology (see pp. 17-19) and review available recorded hydrologic information. If one or more indicators of wetland hydrology are materially present in the plot, then the wetland hydrology criterion is met. Available hydrologic data may also verify this criterion. Record observations on the appropriate data form and proceed to Step 13. If no such indicators or evidence exist, then wetland hydrology does not occur at the plot; complete the hydrology section on the data sheet.

Step 13. *Make the wetland determination for the sample plot.* Examine the data forms for the plot. When the plot meets the hydrophytic vegetation, hydric soil, and wetland hydrology criteria, it is considered wetland. Complete the summary data sheet; proceed to Step 14 when continuing to sam-

ple transects, or to Step 15 when determining a boundary between wetland and nonwetland sample plots. (*Note*: Double check all data sheets to ensure that they are completed properly before going to another plot.)

Step 14. *Take other samples along the transect.* Repeat Steps 5 through 13, as appropriate. When sampling is completed for this transect proceed to Step 15.

Step 15. *Determine the wetland-nonwetland boundary point along the transect.* When the transect contains both wetland and nonwetland plots, then a boundary must be established. Proceed along the transect from the wetland plot toward the nonwetland plot. Look for the occurrence of upland species, the appearance of nonhydric soil types, subtle changes in hydrologic indicators, and/or slight changes in topography. When such features are noted, establish a new sample plot and repeat Steps 8 through 12. (*Note*: New data sheets must be completed for this new sample plot.) If this area is a nonwetland, move halfway back along the transect toward the last documented wetland plot and repeat Steps 8 through 12, varying plot size as appropriate. (*Note*: Soils generally are more useful than vegetation in establishing the wetland-nonwetland boundary, particularly if there is no evident vegetation break or when FAC species dominate two adjacent areas.) Continue this procedure until the wetland-nonwetland boundary point is found. It is not necessary to complete new data sheets for all intermediate points, but data sheets should be completed for each plot immediately adjacent to the wetland-nonwetland boundary point (i.e., one set for each side of the boundary). Mark the position of the wetland boundary point on the base map or photo and place a surveyor flag or stake at the boundary point in the field, as necessary. Continue along the transect until the boundary points between all wetland and nonwetland plots have been established. (*CAUTION*: In areas with a high interspersion of wetland and nonwetland plant communities, several boundary determinations will be required.) When all wetland determinations along this transect have been completed, proceed to Step 16.

Step 16. *Sample other transects and make wetland determinations along each.* Repeat Steps 5 through 15 for each remaining transect. When wetland boundary points for all transects have been established, proceed to Step 17.

Step 17. *Determine the wetland-nonwetland boundary for the entire project area.* Examine all completed copies of the data sheets and mark the location of each plot on the base map or photo. Identify each plot as either wetland (W) or nonwetland (N) on the map or photo. If all plots are wetlands, then the entire project area is wetland. If all plots are nonwetlands, then the entire project area is nonwetland. If both wetland and nonwetland plots are present, identify the boundary points on the base map or on the ground, and connect these points on the map by generally following contour lines to separate wetlands from nonwetlands. Confirm this boundary on the ground by walking the contour lines between the transects. Should anomalies be encountered, it will be necessary to establish short transects in these areas to refine the boundary, apply Step 15, and make any necessary adjustments to the boundary on the base map and/or on the ground. It may be worthwhile to place surveyor flags or stakes at these boundary points, especially when marking the boundary for subsequent surveying by engineers.

Point Intercept Sampling Procedure

4.19. The point intercept sampling procedure is a frequency analysis of vegetation used in areas that may meet the hydric soil and wetland hydrology criteria (see Part II, p. 5). It involves first identifying areas that may meet the hydric soil and wetland hydrology criteria within the area of concern and then refining the boundaries of areas that meet the hydric soil criterion. Transects are then established for analyzing vegetation and determining the presence of hydrophytic vegetation by calculating a prevalence index. Sample worksheets and a sample problem using this method are presented in Appendices B and D, respectively.

Step 1. *Identify the approximate limits of areas that may meet the hydric soil criterion within the area of concern and sketch limits on an aerial photograph.* To help identify these limits use sources of information such as Agricultural Stabilization and Conservation Service slides, soil surveys, NWI maps, and other maps and photographs. (*Note*: This step is more convenient to perform offsite, but may be done onsite.) Proceed to Step 2.

Step 2. *Scan the areas that may meet the hydric soil criterion and determine if disturbed conditions exist.* Are any significantly disturbed areas present? If *YES*, identify their limits for they should be evaluated separately for wetland determination purposes (usually after evaluating undisturbed areas). Refer to the section on disturbed areas (p. 50), if necessary, to evaluate the altered characteristic(s) (vegetation, soils, or hydrology), then return to this method and continue evaluating characteristics not altered. (*Note*: Prior experience with disturbed sites may allow one to easily evaluate an altered characteristic, such as when vegetation is not present in a farmed wetland due to cultivation.) Keep in mind that if at any time during this determination one or more of these three characteristics is found to have been significantly altered, the disturbed area wetland determination procedures should be followed. If the area is not significantly disturbed, proceed to Step 3.

Step 3. *Scan the areas that may meet the hydric soil criterion and determine if obvious signs of wetland hydrology are present.* The wetland hydrology criterion is met for any area or portion thereof where, it is obvious or known that the area is frequently inundated or saturated to the surface during the growing season. If the above condition exists, the hydric soil criterion is met for the subject area and the area is considered wetland. If necessary, confirm the presence of hydric soil by examining the soil for appropriate field indicators. (*Note*: Hydrophytic vegetation is assumed to be present under these conditions, i.e., undrained hydric soil, so vegetation does not need to be examined. Moreover, hydrophytic vegetation should be obvious in these situations.) Areas lacking obvious indicators of wetland hydrology must be further examined, so proceed to Step 4.

Step 4. *Refine the boundary of areas that meet the hydric soil criterion.* Verify the presence of hydric soil within the appropriate map units by digging a number of holes at least 18 inches deep along the boundary (interface) between hydric soil units and nonhydric soil units. Compare soil samples with descriptions in the soil survey report to see if they are properly mapped, and look for hydric soil characteristics or indicators. In this way, the boundary of areas meeting the hydric soil criterion is further refined by field observations. In map units where only part of the unit is hydric (e.g., complexes, associations, and inclusions), locate hydric soil areas on the ground by considering landscape position and evaluating soil characteristics for hydric soil properties (indicators). (*Note*: Some hydric soils, especially organic soils, have not been given a series name and are referred to by common names, such as peat, muck, swamp, marsh, wet alluvial land, tidal marsh, sulfaquents, and sulfihemists. These areas are also considered hydric soil map units. Certain hydric soils are mapped with nonhydric soils as an association or complex, while other hydric soils occur as inclusions in nonhydric soil map units. Only the hydric soil portion of these map units should be evaluated for hydrophytic vegetation.) In areas where hydric soils are not easily located by landscape position and soil characteristics (morphology), a qualified soil scientist should be consulted. (*CAUTION*: Become familiar with problematic hydric soils that do not possess good hydric field indicators, such as red parent material soils, some sandy soils, and some floodplains soils, so that these hydric soils are not misidentified as nonhydric soils, see section on problem area wetlands, p. 55.) (*Note*: If the project area does not have a soil map, hydric soil areas must be determined in the field to use the point intercept sampling method. Consider landscape position, such as depressions, drainageways floodplains and seepage slopes, and look for field indicators of hydric soil, then delineate the hydric soil areas accordingly. If the boundary of the hydric soil area cannot be readily delineated, one should use the quadrat sampling procedure on p. 40.)

After establishing the boundary of the area in question, proceed to Step 5.

Step 5. *Determine whether normal environmental conditions are present.* Determine whether normal environmental conditions are present by considering the following:

1) Is the area presently lacking hydrophytic vegetation or hydrologic indicators due to annual, seasonal, or long-term fluctuations in precipitation, surface water, or ground water levels?

2) Are hydrophytic vegetation indicators lacking due to seasonal fluctuations in temperature (e.g., seasonality of plant growth)?

If the answer to either of these questions is *YES* or uncertain, proceed to the section on problem area wetland determinations (p. 55). If the answer to

both questions is *NO*, normal conditions are assumed to be present. Proceed to Step 6.

Step 6. *Determine random starting points and random directions for three 200-foot line transects in each area that meets or may meet the hydric soil criterion.* (*Note*: More than three transects may be required depending on the standard error obtained for the three transects.) There are many ways to determine random starting points and random transect direction. The following procedures are suggested:

1) *Starting point* – Superimpose a grid over an aerial photo or map of the study area. Assign numbers (1, 2, 3 ...N) to each vertical and horizontal line on the grid. Starting points for a transect are selected by using a table for generating random numbers or other suitable method. The first selected d[illegible] represents a line on the horizontal axis; the se[illegible] vertical axis. The intersection of the two lines establishes a starting point.

2) *Transect direction* – At a starting point, spin a pencil or similar pointed object in the air and let it fall to the ground. The direction that the pencil is pointing indicates the direction of the transect. Proceed to Step 7.

Step 7. *Lay out the transect in the established direction.* If the transect crosses the hydric soil boundary (into the nonhydric soil area), bend the line back into the hydric soil area by randomly selecting a new direction for the transect following the procedure suggested above. Mark the approximate location of the transect on a base map or aerial photo. Proceed to Step 8.

Step 8. *Record plant data (e.g., species name, indicator group, and number of occurrences) at interval points along the transect.* At the starting point and at each point on 2-foot intervals along the transect, record all plants that would intersect an imaginary vertical line extending through the point. If this line has no plants intersecting it (either above or below the sample point), record nothing.

Identify each plant observed to species (or other taxonomic category if species cannot be identified), enter species name on the Prevalence Index Worksheet, and record all occurrences of each species along the transect. For each species listed, identify its indicator group from the appropriate regional list of plant species that occur in wetlands (i.e., OBL, FACW, FAC, FACU, and UPL; see p. 5). Plant species not recorded on the lists are assumed to be upland species. If no regional indicator status and only one national indicator status is assigned, apply the national indicator status to the species. If no regional indicator status is assigned and more than one national indicator status is assigned, do not use the species to calculate a prevalence index. If the plant species is on the list and no regional or national indicator status is assigned, do not use the species to calculate the prevalence index. *For a transect to be valid for a prevalence calculation, at least 80 percent of the occurrences must be plants that have been identified and placed in an indicator group.* Get help in plant identification if necessary. (*Note*: Unidentified plants or plants without indicator status are recorded but are not used to calculate the prevalence index.) Proceed to Step 9.

Step 9. *Calculate the total frequency of occurrences for each species (or other taxonomic category), for each indicator group of plants, and for all plant species observed, and enter on the Prevalence Index Worksheet.* The frequency of occurrences of a plant species equals the number of times it occurs at the sampling points along the transect. Proceed to Step 10.

Step 10. *Calculate the prevalence index for the transect using the following formula:*

$$PI_i = \frac{F_o + 2F_{fw} + 3F_f + 4F_{fu} + 5F_u}{F_o + F_{fw} + F_f + F_{fu} + F_u}$$

where

PI_i = Prevalence Index for transect i;
F_o = Frequency of occurrence of obligate wetland species;
F_{fw} = Frequency of occurrence of facultative wetland species;
F_f = Frequency of occurrence of facultative species;
F_{fu} = Frequency of occurrence of facultative upland species;
F_u = Frequency of occurrence of upland species.

After calculating and recording the prevalence index for this transect, proceed to Step 11.

Step 11. *Repeat Steps 5 through 10 for two other transects.* After completing the three transects, proceed to Step 12.

Step 12. *Calculate a mean prevalence index for the three transects.* To be considered wetland, a hydric soil area usually must have a mean prevalence index (PI_M) of less than 3.0. A minimum of three transects are required in each delineated area of hydric soil, but enough transects are required so that the standard error for PI_M does not exceed 0.20 percent.

Compute the mean prevalence index for the three transects by using the following formula:

$$PI_M = \frac{PI_T}{N}$$

where

PI_M = mean prevalence index for transects;
PI_T = sum of prevalence index values for all transects;
N = total number of transects.

After computing the mean prevalence index for the three transects, proceed to Step 13.

Step 13. *Calculate the standard deviation (s) for the prevalence index* using the following formula:

$$s = \sqrt{\frac{(PI_1-PI_M)^2 + (PI_2-PI_M)^2 + (PI_3-PI_M)^2}{N-1}}$$

(*Note*: See formulas in Steps 8 and 10 for symbol definitions.)

After performing this calculation, proceed to Step 14.

Step 14. *Calculate the standard error ($s\bar{x}$) of the mean prevalence index using the following formula:*

$$s\bar{x} = \frac{s}{N}$$

where

s = standard deviation for the Prevalence Index
N = total number of transects

(*Note*: The $s\bar{x}$ cannot exceed 0.20. If $s\bar{x}$ exceeds 0.20, one or more additional transects are required. Repeat Steps 6 through 14, as necessary, for each additional transect.) When $s\bar{x}$ for all transects does not exceed 0.20, proceed to Step 15.

Step 15. *Record final mean prevalence index value for each hydric soil map unit and make a wetland determination.* All areas having a mean prevalence index of less than 3.0 meet the hydrophytic vegetation criterion (see p. 5). One should also look for evidence or field indicators of wetland hydrology, especially if there is some question as to whether the wetland hydrology criterion is met. If such evidence or indicators are present or the area's hydrology has not been disturbed, then the area is considered a wetland. If the area has been hydrologically disturbed, one must determine whether the area is effectively drained before making a wetland determination (see disturbed area discussion, p. 50). If the area is effectively drained, it is considered nonwetland; if it is not, the wetland hydrology criterion is met and the area is considered a wetland.

Areas where the prevalence index value is greater than or equal to 3.0 (especially greater than 3.5) are usually not wetlands, but can, on occasion, be wetlands. These exceptions are disturbed or problem area wetlands (see discussion on pp. 50-59) and further evaluation of wetland hydrology must be undertaken. When the prevalence index falls between 3.0 and 3.5 (inclusive) in the absence of significant hydrologic modification, the area is presumed to meet the wetland hydrology criterion and is, therefore, wetland; the plant community is considered hydrophytic vegetation since the plants are growing in an undrained hydric soil. If the prevalence index of the plant community is greater than 3.5, stronger evidence of wetland hydrology is required to make a wetland determination. Walk through the area of concern and look for field indicators of wetland hydrology. If field observations, aerial photographs or other reliable sources provide direct evidence of inundation or soil saturation within 6, 12, or 18 inches depending on soil permeability and drainage class for one week or more during the growing season, or if oxidized

channels (rhizospheres) are present around living roots and rhizomes of any plants, or if water-stained leaves caused by inundation are present, then these areas are considered to meet the wetland hydrology criteria and are wetlands. If direct evidence or these field indicators are not present, then one must use best professional judgement to make the wetland determination. In doing so, one should review the problem area wetland discussion (p. 55), consider other hydrologic indicators that may be present (see pp. 17-19), and perhaps even consult with a wetland expert to assist in the determination.

Disturbed Area and Problem Area Wetland Determination Procedures

4.20. In the course of field investigations, one will undoubtedly encounter significantly disturbed or altered areas, or natural areas where making a wetland determination is not easy. Disturbed areas include situations where field indicators of one or more of the three wetland identification criteria are obliterated or not present due to recent change. In contrast, there are other wetlands that, under natural conditions, are simply difficult to identify, such as wetlands dominated by FACU species, wetlands lacking field indicators for one or more of the technical criteria for wetlands, and wetlands occurring on difficult to identify hydric soils. These wetlands are considered problem area wetlands. The following sections discuss these difficult, confounding situations and present procedures for distinguishing wetlands from nonwetlands.

Disturbed Areas

4.21. Disturbed areas have been altered either recently or in the past in some way that makes wetland identification more difficult than it would be in the absence of such changes. Disturbed areas include both wetlands and nonwetlands that have been modified to varying degrees by human activities (e.g., filling, excavation, clearing, damming, and building construction) or by natural events (e.g., avalanches, mudslides, fire, volcanic deposition, and beaver dams). Such activities and events change the character of the area often making it difficult to identify field characteristics of one or more of the wetland identification criteria (i.e., hydrophytic vegetation, hydric soils, and wetland hydrology). Disturbed wetlands include areas subjected to deposition of fill or dredged material, removal or other alteration of vegetation, conversion to agricultural land and silviculture plantations, and construction of levees, channelization and drainage systems, and/or dams (e.g., reservoirs and beaver dams) that significantly modify an area's hydrology. In cases where recent human activities have caused these changes, it may be necessary to determine the date of the alteration or conversion for legal purposes. (*Note*: If the activity occurred prior to the effective date of regulation or other jurisdiction, it may not be necessary to make a wetland determination for regulatory purposes.) In considering the effects of natural events (e.g., a wetland buried by a mudslide), the relative permanence of the change and whether the area is still functioning as a wetland must be considered.

4.22. In disturbed wetlands, field indicators for one or more of the three technical criteria for wetland identification are usually absent. It may be necessary to determine whether the "missing" indicator(s) (especially wetland hydrology) existed prior to alteration. To do this requires review of aerial photographs, existing maps, and other available information about the site, and may involve evaluating a nearby reference site (similar to the original character of the one altered) for indicator(s) of the "altered" characteristic.

4.23. When a significantly disturbed condition is detected during an onsite determination, the following steps should be taken to determine if the "missing" indicator(s) was present before alteration and whether the criterion in question was originally met. Be sure to record findings on the appropriate data form. After completing the necessary steps below, return to the applicable step of the onsite determination method being used and continue evaluating the site's characteristics.

Step 1. *Determine whether vegetation, soils, and/or hydrology have been significantly altered at the site.* Proceed to Step 2.

Step 2. *Determine whether the "altered" characteristic met the wetland criterion in question prior to site alteration.* Review existing information for the area (e.g., aerial photos, NWI maps, soil surveys, hydrologic data, and previous site inspection reports) contact knowledgeable persons familiar with the area, and conduct an onsite inspection to build supportive evidence. The strongest evidence involves considering all of the above *plus* evaluating a nearby reference site (an area similar to the

one altered before modification) for field indicators of the three technical criteria for wetland. If a human activity or natural event altered the vegetation, proceed to Step 3; the soils, proceed to Step 4; the hydrology, proceed to Step 5.

Step 3. *Determine whether hydrophytic vegetation previously occurred:*

1) *Describe the type of alteration.* Examine the area and describe the type of alteration that occurred. Look for evidence of selective harvesting, clearcutting, bulldozing, recent conversion to agriculture, or other activities (e.g., burning, discing, the presence of buildings, dams, levees, roads, and parking lots).

2) *Determine the approximate date when the alteration occurred if necessary.* Check aerial photographs, examine building permits, consult with local individuals, and review other possible sources of information.

3) *Describe the effects on the vegetation.* Generally describe how the recent activities and events have affected the plant communities. Consider the following:

A) Has all or a portion of the area been cleared of vegetation?

B) Has only one layer of the plant community (e.g., trees) been removed?

C) Has selective harvesting resulted in the removal of some species?

D) Has the vegetation been burned, mowed, or heavily grazed?

E) Has the vegetation been covered by fill, dredged material, or structures?

F) Have increased water levels resulted in the death of all or some of the vegetation?

4) *Determine whether the area had hydrophytic vegetation communities.* Develop a list of species that previously occurred at the site from existing information, if possible, and determine presence of hydrophytic vegetation. If site-specific data do not exist, evaluate a neighboring undisturbed area (reference site) with characteristics (i.e., vegetation, soils, hydrology, and topography) similar to the area in question prior to its alteration. Be sure to record the location and major characteristics (vegetation, soils, hydrology, and topography) of the reference site. Sample the vegetation in this reference area using an appropriate onsite determination method to determine whether hydrophytic vegetation is present. If hydrophytic vegetation is present at the reference site, then hydrophytic vegetation is presumed to have existed in the altered area. If no indicators of hydrophytic vegetation are found at the reference site, then the original vegetation at the project area is not considered hydrophytic vegetation. If soils and/or hydrology also have been disturbed, then continue Steps 4, 5, and 6 below, as necessary. Otherwise, return to the applicable step of the onsite determination method being used.

Step 4. *Determine whether or not hydric soils previously occurred:*

1) *Describe the type of alteration.* Examine the area and describe the type of alteration that occurred. Look for evidence of:

A) *deposition of dredged or fill material or natural sedimentation* - In many cases the presence of fill material will be obvious. If so, it will be necessary to dig a hole to reach the original soil (sometimes several feet deep). Fill material will usually be a different color or texture than the original soil (except when fill material has been obtained from similar areas onsite). Look for decomposing vegetation between soil layers and the presence of buried organic or hydric mineral soil layers. In accreting or recently formed sandbars in riverine situations, the soils may support hydrophytic vegetation but lack hydric soil indicators.

B) *presence of nonwoody debris at the surface* - This can only be applied in areas where the original soils do not contain rocks. Nonwoody debris includes items such as rocks, bricks, and concrete fragments.

C) *subsurface plowing* - Has the area recently been plowed below the A-horizon or to depths of greater than 10 inches?

D) *removal of surface layers* - Has the surface soil layer been removed by scraping or natural landslides? Look for bare soil surfaces with exposed plant roots or scrape scars on the surface.

E) *presence of manmade structures* - Are buildings, dams, levees, roads, or parking lots present?

2) *Determine the approximate date when the alteration occurred, if necessary.* Check aerial photographs, examine building permits, consult with local individuals, and review other possible sources of information.

3) *Describe the effects on soils.* Consider the following:

A) Has the soil been buried? If so, record the depth of fill material and determine whether the original soil was left intact or disturbed. (*Note*: The presence of a typical sequence of soil horizons or layers in the buried soil is an indication that the soil is still intact; check description in the soil survey report.)

B) Has the soil been mixed at a depth below the A-horizon or greater than 10 inches? If so, it will be necessary to examine the soil at a depth immediately below the plow layer or disturbed zone.

C) Has the soil been sufficiently altered to change the soil phase? Describe these changes. If a hydric soil has been drained to some extent, refer to Step 5 below to determine whether soil is effectively drained or is still hydric.

4) *Characterize the soils that previously existed at the disturbed site.* Obtain all possible evidence that may be used to characterize soils that previously occurred on the area. Consider the following potential sources of information:

A) *soil surveys* - In many cases, recent soil surveys are available. If so, determine the soils that were mapped for the area. If all soils are hydric soils, it is presumed that the entire area had hydric soils prior to alteration.

B) *buried soils* - When fill material has been placed over the original soil without physically disturbing the soil, examine and characterize the buried soils. Dig a hole through the fill material until the original soil is encountered. Determine the point at which the original soil material begins. Remove 18 inches of the original soil from the hole and look for indicators of hydric soils immediately below the A-horizon and within 6-18 inches (depending on soil permeability and drainage class). Be sure to record the color of the soil matrix, presence of an organic layer, presence of mottles or gleying, and/or presence of iron and manganese concretions. (*Note*: When the fill material is a thick layer, it might be necessary to use a backhoe or posthole digger to excavate the soil pit.) If USGS topographic maps indicate distinct variation in the area's topography, this procedure must be applied in each portion of the area that originally had a different surface elevation.

C) *plowed soils* - Determine the depth to which the soil has been disturbed by plowing. Look for hydric soil characteristics immediately below this depth.

D) *removed surface layers* - Dig a hole 18 inches deep and determine whether the entire surface layer (A-horizon) has been removed. If so, examine the soil immediately below the top of the subsurface layer (B-horizon) for hydric soil characteristics. As an alternative, examine an undisturbed soil of the same soil series occurring at the same topographic position in an immediately adjacent undisturbed reference area. Look for hydric soil indicators immediately below the A-horizon and within 18 inches of the surface. Record and use these data to determine the presence of hydric soils in substep 5 below.

5) *Determine whether hydric soils were present at the project area prior to alteration.* Examine the available data and determine whether indicators of hydric soils were formerly present. If no indicators and/or evidence of hydric soils are found, the original soils are considered nonhydric soils. If indicators and/or evidence of hydric soils are found the hydric soil criterion has been met. Continue to Step 5 if hydrology also was altered. Otherwise, record decision and return to the applicable step of the onsite determination method being used.

Step 5. *Determine whether wetland hydrology existed prior to alteration or whether wetland hydrology still exists (i.e., is the area effectively drained?).* To determine whether wetland hydrology still occurs, proceed to Step 6. To determine whether wetland hydrology existed prior to the alteration:

1) *Describe the type of alteration.* Examine the area and describe the type of alteration that occurred. Look for evidence of:

A) *dams* - Has recent construction of a dam or some natural event (e.g., beaver activity or landslide) caused the area to become increasingly wetter or drier? (*Note*: This activity could have occurred at a considerable distance from the site in question, so be aware of and consider the impacts of major dams in the watershed above the project area.)

B) *levees, dikes, and similar structures* - Have levees or dikes been recently constructed that prevent the area from periodic overbank flooding?

C) *ditches* - Have ditches been recently constructed causing the area to drain more rapidly?

D) *channelization* - Have feeder streams recently been channelized sufficiently to alter the frequency and/or duration of inundation?

E) *filling of channels and/or depressions (land-leveling)* - Have natural channels or depressions been recently filled?

F) *diversion of water* - Has an upstream drainage pattern been altered that results in water being diverted from the area?

G) *groundwater withdrawal* - Has prolonged and intensive pumping of groundwater for irrigation or other purposes significantly lowered the water table and/or altered drainage patterns?

2) *Determine the approximate date when the alteration occurred, if necessary.* Check aerial photographs, consult with local individuals, and review other possible sources of information.

3) *Describe the effects of the alteration on the area's hydrology.* Consider the following and generally describe how the observed alteration affected the project area:

A) Is the area more frequently or less frequently inundated than prior to alteration? To what degree and why?

B) Is the duration of inundation and soil saturation different than prior to alteration? How much different and why?

4) *Characterize the hydrology that previously existed at the area.* Obtain and record all possible evidence that may be useful for characterizing the previous hydrology. Consider the following:

A) *stream or tidal gauge data* - If a stream or tidal gauging station is located near the area, it may be possible to calculate elevations representing the upper limit of wetland hydrology based on duration of inundation. Consult SCS district offices, hydrologists from the local CE district offices or other agencies for assistance. If fill material has not been placed on the area, survey this elevation from the nearest USGS benchmark. If fill material has been placed on the area, compare the calculated elevation with elevations shown on a USGS topographic map or any other survey map that predates site alteration.

B) *field hydrologic indicators onsite or in a neighboring reference area* - Certain field indicators of wetland hydrology may still be present. Look for water marks on trees or other structures, drift lines, and debris deposits (see pp. 17-19 for additional hydrology indicators). If adjacent undisturbed areas are in the same topographic position, have the same soils (check soil survey map), and are similarly influenced by the same sources of inundation, look for wetland hydrology indicators in these areas.

C) *aerial photographs* - Examine aerial photographs and determine whether the area has been inundated or saturated during the growing season. Consider the time of the year that the aerial photographs were taken and use only photographs taken prior to site alteration.

D) *historical records* - Examine historical records for evidence that the area has been periodically inundated. Obtain copies of any such information.

E) *National Flood Insurance Agency flood maps* - Determine the previous frequency of inundation of the area from national floods maps (if available).

F) *local government officials or other knowledgeable individuals* - Contact individuals who might have knowledge that the area was periodically inundated or saturated.

If sufficient data on hydrology that existed prior to site alteration are not available to determine whether wetland hydrology was previously present, then use the other wetland identification criteria (i.e., hydrophytic vegetation and hydric soils) to make a wetland determination.

5) *Determine whether wetland hydrology previously occurred.* Examine available data. If no indicators of wetland hydrology are found, and other evidence of wetland hydrology is lacking, the original hydrology of the area is not considered wetland hydrology. If wetland hydrology indicators and other evidence of wetland hydrology are found, the area meets the wetland hydrology criterion. Record decision and return to the applicable step of the onsite determination method being used.

Step 6. *Determine whether wetland hydrology still exists.* Many wetlands have a single ditch dissecting them, while others may have an extensive network of ditches. A single ditch through a wetland may not be sufficient to effectively drain it; in other words, the wetland hydrology criterion still may be met under these circumstances. Undoubtedly, when ditches are observed, questions as to the extent of drainage arise, especially if the ditches are part of a more elaborate stream channelization or other drainage project. In these cases and other situations where the hydrology of an area has been significantly altered (e.g., dams, levees, groundwater withdrawals, and water diversions), one must determine whether wetland hydrology still exists. If it is present, the area is not effectively drained. To determine whether wetland hydrology still exists:

1) *Describe the type or nature of the alteration.* Look for evidence of:

A) *dams;*
B) *levees, dikes, and similar structures;*
C) *ditches;*
D) *channelization;*
E) *filling of channels and/or depressions;*
F) *diversion of water; and*
G) *groundwater withdrawal.*

(See Step 5 above for discussion of these factors.)

2) *Determine the approximate date when the alteration occurred, if necessary.* Check aerial photographs, consult with local officials, and review other possible sources of information.

3) *Characterize the hydrology that presently exists at the area.* The following sequence of actions is recommended:

A) *Review existing information* (e.g., stream gauge data, groundwater well data, and recent observations) to learn if data provide evidence that wetland hydrology is still present.

B) *Examine early spring or wet growing season aerial photographs for several recent years and look for signs of inundation and/or soil saturation.* (*Note*: Large-scale aerial photographs, 1:24,000 and larger, are preferred.) These signs of wetness indicate that the area still meets the wetland hydrology criterion. If these signs are observed, return to the applicable step of the onsite determination method being used. If such signs are not present, then one should conduct an onsite inspection as follows.

C) *Inspect the site on the ground, look for field indicators of wetland hydrology, and assess changes in the plant community, if necessary.* If field indicators of wetland hydrology (excluding hydric soil morphological characteristics) are present, then wetland hydrology exists; return to the applicable step of the onsite determination method being used. If such indicators are lacking, then examine the vegetation following an appropriate onsite determination method. If OBL and FACW plant species (especially in the herb stratum) are dominant or scattered throughout the site and UPL species are absent or not dominant, the area is considered to meet the wetland hydrology criterion and remains wetland. If UPL species predominate one or more strata (i.e., they represent more than 50 percent of the dominants in a given stratum) and no OBL species are present, then the area is considered effectively drained and no longer wetland. If the vegetation differs from the above situations, then the vegetation at this site should be compared if possible with a nearby undisturbed reference area, so proceed to substep 3D; if it is not possible to evaluate a reference site and the area is ditched, channelized or tile-drained, go to substep 3E, or else go to substep 3F.

D) *Locate a nearby undisturbed reference site with vegetation, soils, hydrology, and topography similar to the subject area prior to its alteration, examine the vegetation (following an appropriate onsite delineation method), and compare it with the vegetation at the project site.* If the vegetation is

similar, (i.e., has the same dominants or the subject area has different dominants with the same indicator status as the reference site) then the area is considered to be wetland -- the wetland hydrology criterion is presumed to be satisfied. If the vegetation has changed to where FACU and UPL species or UPL species alone predominate and OBL species are absent, then the area is considered effectively drained and is nonwetland. If the vegetation is different than indicated above, additional work is required -- go to substep 3E if the area is ditched, channelized, or tile-drained, or to substep 3F if the hydrology is modified in other ways.

E) *Determine the "zone of influence" of the ditch (or drainage structure) and the effect on the water table by using existing SCS soil drainage guides.* Obtain the appropriate guide for the project area's soil(s) and collect necessary field measurements (e.g., ditch or other drainage structure dimensions) to use the guide. The zone of influence is the area affected by the ditch. The size of this zone depends on many factors including ditch dimensions, water budget, and soil type. The guide should help identify the extent of the zone as well as the water table within the zone. If the zone of influence has a water table that fails to meet the wetland hydrology criterion, then the zone is effectively drained and is nonwetland, while hydric soil areas outside of the zone remain wetland. If the wetland hydrology criterion is met within the zone, the entire area remains wetland.

F) *Conduct detailed groundwater studies.* Make direct observations of inundation and soil saturation by establishing groundwater wells throughout the site, being sure to place them in a range of elevations so that the data obtained will be representative of the site as a whole. To maximize field effort, it may be best to collect data during the wetter part of the growing season (e.g., early spring in temperate regions). These direct observations, when made during a normal rainfall year, should show whether the wetland hydrology criterion is met. It is advisable, however, to take measurements over a multi-year period. (*Note*: One must be aware of regional weather patterns. For example, observations made during a number of consecutive dry years may lead to erroneous conclusions about wetland hydrology.)

If wetland hydrology still exists, return to the applicable step in the onsite determination method being used and continue delineating the wetland.

Problem Area Wetlands

4.24. There are certain types of wetlands and/or conditions that may make wetland identification difficult because field indicators of the three wetland identification criteria may be absent, at least at certain times of the year. These wetlands are considered problem area wetlands and not disturbed wetlands, because the difficulty in identification is generally due to normal environmental conditions and not the result of human activities or catastrophic natural events, with the exception of newly created wetlands. Artificial wetlands are also included in this section because their identification presents problems similar to some of the natural problem area wetlands.

4.25. Examples of these problem area wetlands are discussed below. Be sure to learn how to recognize these wetlands.

1) *Wetlands dominated by FACU plant species (or communities with a prevalence index greater than 3.5).* Since wetlands often exist along a natural wetness gradient between permanently flooded substrates and better drained soils, the wetland plant communities sometimes may be dominated by FACU species. Although FACU-dominated plant communities are usually uplands, they sometimes become established in wetlands. In order to determine whether a FACU-dominated plant community constitutes hydrophytic vegetation, the soil and hydrology must be examined. If the area meets the hydric soil and wetland hydrology criteria (see pp. 6-7), then the vegetation is hydrophytic.

In these plant communities, take the following steps to make a wetland determination:

Step 1. *Are 25 percent or more and 50 percent or less of the dominant plants in the plant community OBL, FACW, and/or FAC species, or does the community have a prevalence index greater than 3.5 and less than or equal to 4.0 ?* If the answer is *YES*, then proceed to Step 3. If *NO*, proceed to Step 2.

Step 2. *Is the community located: (1) in a depressional or flat area, (2) along a river, stream or drainageway, or (3) adjacent to a more typical wetland plant community (i.e., where greater than 50 percent of the dominants are OBL, FACW, and/ or FAC, or where the prevalence index is less than or equal to 3.5)?* If *YES*, proceed to Step 3. If *NO*,

the plant community is usually nonwetland (proceed to Step 3 if any question). Record the data and return to the applicable step of the onsite determination method being used.

Step 3. *Are hydric soils present?* If *YES*, record the data and proceed to Step 4. If *NO*, then the area is nonwetland and the plant community is not hydrophytic. Record the data and return to the applicable step of the onsite determination method being used. (*CAUTION*: Become familiar with problematic hydric soils that do not possess good hydric field indicators, such as red parent material soils, some sandy soils, and some floodplain soils, so that these hydric soils are not misidentified as nonhydric soils; see pp. 58-59.)

Step 4. Answer the following questions:

1) Is there evidence of inundation or soil saturation during the growing season, as indicated by aerial photographs, recorded hydrologic data, previous site inspections, testimony of reliable persons, or direct observations?

2) Are oxidized channels (rhizospheres) present along the living roots and rhizomes of any plants growing in the area?

3) Are water-stained leaves caused by inundation present in the area?

If the answer is *YES* to one or more of these questions, then the area showing these signs is a wetland. Record the data and return to the applicable step of the onsite determination method being used. If the answer *NO* to all questions, proceed to Step 5.

Step 5. *Use one's best professional judgement in determining whether the FACU-dominated community is wetland or nonwetland. Consider the following questions in making this determination:*

1) Are other indicators of wetland hydrology present? (See pp.17-19.)

2) Are observations being made during the dry time of the year? Would conditions be different enough during the wetter part of growing season to affect the determination?

3) Could this plant community be one of the problem area wetlands listed in the following subsection?

4) Is the dominant vegetation introduced or planted? (*Note*: If *YES*, one may choose to evaluate a nearby reference site having natural vegetation.)

5) Could the plant community reflect succession in a wetland?

6) Are OBL or UPL species present in substantial numbers?

7) If the area is forested, does a nearby reference area (where timber has not been harvested) have a plant community where more than 50 percent of the dominant species from all strata are OBL, FACW, and/or FAC species, or a plant community with a prevalence index of less than 3.0?

8) Is the region experiencing a series of dry years or long-term drought during the natural hydrologic cycle and could vegetation be reflecting this condition? If so, is hydrophytic vegetation present during the wet phase of the cycle?

9) Is the area exposed to wide annual fluctuations in vegetation, i.e., wet season vegetation is hydrophytic, while dry season vegetation is dominated by FACU and UPL species?

10) Is the area designated as wetland on National Wetlands Inventory maps, USGS topographic maps, or other maps?

In making a determination in these situations, it may be advisable to consult a wetland expert. Decide whether the area is wetland or nonwetland, record data, and return to the applicable step of the onsite determination method being used.

2) *Evergreen forested wetlands* - Wetlands dominated by evergreen trees occur in many parts of the country. In some cases, the trees are OBL, FACW, and FAC species, e.g., Atlantic white cedar (*Chamaecyparis thyoides*), black spruce (*Picea mariana*), balsam fir (*Abies balsamea*), slash pine (*Pinus elliottii*), and loblolly pine (*P. taeda*). In other cases, however, the dominant evergreen trees are FACU species, including red spruce

(*Picea rubens*), Engelmann spruce (*P. engelmannii*), white spruce (*P. glauca*), Sitka spruce (*P. sitchensis*), eastern white pine (*Pinus strobus*), pitch pine (*P. rigida*), lodgepole pine (*P. contorta*), longleaf pine (*P. palustris*), ponderosa pine (*P. ponderosa*), red pine (*P. resinosa*), jack pine (*P. banksiana*), eastern hemlock (*Tsuga canadensis*), western hemlock (*T. heterophylla*), Pacific silver fir (*Abies amabilis*), white fir (*A. concolor*), and subalpine fir (*A. lasiocarpa*). In dense stands, these evergreen trees may preclude the establishment of understory vegetation or, in some cases, understory vegetation is also FACU species. Since these plant communities are usually found on nonwetlands, the ones established in wetland areas may be difficult to recognize at first glance. The landscape position of the evergreen forested areas such as depressions, drainageways, bottomlands, flats in sloping terrain, and seepage slopes, should be considered because it often provides good clues to the likelihood of wetland. Soils also should be examined in these situations. For identification, follow procedures for FACU-dominated wetlands described above.

3) *Wetlands on glacial till* - Sloping wetlands occur in glaciated areas where thin soils cover relatively impermeable glacial till or where layers of glacial till have different hydraulic conditions that permit groundwater seepage. Such areas are seldom, if ever, flooded, but downslope groundwater movement keeps the soils saturated for a sufficient portion of the growing season to produce anaerobic and reducing soil conditions. This promotes development of hydric soils and hydrophytic vegetation. Indicators of wetland hydrology may be lacking during the drier portion of the growing season. Hydric soil indicators also may be lacking because certain areas are so rocky that it is difficult to examine soil characteristics within 18 inches.

4) *Highly variable seasonal wetlands* - In many regions (especially in arid and semiarid regions), depressional areas occur that may have indicators of all three wetland criteria during the wetter portion of the growing season, but normally lack indicators of wetland hydrology and/or hydrophytic vegetation during the drier portion of the growing season. In addition, some of these areas lack field indicators of hydric soil. OBL and FACW plant species normally are dominant during the wetter portion of the growing season, while FACU and UPL species (usually annuals) may be dominant during the drier portion of the growing season and during and for some time after droughts. Examples of highly variable seasonal wetlands are pothole wetlands in the upper Midwest, playa wetlands in the Southwest, and vernal pools along the coast of California. Become familiar with the ecology of these and similar types of wetlands (see Appendix A for readings). Also, be particularly aware of drought conditions that permit invasion of UPL species (even perennials).

5) *Interdunal swale wetlands* - Along the U.S. coastline, seasonally wet swales supporting hydrophytic vegetation are located within sand dune complexes on barrier islands and beaches. Some of these swales are inundated or saturated to the surface for considerable periods during the growing season, while others are wet for only the early part of the season. In some cases, swales may be flooded irregularly by the tides. These wetlands have sandy soils that generally lack field indicators of hydric soil. In addition, indicators of wetland hydrology may be absent during the drier part of the growing season. Consequently, these wetlands may be difficult to identify.

6) *Vegetated river bars and adjacent flats* - Along western streams in arid and semiarid parts of the country, some river bars and flats may be vegetated by FACU species while others may be colonized by wetter species. If these areas are frequently inundated for one or more weeks during the growing season, they are wetlands. The soils often do not reflect the characteristic field indicators of hydric soils, however, and thereby pose delineation problems.

7) *Vegetated flats* - Vegetated flats are characterized by a marked seasonal periodicity in plant growth. They are dominated by annual OBL species, such as wild rice (*Zizania aquatica*), and/or perennial OBL species, such as spatterdock (*Nuphar luteum*), that have nonpersistent vegetative parts (i.e., leaves and stems breakdown rapidly during the winter, providing no evidence of the plant on the wetland surface at the beginning of the next growing season). During winter and early spring, these areas lack vegetative cover and resemble mud flats; therefore, they do not appear to qualify as wetlands. But during the growing season the vegetation becomes increasingly evident, qualifying the area as wetland. In evaluating these areas, which occur both in coastal and interior parts of the country, one must consider the time of year of the field observation and the seasonality of the

vegetation. Again, one must become familiar with the ecology of these wetland types (see Appendix A for readings).

8) *Caprock limestone wetlands* - These wetlands are found in the Everglades region of southern Florida. The substrate, commonly called "rockland," is composed mainly of Miami oolite or Tamiami limestone with a very thin covering of unconsolidated soil material in places. Plant communities are varied ranging from saw grass (*Cladium jamaicense;* OBL) marshes to slash pine (*Pinus elliottii*; FACW) forested wetlands. However, exotic species with drier indicator statuses are invading many areas and replacing native species. These exotics include Brazilian pepper (*Schinus terebinthifolius*; FAC), cajeput (*Melaleuca quinquenervis*; FAC), and Australian pines (*Casuarina* spp.; FACU). These wetlands are inundated annually and the water table is at or near the land surface for prolonged periods, as long as nine months in places. Hydric soils may not be present in many places in these wetlands, since substrate (consolidated material) predominates and little or no soil (unconsolidated material) may exist. Despite the lack of hydric soils in places, these areas are wetlands because they meet the wetland hydrology criterion.

9) *Newly created wetlands* - These wetlands include manmade (artificial) wetlands, beaver-created wetlands, and other natural wetlands. Artificial wetlands may be purposely or accidentally created (e.g., road impoundments, undersized culverts, irrigation, and seepage from earth-dammed impoundments) by human activities. Many of these areas will have indicators of wetland hydrology and hydrophytic vegetation. But the area may lack typical field characteristics of hydric soils, since the soils have just recently been inundated and/or saturated. Since all of these wetlands are newly established, field indicators of one or more of the wetland identification criteria may not be present.

10) *Entisols (floodplain and sandy soils)* - Entisols are usually young or recently formed soils that have little or no evidence of pedogenically developed horizons (U.S.D.A. Soil Survey Staff 1975). These soils are typical of floodplains throughout the U.S., but are also found in glacial outwash plains, along tidal waters, and in other areas. They include sandy soils of riverine islands, bars, and banks and finer-textured soils of floodplain terraces. Wet entisols have an aquic or peraquic moisture regime and are considered hydric soils, unless effectively drained. Some entisols are easily recognized as hydric soils such as the sulfaquents of tidal salt marshes, whereas others pose problems because they do not possess typical hydric soil field indicators. Wet sandy entisols (with loamy fine sand and coarser textures in horizons within 20 inches of the surface) may lack sufficient organic matter and clay to develop hydric soil colors. When these soils have a hue between 10YR and 10Y and distinct or prominent mottles present, a chroma of 3 or less is permitted to identify the soil as hydric (i.e., an aquic moisture regime). Also, hydrologic data showing that NTCHS criteria #3 or #4 (p. 6) are met are sufficient to verify these soils as hydric. Become familiar with wet entisols and their diagnostic field properties (see "Soil Taxonomy", U.S.D.A. Soil Survey Staff 1975 and county soil surveys).

11) *Red parent material soils* - Hydric mineral soils derived from red parent materials (e.g., weathered clays, Triassic sandstones, and Triassic shales) may lack the low chroma colors characteristic of most hydric mineral soils. In these soils, the hue is redder than 10YR because of parent materials that remain red after citrate-dithionite extraction, so the low chroma requirement for hydric soil is waived (U.S.D.A. Soil Conservation Service 1982). Red soils are most common along the Gulf-Atlantic Coastal Plain (Ultisols), but are also found in the Midwest and parts of the Southwest and West (Alfisols), in the tropics, and in glacial areas where older landscapes of red shales and sandstones have been exposed. Become familiar with these hydric soils and learn how to recognize them in the field (see "Soil Taxonomy", U.S.D.A. Soil Survey Staff 1975 and county soil surveys).

12) *Spodosols (evergreen forest soils)* - These soils, usually associated with coniferous forests, are common in northern temperate and boreal regions of the U.S. and are also prevalent along the Gulf-Atlantic Coastal Plain. Spodosols have a gray eluvial E-horizon overlying a diagnostic spodic horizon of accumulated (sometimes weakly cemented) organic matter and aluminum (U.S.D.A. Soil Survey Staff 1975). A process called podzolization is responsible for creating these two soil layers. Organic acids from the leaf litter on the soil surface are moved downward through the soil with rainfall, cleaning the sand grains in the first horizon then coating the sand grains with organic matter and iron oxides in the second layer. Certain vegeta-

tion produce organic acids that speed podzolization including eastern hemlock (*Tsuga canadensis*), spruces (*Picea* spp.), pine (*Pinus* spp.), larches (*Larix* spp.), and oaks (*Quercus* spp.) (Buol, *et al.* 1980). To the untrained observer, the gray leached layer may be mistaken as a field indicator of hydric soil, but if one looks below the spodic horizon the brighter matrix colors often distinguish nonhydric spodosols from hydric ones. The wet spodosols (formerly called "groundwater podzolic soils") usually have thick dark surface horizons, dull gray E-horizons, and low chroma subsoils. Become familiar with these soils and their diagnostic properties (see "Soil Taxonomy", U.S.D.A. Soil Survey Staff 1975 and county soil surveys).

13) *Mollisols (prairie and steppe soils)* - Mollisols are dark colored, base-rich soils. They are common in the central part of the conterminous U.S. from eastern Illinois to Montana and south to Texas. Natural vegetation is mainly tall grass prairies and short grass steppes. These soils typically have deep, dark topsoil layers (mollic epipedons) and low chroma matrix colors to considerable depths. They are rich in organic matter due largely to the vegetation (deep roots) and reworking of the soil and organic matter by earthworms, ants, moles, and rodents. The low chroma colors of mollisols are not necessarily due to prolonged saturation, so be particularly careful in making wetland determinations in these soils. Become familiar with the characteristics of mollisols with aquic moisture regimes, since they are usually hydric, unless effectively drained, and be able to recognize these from nonhydric mollisols (see "Soil Taxonomy", U.S.D.A. Soil Survey Staff 1975 and county soil surveys).

4.26. The steps for making wetland determinations in problem area wetlands, except FACU-dominated wetlands, are presented below. (*Note*: Procedures for FACU-dominated communities are on pp. 55-56.) Application of these steps is appropriate only when a decision has been made during an onsite determination that wetland indicators of one or more criteria were lacking. Specific procedures to be used will vary according to the nature of the area, site conditions, and affected criterion. A determination must be based on the best available evidence, including: (1) information obtained from such sources as aerial photos, wetland maps, soil survey maps, and hydrologic records; (2) field data collected during an onsite inspection; and (3) basic knowledge of the ecology of the particular wetland type and associated environmental conditions. (*Note*: The following procedures should only be applied to situations not adequately characterized by the onsite methods in Part IV. Be sure to record necessary information on appropriate data forms.)

Step 1. *Identify each criterion to be reconsidered and determine the reason for further consideration.* Consider how environmental conditions have affected the criterion in question (hydrophytic vegetation, hydric soil, and/or wetland hydrology). If hydrophytic vegetation is the criterion in question and the plant community is FACU-dominated, then follow special procedures presented earlier in this section (see pp. 55-56). Proceed to Step 2.

Step 2. *Document available information on each criterion in question.* Examine the available information and consider personal experience and knowledge of wetland ecology and the range of normal environmental conditions of the area. Contact local experts (e.g., government agency and university scientists) for additional information, if possible. Proceed to Step 3.

Step 3. *Determine whether each wetland criterion in question is met.* If no information can be found that demonstrates that the wetland criterion in question is satisfied, the area is nonwetland. (*EXCEPTION*: Caprock limestone wetlands do not meet the hydric soil criterion where limestone rock is the predominant substrate; this is an exception to the rule.)

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Glossary

Adaptation - The condition of showing fitness for a particular environment, as applied to characteristics of a structure, function, or entire organism; a modification of a species that makes it more fit for reproduction and/or existence under the conditions of its environment.

Adventitious roots - Roots found on plant stems in positions where roots normally do not occur.

Aerenchymous tissue (Aerenchyma) - A type of plant tissue in which cells are unusually large, resulting in large air spaces in the plant organ; such tissues are often referred to as spongy and usually provide increased buoyancy.

Aerobic - A condition in which molecular oxygen is a part of the environment.

Alfisols - Soils having significantly more clay in the B-horizon than in the A-horizon and high base status.

Anaerobic - A condition in which molecular oxygen is absent (or effectively so) from the environment.

Annual - Occurring yearly or, as in annual plants, living for only one year.

Aqualfs - Soils with an aquic or peraquic moisture regime and having clay accumulating in the B-horizon; wet Alfisols.

Aquents - Soils with an aquic or peraquic moisture regime and lacking distinct soil horizons in the subsoil; wet Entisols.

Aquepts - Soils with an aquic moisture regime and showing some soil development in the B-horizon; wet Inceptisols.

Aquic moisture regime - A moisture condition associated with a seasonal reducing environment that is virtually free of dissolved oxygen because the soil is saturated by ground water or by water of the capillary fringe, as in soils in Aquic suborders and Aquic subgroups.

Aquods - Soils having an accumulation of iron, aluminum, and organic matter in the B-horizon in addition to having an aquic moisture regime; wet Spodosols.

Areal cover - A measure of dominance that defines the degree to which above ground portions of plants cover the ground surface; it is possible for the total areal cover for all strata combined in a community or for single stratum to exceed 100 percent because: 1) most plant communities consist of two or more vegetative strata; 2) areal cover is estimated by vegetative layer; and 3) foliage within a single layer may overlap.

Disturbed condition - As used herein, this term refers to areas in which indicators of one or more characteristics (vegetation, soil, and/or hydrology) have been sufficiently altered by man's activities or natural events so as to make it more difficult to recognize whether or not the wetland identification criteria are met.
Artificial wetlands - Wetlands created by the activities of man, either purposefully or accidentally.

Basal area - The cross-sectional area of a tree trunk measured in square inches, square centimeters, etc.; basal area is normally measured at 4.5 feet above ground level and is used as a measure of dominance; the most commonly used tool for measuring basal area is a diameter tape or a D-tape (then convert to basal area).

Baseline - A line, generally a highway, unimproved road, or some other evident feature, from which sampling transects extend into a site for which a jurisdictional wetland determination is to be made.

Bench mark - A fixed, more or less permanent reference point or object of known elevation; the U.S. Geological Survey (USGS) installs brass caps in bridge abutments or otherwise permanently sets bench marks at convenient locations nationwide; the elevations on these marks are referenced to the National Geodetic Vertical Datum (NGVD), also commonly known as mean sea level (MSL); locations of these bench marks on USGS topographic maps are shown as small triangles; since the marks are sometimes destroyed by construction or vandalism, the existence of any bench mark should be field verified before planning work which relies on a particular reference point; the USGS or local state surveyors office can provide information on the existence, exact location and exact elevation of bench marks.

Biennial - An event that occurs at 2-year intervals.

Bog - A shrub peatland dominated by ericaceous shrubs (Family *Ericaceae*), sedges, and peat moss (*Sphagnum* spp.) and usually having a saturated water regime or a forested peatland dominated by evergreen trees (usually spruces and firs) and/or larch (*Larix laricina*).

Boreal region - The geographical area just below the arctic tundra and usually characterized by evergreen forests.

Bryophytes - A major taxonomic group of nonvascular plants comprised of true liverworts, horned liverworts, and mosses.

Buried soil - Soil covered by an alluvial, loessal, or other deposit (including manmade), usually to a depth greater than the thickness of the solum.

Buttressed - The swollen or enlarged bases of trees developed in response to conditions of prolonged inundation.

Capillary fringe - A zone immediately above the water table in which water is drawn upward from the water table by capillary action.

Chemical reduction - Any process by which one compound or ion acts as an electron donor; in such cases, the valence state of the electron donor is decreased.

Chroma - The relative purity or saturation of a color; intensity of distinctive hue as related to grayness; one of the three variables of color.

Comprehensive wetland determination - A type of wetland determination that is based on the strongest possible evidence, requiring the collection of quantitative data for all three wetland identification criteria.

Concretion - A localized concentration of chemical compounds (e.g., calcium carbonate and iron oxide) in the form of a grain or nodule of varying size, shape, hardness, and color; concretions of significance in hydric soils are usually iron oxides and manganese oxides occurring at or near the soil surface, which have developed under conditions of fluctuating water tables.

Contour - An imaginary line of constant elevation on the ground surface; the corresponding line on a map is called a "contour line".

Cover class - A category into which plant species would fit based upon their percent areal cover; the cover classes used (midpoints in parentheses) are T = <1% cover (0), 1 = 1-5% (3.0), 2 = 6-15% (10.5), 3 = 16-25% (20.5), 4 = 26-50% (38.0), 5 = 51-75% (63.0), 6 = 76-95% (85.5), 7 = 96-100% (98.0).

Criteria - Technical requirements upon which a judgment or decision may be based.

Deepwater habitat - Any open water area in which the mean water depth exceeds 6.6 feet at mean low water in nontidal and freshwater tidal areas, or is below extreme low water at spring tides in salt and brackish tidal areas, or the maximum depth of emerging vegetation, whichever is greater.

Density - The number of individuals per unit area.

Detritus - Fragments of plant parts found on the soil surface or in water; when fused together by algae or soil particles, this detritus is an indicator that the soil surface was recently inundated.

Diameter at breast height (dbh) - The width of a plant stem (e.g., tree trunk) as measured at 4.5 feet above the ground surface.

Dike - An embankment (usually of earth) constructed to keep water in or out of a given area.

Disturbed area - An area where vegetation, soil, and/or hydrology have been significantly altered, thereby making a wetland determination difficult.

Dominance - As used herein, refers to the spatial extent of a species; commonly the most abundant species in each vegetation stratum that, when ranked in descending order of abundance and cumulatively totaled, immediately exceeds 50 percent of the total dominance measure (e.g., areal cover or basal area) for the stratum, plus any additional species comprising 20 percent or more of the total dominance measure for the stratum.

Dominance measure - The means or method by which dominance is established, including areal coverage and basal area; the total dominance measure is the sum total of the dominance measure values for all species comprising a given stratum.

Dominance threshold number - The number at which 50 percent of the total dominance measure for a given stratum is represented by one or more plant species when ranked in descending order of abundance (i.e., from most to least abundant); when this number is immediately exceeded, the dominant species for the stratum are realized.

Dominant species - For each stratum, dominant species are those that, when ranked in descending rank order and cumulatively totaled, immediately exceed 50 percent of the total dominance measure (i.e., the dominance threshold number), plus any additional species comprising 20 percent or more of the total dominance measure for the stratum.

Drained, effectively - A condition where ground or surface water has been removed by artificial means to the point that an area no longer meets the wetland hydrology criterion.

Drift line - An accumulation of water-carried debris along a contour or at the base of vegetation that provides direct evidence of prior inundation and often indicates the directional flow of flood waters.

Duff - The matted, partly decomposed, organic surface layer of forested soils.

Duration (of inundation or soil saturation) - The length of time that water stands above the soil surface (inundation), or that water fills most soil pores near the soil surface; as used herein, "duration" refers to a period during the growing season.

Entisols - Soils of slight or recent development; common along rivers and floodplains.

Evergreen (plant) - Retaining its leaves at the end of the growing season and usually remaining green through the winter.

Facultative species - Species that can occur both in wetlands and uplands; there are three subcategories of facultative species: (1) *facultative wetland plants* (FACW) that usually occur in wetlands (estimated probability 67-99%), but occasionally are found in nonwetlands, (2) *facultative plants* (FAC) that are equally likely to occur in wetlands or nonwetlands (estimated probability 34-66%), and (3) *facultative upland plants* (FACU) that usually occur in nonwetlands (estimated probability 67-99%), but occasionally are found in wetlands (estimated probability 1-33%).

Fern allies - A group of nonflowering vascular plants comprised of clubmosses (Family Lycopodiaceae), small clubmosses (Family Selaginellaceae), and quillworts (Family Isoetaceae).

Fibrists - Organic soils (peats) in which plant remains show very little decomposition and retain their original shape; more than two-thirds of the fibers remain after rubbing the materials between the fingers.

Flooded - A condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow from high tides, or any combination of sources.

Flooding, frequent - Flooding is likely to occur often during usual weather conditions (i.e., more that a 50 percent chance of flooding in any year, or more than 50 times in 100 years).

Flora - A list or manual of all plant species that may occur in an area.

Fluvents - Floodplain soils, characterized by buried horizons and irregularly decreasing amounts of organic matter with depth.

Forbs - Broad-leaved herbs, in contrast to bryophytes, ferns, fern allies, and graminoids.

Frequency (of inundation or soil saturation) - The periodicity of coverage of an area by surface water or saturation of the soil; it is usually expressed as the number of years the soil is inundated or saturated during part of the growing season of the prevalent vegetation (e.g., 50 years per 100 years) or as a 1-, 2-, 5-year, etc., inundation frequency.

Frequency analysis - A method of evaluating vegetation in an area by establishing a transect and counting the occurrences of plant species at various sampling points along the transect.

Frequency of occurrence - The number of times a given plant species occurs at sample points along a transect.

Gleization - A process in saturated or nearly saturated soils which involves the reduction of iron, its segregation into mottles and concretions, or its removal by leaching from the gleyed horizon.

Gleyed - A soil condition resulting from gleization which is manifested by the presence of neutral grey, bluish or greenish colors through the soil matrix or in mottles (spots or streaks) among other colors.

Graminoids - Grasses (Family Gramineae or Poaceae) and grasslike plants such as sedges (Family Cyperaceae) and rushes (Family Juncaceae).

Ground water - That portion of the water below the surface of the ground whose pressure is greater than atmospheric pressure.

Growing season - The portion of the year when soil temperatures are above biologic zero (41° F) as defined by "Soil Taxonomy;" the following growing season months are assumed for each of the soil temperature regimes: (1) thermic (February-October); (2) mesic (March-October); (3) frigid (May-September); (4) cryic (June-August); (5) pergelic (July-August); (6) isohyperthermic (January-December); (7) hyperthermic (February-December), (8) isothermic (January-December) and (9) isomesic (January-December).

Hardpan - A very dense soil layer caused by compaction or cementation of soil particles by organic matter, silica, sesquioxides, or calcium carbonate, for example.

Hemists - Organic soils (mucky peats and peaty mucks) in which plant remains show a fair amount of decomposition; between one-third and two-thirds of the fibers are still visible upon rubbing the material between the fingers.

Herb - Nonwoody (herbaceous) plants including graminoids (grass and grasslike plants), forbs, ferns, fern allies, and nonwoody vines; for the purposes of this manual, seedlings of woody plants that are less than three feet in height are also considered herbs.

Herb stratum - Any vegetative layer of a plant community that is composed predominantly of herbs.

Histic epipedon - A 8- to 16-inch soil layer at or near the surface that is saturated for 30 consecutive days or more during the growing season in most years and contains a minimum of 20 percent organic matter when no clay is present or a minimum of 30 percent of organic matter when 60 percent or more clay is present; generally a thin horizon of peat or muck if the soil has not been plowed.

Histosols - An order in "Soil Taxonomy" (Soil Survey Staff 1975) composed of organic soils (mucks and peats) that have organic soil materials in more than half of the upper 32 inches or that are of any thickness if overlying rock.

Horizon - A distinct layer of soil, more or less parallel with the soil surface, having similar properties such as color, texture, and permeability; the soil profile is subdivided into the following major horizons: A-horizon, characterized by an accumulation of organic material; B-horizon, characterized by relative accumulation of clay, iron, organic matter, or aluminum; and the C-horizon, the undisturbed and unaltered parent material. (*Note*: Some soils have an E-horizon, characterized by leaching of organic and other material.)

Hue - A characteristic of color related to one of the main spectral colors (red, yellow, green, blue, or purple), or various combinations of these principle colors; one of the three variables of color; each color chart in the Munsell Soil Color Charts (Kollmorgen Corporation 1975) represents a specific hue.

Hydric soil - A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part.

Hydrology - The science dealing with the properties, distribution, and circulation of water.

Hydrophyte - Any macrophyte that grows in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content; plants typically found in wetlands and other aquatic habitats.

Hydrophytic vegetation - Plant life growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

Hypertrophied lenticels - An exaggerated (oversized) pore on the stem of woody plants through which gases are exchanged between the plant and the atmosphere; serving to increase oxygen to plant roots during periods of inundation or soil saturation.

Indicator - An event, entity, or condition that typically characterizes a prescribed environment or situation; indicators determine or aid in determining whether or not certain stated circumstances exist or criteria are satisfied.

Inundation - A condition in which water temporarily or permanently covers a land surface.

Levee - A natural or manmade feature of the landscape that restricts movement of water into or through an area.

Litter - The undecomposed plant and animal material found above the duff layer on the forest floor.

Long duration (flooding) - A duration class in which inundation for a single event ranges from 7 days to 1 month.

Macrophyte - Any plant species that can be readily observed without the aid of optical magnification, including all vascular plant species and bryophytes (e.g., *Sphagnum* spp.), as well as large algae (e.g. *Chara* spp., and *Fucus* spp.).

Manmade wetland - Any wetland area that has been purposely or accidentally created by some activity of man; also called artificial wetlands.

Map unit - A portion of a map that depicts an area having some common characteristic.

Matrix - The natural soil material composed of both mineral and organic matter; matrix color refers to the predominant color of the soil in a particular horizon.

Microbial - Pertaining to work by microorganisms too small to be seen with the naked eye.

Mineral soil - Any soil consisting primarily of mineral (sand, silt, and clay) material, rather than organic matter.

Mollisols - Grassland soils of steppes and prairies characterized by deep topsoil (mollic epipedon); common in the Great Plains of the West.

Morphological adaptation - A structural feature that aids in fitting a species to its particular environment (e.g., buttressed bases, adventitious roots, and aerenchymous tissue).

Morphological features - Properties related to the external structure of soil (such as color and texture) or of plants.

Moss-lichen wetland - A wetland dominated by mosses (mainly peat mosses) and lichens with little taller vegetation.

Mottles - Spots or blotches of different color or shades of color interspersed within the dominant matrix color in a soil layer; distinct mottles are readily seen and easily distinguished from the color of the matrix; prominent mottles are obvious and mottling is one of the outstanding features of the horizon.

Nonhydric soil - A soil that has developed under predominantly aerobic soil conditions.

Nonpersistent vegetation - Plants that break down readily after the growing season; no evidence of previous year's growth at beginning of next growing season.

Nontidal - Not influenced by tides.

Nonwetland - Any area that has sufficiently dry conditions that hydrophytic vegetation, hydric soils, and/or wetland hydrology are lacking; it includes upland as well as former wetlands that are effectively drained.

Normal circumstances - Refers to the soil and hydrology conditions that are normally present, without regard to whether the vegetation has been removed.

Obligate wetland species - A plant species that is nearly always found in wetlands; its frequency of occurrence in wetlands is 99% or more.

Offsite determination method - A technique for making a wetland determination in the office.

Onsite determination method - A technique for making a wetland determination in the field.

Organic soil - See Histosols.

Overbank flooding - Any situation in which inundation occurs as a result of the water level of a river or stream rising above bank level.

Oxidation-reduction process - A complex of biochemical reactions in soil that influences the valence state of elements and their ions found in the soil; long periods of soil saturation during the growing season tend to elicit anaerobic conditions that shift the overall process to a reducing condition.

Oxidized rhizospheres - Oxidized channels and soil surrounding living roots and rhizomes of hydrophytic plants.

Parent material - The unconsolidated and more or less weathered mineral or organic matter from which the soil profile is developed.

Pedogenic - Related to soil-building processes occurring within the soil.

Peraquic moisture regime - A soil condition in which reducing conditions always occur due to the presence of ground water at or near the soil surface.

Perennial (plant) - Living for many years.

Periodically - Used herein, to define detectable regular or irregular saturated soil conditions or inundation, resulting from ponding of ground water, precipitation, overland flow, stream flooding, or tidal influences that occur(s) with hours, days, weeks, months, or even years between events.

Permanently flooded - A water regime condition where standing water covers the land surface throughout the year (but may be absent during extreme droughts).

Permeability - The quality of the soil that enables water to move downward through the profile, measured as the number of inches per hour that water moves downward through the saturated soil.

Phase, soil - A subdivision of a series based on features such as slope, surface texture, stoniness, and thickness.

Physiological adaptation - A peculiarity of the basic physical and chemical activities that occur in cells and tissues of a species, which results in it being better fitted to its environment (e.g., ability to absorb nutrients under low oxygen tensions).

Plant community - The plant populations existing in a shared habitat or environment.

Playa - Periodically flooded wetland basin common in parts of the Southwest.

Pneumatophore - Modified roots rising above ground that may function as a respiratory organ in species subjected to frequent inundation or soil saturation.

Podzolization - The process by which sesquioxides (aluminum and iron) are leached from the A-horizon and precipitated in the B-horizon, often resulting in a leached layer, the E-horizon.

Polymorphic (leaves) - Two or more different types of leaves formed on plants; in wetland plants, polymorphic leaves may develop due to extended flooding.

Ponded - A condition in which free water covers the soil surface, for example, in a closed depression; the water is removed only by percolation, evaporation, or transpiration.

Poorly drained - A condition in which water is removed from the soil so slowly that the soil is saturated periodically during the growing season or remains wet for long periods greater than 7 days.

Pothole - A depressional wetland commonly found in Upper Midwest (North and South Dakota and western Minnesota) and similar wetlands found elsewhere.

Prevalence index - A weighted average measure of the sum of the frequency of occurrences of all species along a single transect or as calculated for a plant community by averaging the prevalence index of all sample transects through the community.

Problem area wetland - A wetland that is difficult to identify because it may lack indicators of wetland hydrology and/or hydric soils, or its dominant plant species are more common in nonwetlands.

Profile - Vertical section of the soil through all its horizons and extending into the parent material.

Quadrat - Sample units or plots that vary in size, shape, number, and arrangements, depending on the nature of the vegetation, site conditions, and purpose of study.

Quantitative - A precise measurement or determination expressed numerically.

Range - The set of conditions throughout which an organism (e.g., plant species) naturally occurs.

Reduction - The process of changing an element from a higher to a lower oxidation state as in the reduction of ferric (Fe^{3+}) iron into ferrous iron (Fe^{2+}).

Relative basal area - An estimate of basal area for trees, such as produced by the Bitterlich sampling technique.

Relief - The change in elevation of a land surface between two points; collectively, the configuration of the earth's surface, including such features as hills and valleys.

Reproductive adaptation - A peculiarity of the reproductive mechanism of a species that results in it being better fitted to its environment (e.g., prolonged seed dormancy).

Rhizosphere - The zone of soil in which interactions between living plant roots and microorganisms occur.

Salic horizon - A layer 6 inches or more thick comprised of secondary soluble salts.

Salorthids - Soils of arid regions with a salic horizon within 30 inches of the surface and saturated within 40 inches for one month or more in most years; common in playas of the Southwest.

Sample plot - As used herein, an observation point at which a wetland determination is made.

Sapling - Woody vegetation between 0.4 and 5.0 inches in diameter at breast height and greater than or equal to 20 feet in height, exclusive of woody vines.

Saprists - Organic soils (mucks) in which most of the plant material is decomposed and the original constituents cannot be recognized; less than one-third of the fibers remain visible upon rubbing the material between the fingers.

Saturated - A condition in which all easily drained voids (pores) between soil particles are temporarily or permanently filled with water; significant saturation during the growing season is considered to be usually one week or more.

Seedling - A young tree that is generally less than 3 feet high.

Shrub - Woody vegetation usually greater than 3 feet but less than 20 feet tall, including multi-stemmed, bushy shrubs and small trees and saplings. (*Note*: Woody seedlings less than 3 feet tall are considered part of the herbaceous layer.)

Soil - Unconsolidated material on the earth's surface that supports or is capable of supporting plants out-of-doors.

Soil horizon - A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics (e.g., color, structure, and texture).

Soil matrix - The portion of a given soil having the dominant color; in most cases, the matrix will be the portion of the soil having more than 50 percent of the same color.

Soil permeability - The ease with which gases, liquids, or plant roots penetrate or pass through a layer of soil.

Soil phase - A subdivision of a soil series having features (e.g., slope, surface texture, and stoniness) that affect the use and management of the soil, but which do not vary sufficiently to differentiate it as a separate series.

Soil pore - An area within soil occupied by either air or water, resulting from the arrangement of individual soil particles or peds.

Soil profile - A vertical section of the soil through all its horizons and extending into the parent material.

Soil series - A group of soils having horizons similar in differentiating characteristics and arrangements in the soil profile, except for texture of the surface layer.

Soil structure - The combination or arrangement of primary soil particles into secondary particles, units, or peds.

Soil surface - The upper limits of the soil profile; for mineral soils, the upper limits of the highest mineral horizon (A-horizon); for organic soils, the upper limit of undecomposed organic matter.

Soil texture - The relative proportions of the various sizes of particles (silt, sand and clay) in a soil.

Somewhat poorly drained - A condition in which water is removed slowly enough that the soil is wet for significant periods during the growing season.

Species area curve - The curve on a graph produced when plotting the cumulative number of plant species found in a series of quadrats against the cumulative number or area of those quadrats; it is used to determine the number of quadrats sufficient to adequately survey the herb stratum.

Spodic horizon - A subsurface layer of soil characterized by the accumulation of aluminum oxides (with or without iron oxides) and organic matter; a diagnostic horizon for Spodosols.

Stratigraphy - A term referring to the origin, composition, distribution, and succession of geologic strata (layers).

Stratum - A layer of vegetation used to determine dominant species in a plant community.

Suborder (soils) - Second highest taxonomic level of the current U.S. soil classification system.

Substrate - nonsoil.

Surface water - Water present above the substrate or soil surface.

Temperate region - The geographic area having a climate that is neither very hot nor very cold.

Tidal - A situation in which the water level periodically fluctuates due to the action of lunar (moon) and solar (sun) forces upon the rotating earth.

Topography - The configuration of a surface, including its relief and the position of its natural and man-made features.

Transect - A line on the ground along which sample plots or points are established for collecting vegetation data and in many cases, soil and hydrology data as well.

Translocation - The transfer of matter from one location to another within the soil.

Transpiration - The process in plants by which water is released into the gaseous environment (atmosphere), primarily through stomata.

Tree - A woody plant 5 inches or greater in diameter at breast height and 20 feet or taller.

Typical - That which normally, usually, or commonly occurs.

Ultisols - Highly weathered soils having significantly more clay in the B-horizon than in the A-horizon and having low base status; acidic soils common in the Southeast.

Unconsolidated parent material - Material from which a soil develops.

Upland - Any area that does not qualify as a wetland because the associated hydrologic regime is not sufficiently wet to elicit development of vegetation, soils, and/or hydrologic characteristics associated with wetlands. Such areas occurring in floodplains are more appropriately termed nonwetlands.

Value (soil color) - The relative lightness or intensity of color; approximately a function of the square root of the total amount of light; one of the three variables of color.

Vascular (plant) - Possessing a well-developed system of conducting tissue to transport water, mineral salts, and foods within the plant.

Vegetation - The sum total of macrophytes that occupy a given area.

Vegetation unit - A patch, grouping, or zone of plants evident in overall plant cover, which appears distinct from other such units because of the vegetation's structure and floristic composition; a given unit is typically topographically distinct and typically has a rather uniform soil, except possibly for relatively dry microsites (e.g., tree bases, old tree stumps, mosquito ditch spoil piles, and small earth hummocks) in an otherwise wet area or relatively wet microsites (e.g., small depressions) in an otherwise dry area.

Very long duration (flooding) - A duration class in which inundation for a single event is greater than 1 month.

Vertisols - Shrinking and swelling dark clay soils; most common in Texas.

Very poorly drained - A condition in which water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season.

Water mark - A line on vegetation or other upright structures that represents the maximum height reached in an inundation event.

Water table - The zone of saturation at the highest average depth during the wettest season; it is at least six inches thick and persists in the soil for more than a few weeks.

Wetlands - As used herein, areas that under normal circumstances have hydrophytic vegetation, hydric soils, and wetland hydrology.

Wetland boundary - The point on the ground at which a shift from wetlands to nonwetlands occurs.

Wetland determination - The process by which an area is identified as a wetland or nonwetland.

Wetland hydrology - In general terms, permanent or periodic inundation or prolonged soil saturation sufficient to create anaerobic conditions in the soil.

Wetland indicator status - The exclusiveness with which a plant species occurs in wetlands; the different indicator categories (i.e., facultative species, and obligate wetland species) are defined elsewhere in this glossary.

Wooded swamp - A wetland dominated by trees; a forested wetland.

Zone of influence - The area contiguous to a ditch, channel, or other drainage structure that is directly affected by it.

Appendix A
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I. WETLAND FIELD GUIDES

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Appendix B
Examples of Data Sheets

DATA FORM
ROUTINE ONSITE DETERMINATION METHOD[1]

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____ Plant Community #/Name: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Do normal environmental conditions exist at the plant community?
Yes _____ No _____ (If no, explain on back)
Has the vegetation, soils, and/or hydrology been significantly disturbed?
Yes _____ No _____ (If yes, explain on back)

VEGETATION

Dominant Plant Species	Indicator Status	Stratum	Dominant Plant Species	Indicator Status	Stratum
1.			11.		
2.			12.		
3.			13.		
4.			14.		
5.			15.		
6.			16.		
7.			17.		
8.			18.		
9.			19.		
10.			20.		

Percent of dominant species that are OBL, FACW, and/or FAC _____
Is the hydrophytic vegetation criterion met? Yes _____ No _____
Rationale: _____

SOILS

Series/phase: _____ Subgroup:[2] _____
Is the soil on the hydric soils list? Yes _____ No _____ Undetermined _____
Is the soil a Histosol? Yes _____ No _____ Histic epipedon present? Yes _____ No _____
Is the soil: Mottled? Yes _____ No _____ Gleyed? Yes _____ No _____
Matrix Color: _____ Mottle Colors: _____
Other hydric soil indicators: _____
Is the hydric soil criterion met? Yes _____ No _____
Rationale: _____

HYDROLOGY

Is the ground surface inundated? Yes _____ No _____ Surface water depth: _____
Is the soil saturated? Yes _____ No _____
Depth to free-standing water in pit/soil probe hole: _____
List other field evidence of surface inundation or soil saturation.

Is the wetland hydrology criterion met? Yes _____ No _____
Rationale: _____

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? Yes _____ No _____
Rationale for jurisdictional decision: _____

[1] This data form can be used for the Hydric Soil Assessment Procedure and the Plant Community Assessment Procedure.
[2] Classification according to "Soil Taxonomy."

DATA FORM
INTERMEDIATE-LEVEL ONSITE DETERMINATION METHOD
QUADRAT TRANSECT SAMPLING PROCEDURE
(Vegetation Data)

Field Investigator(s): _____
Project/Site: _____ Date: _____
Applicant/Owner: _____ State: _____ County: _____
Transect # _____ Plot # _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

DOMINANT PLANT SPECIES

Herbs (Bryophytes)	Indicator Status	Saplings	Indicator Status
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	
6.		6.	
7.		7.	
8.		8.	
9.		9.	
10.		10.	
11.		11.	
12.		12.	
13.		13.	

Shrubs		Trees	
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	
6.		6.	
7.		7.	
8.		8.	
9.		9.	
10.		10.	
11.		11.	
12.		12.	
13.		13.	

Woody Vines	
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	

Percent of dominant species that are OBL, FACW, and/or FAC _____

DATA FORM
INTERMEDIATE-LEVEL ONSITE DETERMINATION METHOD
VEGETATION UNIT SAMPLING PROCEDURE
(Herbs and Bryophytes)

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____ Vegetation Unit #/Name: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Species	Indicator Status	Percent Areal Cover	Cover[1] Class	Midpoint[1] of Cover Class	Rank[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					
34.					
35.					
36.					
				Sum of Midpoints	
				Dominance Threshold Number Equals 50% x Sum of Midpoints	

[1] Cover classes (midpoints): T<1% (none); 1 = 1-5% (3.0); 2 = 6-15% (10.5); 3 = 16-25% (20.5); 4 = 26-50% (38.0); 5 = 51-75% (63.0); 6 = 76-95% (85.5); 7 = 96-100% (98.0).

[2] To determine the dominants, first rank the species by their midpoints. Then cumulatively sum the midpoints of the ranked species until 50% of the total for all species midpoints is immediately exceeded. All species contributing to that cumulative total (the dominance threshold number) *plus* any additional species having 20% of the total midpoint value should be considered dominants and marked with an asterisk.

DATA FORM
INTERMEDIATE-LEVEL ONSITE DETERMINATION METHOD
VEGETATION UNIT SAMPLING PROCEDURE
(Shrubs, Woody Vines and Saplings)

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____ Vegetation Unit #/Name: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Shrub Species	Indicator Status	Percent Areal Cover	Cover[1] Class	Midpoint[1] of Cover Class	Rank[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Sum of Midpoints _____
Dominance Threshold Number Equals 50% x Sum of Midpoints _____

Woody Vine Species	Indicator Status	Percent Areal Cover	Cover[1] Class	Midpoint[1] of Cover Class	Rank[2]
1.					
2.					
3.					
4.					
5.					

Sum of Midpoints _____
Dominance Threshold Number Equals 50% x Sum of Midpoints _____

Sapling Species	Indicator Status	Percent Areal Cover	Cover[1] Class	Midpoint[1] of Cover Class	Rank[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

Sum of Midpoints _____
Dominance Threshold Number Equals 50% x Sum of Midpoints _____

[1] Cover classes (midpoints): T<1% (none); 1 = 1-5% (3.0); 2 = 6-15% (10.5); 3 = 16-25% (20.5); 4 = 26-50% (38.0); 5 = 51-75% (63.0); 6 = 76-95% (85.5); 7 = 96-100% (98.0).

[2] To determine the dominants, first rank the species by their midpoints. Then cumulatively sum the midpoints of the ranked species until 50% of the total for all species midpoints is immediately exceeded. All species contributing to that cumulative total (the dominance threshold number) *plus* any additional species having 20% of the total midpoint value should be considered dominants and marked with an asterisk.

DATA FORM
INTERMEDIATE-LEVEL ONSITE DETERMINATION METHOD
VEGETATION UNIT SAMPLING PROCEDURE
(Trees)

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____ Vegetation Unit #/Name: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Tree Species (Percent Cover Option)	Indicator Status	Percent Areal Cover	Cover[1] Class	Midpoint[1] of Cover Class	Rank[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					

Sum of Midpoints _____
Dominance Threshold Number Equals 50% x Sum of Midpoints _____

Tree Species (Basal Area Option)	Indicator Status	Tally 1 2 3 4 5 6 7 8	Total Trees	Basal[3] Area	Rank[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Basal Area Factor (e.g., Prism Used) _____

Total Basal Area of All Species Combined _____
Dominance Threshold Number Equals 50% of Total Basal Area _____

[1] Cover classes (midpoints): T<1% (none); 1 = 1-5% (3.0); 2 = 6-15% (10.5); 3 = 16-25% (20.5); 4 = 26-50% (38.0); 5 = 51-75% (63.0); 6 = 76-95% (85.5); 7 = 96-100% (98.0).

[2] To determine the dominants, first rank the species by their midpoints (or basal area). Then cumulatively sum the midpoints (basal area) of the ranked species until 50% of the total for all species midpoints (or basal area) is immediately exceeded. All species contributing to that cumulative total (the dominance threshold number) *plus* any additional species having 20% of the total midpoint, or basal area, value should be considered dominants and marked with an asterisk.

[3] The basal area for a species (on a per acre basis) is determined by dividing the total number of individual trees tallied for all tally areas by the number of tallies and multiplying by the basal area factor.

DATA FORM [1]
INTERMEDIATE-LEVEL ONSITE DETERMINATION METHOD OR COMPREHENSIVE ONSITE DETERMINATION METHOD
(Soils and Hydrology)

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____
Intermediate-level Onsite Determination Method _____
Comprehensive Onsite Determination Method _____
Transect # _____ Plot # _____
Vegetation Unit #/Name: _____ Sample # Within Veg. Unit: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

SOILS

Series/phase: _____ Subgroup:[2] _____
Is the soil on the hydric soils list? Yes _____ No _____ Undetermined _____
Is the soil a Histosol? Yes _____ No _____ Histic epipedon present? Yes _____ No _____
Is the soil: Mottled? Yes _____ No _____ Gleyed? Yes _____ No _____
Matrix Color: _____ Mottle Colors: _____
Other hydric soil indicators: _____
Comments: _____

HYDROLOGY

Is the ground surface inundated? Yes _____ No _____ Surface water depth: _____
Is the soil saturated? Yes _____ No _____
Depth to free-standing water in pit/soil probe hole: _____
Mark other field indicators of surface inundation or soil saturation below:

___ Oxidized root zones
___ Water marks
___ Drift lines
___ Water-borne sediment deposits
___ Water-stained leaves
___ Surface scoured areas
___ Wetland drainage patterns
___ Morphological plant adaptations

Additional hydrologic indicators: _____

Comments: _____

[1] This data form can be used for both the Vegetation Unit Sampling Procedure and the Quadrat Transect Sampling Procedure of the Intermediate-Level Onsite Determination Method, or the Quadrat Sampling Procedure of the Compehensive Onsite Determination Method. Indicate which method is used.
[2] Classification according to "Soil Taxonomy."

DATA FORM [1]
INTERMEDIATE-LEVEL ONSITE DETERMINATION METHOD OR COMPREHENSIVE ONSITE DETERMINATION METHOD
(Summary Sheet)

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____
Intermediate-level Onsite Determination Method _____
Comprehensive Onsite Determination Method _____
Transect # _____ Plot # _____ Vegetation Unit #/Name: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Do normal environmental conditions exist at the plant community?
Yes _____ No _____ (If no, explain on back)
Has the vegetation, soils, and/or hydrology been significantly disturbed?
Yes _____ No _____ (If yes, explain on back)

Dominant Plant Species	Indicator Status	Stratum	Dominant Plant Species	Indicator Status	Stratum
1.			14.		
2.			15.		
3.			16.		
4.			17.		
5.			18.		
6.			19.		
7.			20.		
8.			21.		
9.			22.		
10.			23.		
11.			24.		
12.			25.		
13.			26.		

Percent of dominant species that are OBL, FACW and/or FAC _____

Is the hydrophytic vegetation criterion met? Yes _____ No _____

Is the hydric soil criterion met? Yes _____ No _____

Is the wetland hydrology criterion met? Yes _____ No _____

Is the vegetation unit or plot wetland? Yes _____ No _____

Rationale for jurisdictional decision: _____

[1] This data form can be used for either the Intermediate-level Onsite Determination Method or the Comprehensive Onsite Determination Method. Indicate which method is used.

DATA FORM
COMPREHENSIVE ONSITE DETERMINATION METHOD
QUADRAT SAMPLING PROCEDURE [1]
(Herbs and Bryophytes)

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____
Transect # _____ Plot # _____ Vegetation Unit #/Name: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

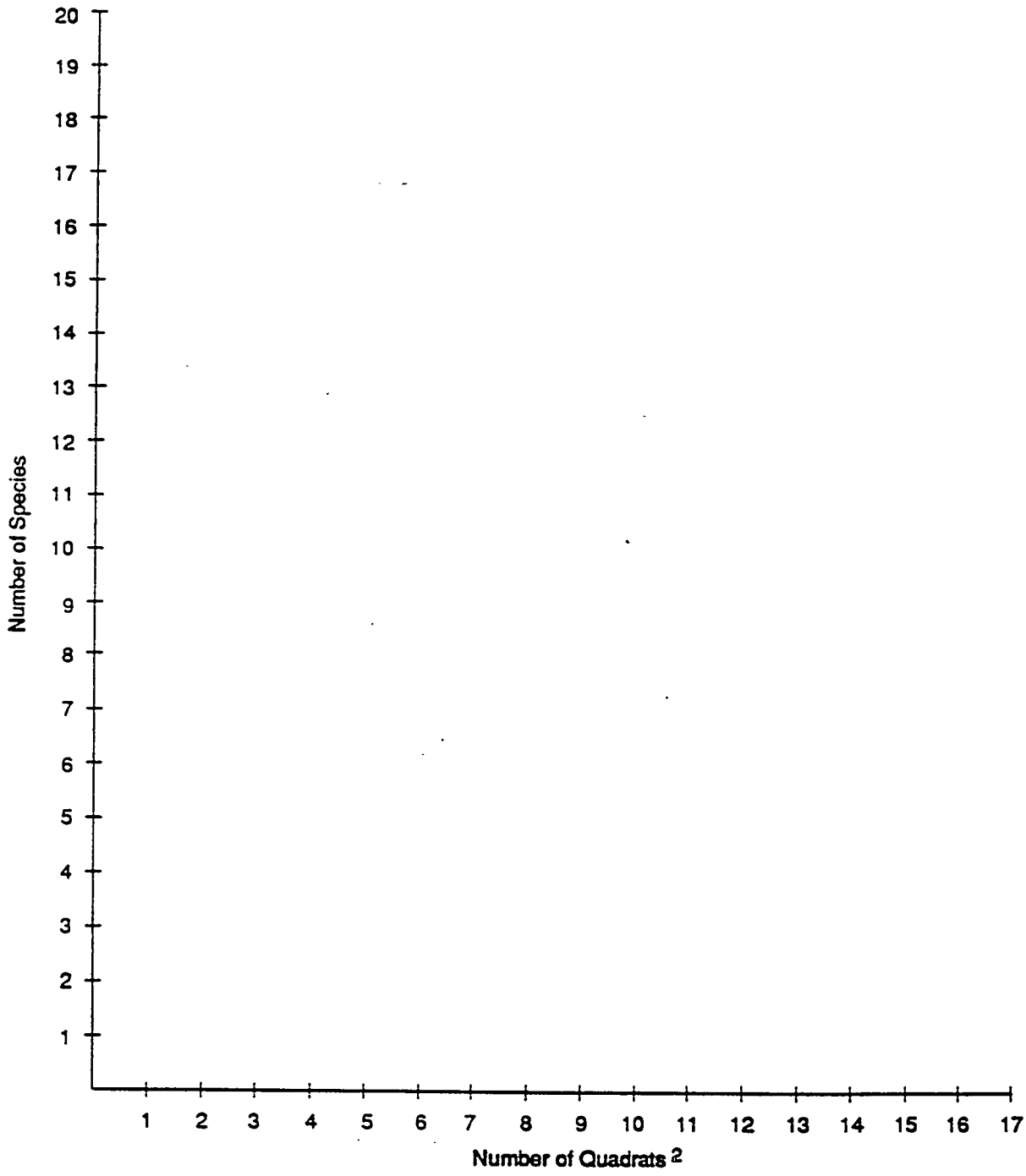
Species	Indicator Status	Quadrat Percent Areal Cover Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	$\bar{X}$	Rank[4]
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											
13.											
14.											
15.											
16.											

Total Cover ___[2]
Dominance Threshold Number Equals 50% x Total Cover ___[2]

Total of Averages ($\bar{X}$'s) ___[3]
Dominance Threshold Number Equals 50% x Total of Averages ($\bar{X}$'s) ___[3]

[1] This data form can be used for both the Plant Community Transect Sampling Approach and the Fixed Interval Transect Sampling Approach.
[2] These entries are only applicable to the Fixed Interval Transect Sampling Approach which uses only one quadrat per sampling point along a transect.
[3] These entries are only applicable to the Plant Community Transect Sampling Approach which uses multiple quadrats per sampling point along a transect.
[4] To determine the dominants, first rank the species by their cover (or mean cover). Then cumulatively sum the cover (mean cover) of the ranked species until 50% of the total for all species cover (mean cover) is immediately exceeded. All species contributing to that cumulative total (the dominance threshold number) *plus* additional species having 20% of the total cover (mean cover) value should be considered dominants and marked with an asterisk.

SPECIES-AREA CURVE [1]



[1] Plot the cumulative number of species against the quadrats (e.g., if quadrat #1 has 3 species and quadrat #2 has any, all, or none of those species but has 2 new species, then 5 cumulative species should be plotted against quadrat #2). The number of quadrats sufficient to adequately survey the understory will corresdpond to the point on the curve where it first levels off and remains essentially level.

[2] Specify size of sample quadrat: _____

DATA FORM
COMPREHENSIVE ONSITE DETERMINATION METHOD
QUADRAT SAMPLING PROCEDURE
(Shrubs and Woody Vines)

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____
Transect # _____ Plot # _____ Vegetation Unit #/Name: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Shrub Species	Indicator Status	Percent Areal Cover	Cover[1] Class	Midpoint[1] of Cover Class	Rank[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					

Sum of Midpoints _____
Dominance Threshold Number Equals 50% x Sum of Midpoints _____

Woody Vine Species	Indicator Status	Percent Areal Cover	Cover[1] Class	Midpoint[1] of Cover Class	Rank[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					

Sum of Midpoints _____
Dominance Threshold Number Equals 50% x Sum of Midpoints _____

[1] Cover classes (midpoints): T<1% (none); 1 = 1-5% (3.0); 2 = 6-15% (10.5); 3 = 16-25% (20.5); 4 = 26-50% (38.0); 5 = 51-75% (63.0); 6 = 76-95% (85.5); 7 = 96-100% (98.0).

[2] To determine the dominants, first rank the species by their midpoints. Then cumulatively sum the midpoints of the ranked species until 50% of the total for all species midpoints is immediately exceeded. All species contributing to that cumulative total (the dominance threshold number) *plus* any additional species having 20% of the total midpoint value should be considered dominants and marked with an asterisk.

DATA FORM
COMPREHENSIVE ONSITE DETERMINATION METHOD
QUADRAT SAMPLING PROCEDURE
(Saplings & Trees)

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____
Transect # _____ Plot # _____ Vegetation Unit #/Name: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Sapling Species	Indicator Status	Percent Areal Cover	Cover[1] Class	Midpoint[1] of Cover Class	Rank[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Sum of Midpoints _____
Dominance Threshold Number Equals 50% x Sum of Midpoints _____

Individual Tree Species	Indicator Status	DBH (inches)	Basal Area (BA) Per Tree (sq ft)	BA Per Species (sq ft)	Rank[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

Total Basal Area of All Species Combined _____
Dominance Threshold Number Equals 50% x Total Basal Area _____

[1] Cover classes (midpoints): T<1% (none); 1 = 1-5% (3.0); 2 = 6-15% (10.5); 3 = 16-25% (20.5); 4 = 26-50% (38.0); 5 = 51-75% (63.0); 6 = 76-95% (85.5); 7 = 96-100% (98.0).

[2] To determine the dominants, first rank the species by their midpoints. Then cumulatively sum the midpoints of the ranked species until 50% of the total for all species midpoints is immediately exceeded. All species contributing to that cumulative total (the dominance threshold number) *plus* any additional species having 20% of the total midpoint value should be considered dominants and marked with an asterisk.

PREVALENCE INDEX WORKSHEET

LOCATION _____ DATE _____ EVALUATOR _____

HYDRIC UNIT NAME _____ TRANSECT NO. _____

Plant Species	Frequency of Occurrence Total for Each Species	F_o Obligate	F_{fw} Facult. Wet.	F_f Facult.	F_{fu} Facult. Upland	F_u Upland
		Frequency of Occurrence of Identified Plants with Known Indicator Status				
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Total occurrence for all plant species	_____	_____	_____	_____	_____	_____
Total occurrences ID'd with known indicator status	_____	_____	_____	_____	_____	_____
E.I. value		1	2	3	4	5

$$\frac{\text{Total occurrences identified with known indicator status}}{\text{Total occurrence for all plant species}} = \%\ \text{valid occurrences}$$

$$PI_i = \frac{(1F_o) + (2F_{fw}) + (3F_f) + (4F_{fu}) + (5F_u)}{(F_o + F_{fw} + F_f + F_{fu} + F_u)}$$

Appendix C
Sample Calculation for Herb Stratum Dominants

DATA FORM
COMPREHENSIVE ONSITE DETERMINATION METHOD
QUADRAT SAMPLING PROCEDURE[1]
(Herbs and Bryophytes)

Field Investigator(s): Bob Barber and Bill Sipple Date: 7/29/87
Project/Site: Weise Slough State: Iowa County: Muscatine
Applicant/Owner: State of Iowa
Transect # 1 Plot # 2 Vegetation Unit #/Name: #1 / Marsh
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

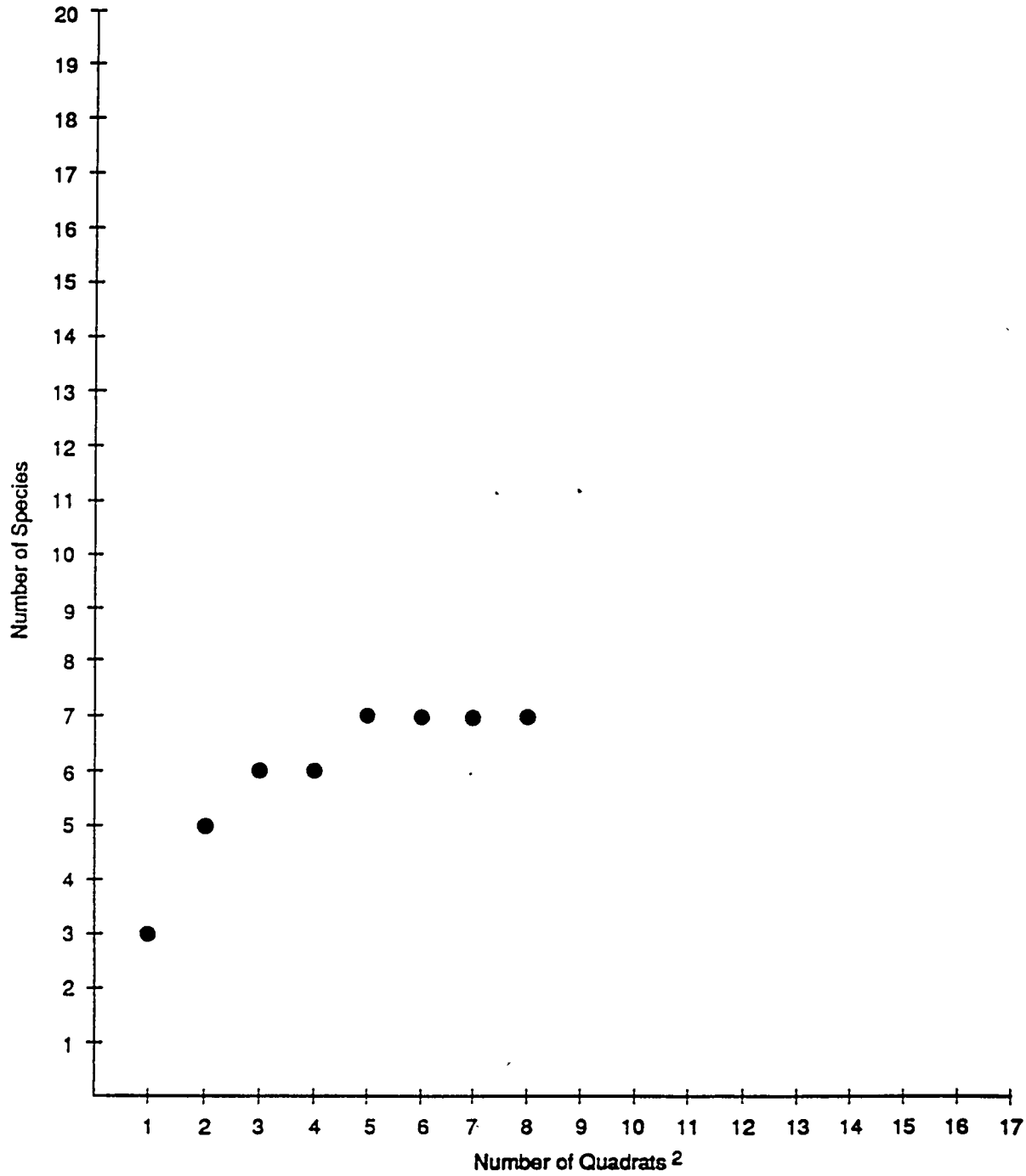
Species	Indicator Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	$\bar{X}$	Rank[4]
		Quadrat Percent Areal Cover									
*1. Leersia oryzoides	OBL	95	99	99	100	<1	30	20	20	57.9	1
2. Echinochloa muricata			2	5	5	15		2	2	3.88	4
3. Lemna Sp.		70	20		5					1.88	2
4. UI Seedling (herb)		<1		<1	<1	<1	15	<1		1.88	6
5. Bidens sp.			1	2		1	10	10	2	3.25	5
6. Sagittaria latifolia			<1	<1						—	7
7. Rumex verticillatus						80				10	3
8.											
9.											
10.											
11.											
12.											
13.											
14.											
15.											
16.											

Total Cover ___[2]
Dominance Threshold Number Equals 50% x Total Cover ___[2]

Total of Averages ($\bar{X}$'s) 88.8[3]
Dominance Threshold Number Equals 50% x Total of Averages ($\bar{X}$'s) 44.4[3]

[1] This data form can be used for both the Plant Community Transect Sampling Approach and the Fixed Interval Transect Sampling Approach.
[2] These entries are only applicable to the Fixed Interval Transect Sampling Approach which uses only one quadrat per sampling point along a transect.
[3] These entries are only applicable to the Plant Community Transect Sampling Approach which uses multiple quadrats per sampling point along a transect.
[4] To determine the dominants, first rank the species by their cover (or mean cover). Then cumulatively sum the cover (mean cover) of the ranked species until 50% of the total for all species cover (mean cover) is immediately exceeded. All species contributing to that cumulative total (the dominance threshold number) *plus* additional species having 20% of the total cover (mean cover) value should be considered dominants and marked with an asterisk.

SPECIES-AREA CURVE [1]



[1] Plot the cumulative number of species against the quadrats (e.g., if quadrat #1 has 3 species and quadrat #2 has any, all, or none of those species but has 2 new species, then 5 cumulative species should be plotted against quadrat #2). The number of quadrats sufficient to adequately survey the understory will corresdpond to the point on the curve where it first levels off and remains essentially level.

[2] Specify size of sample quadrat: 0.1 m^2

Appendix D

Sample Problem for Application of Point Intercept Sampling Method

Sample problem for application of point sampling method. Example follows this sample worksheet.

PREVALENCE INDEX WORKSHEET

LOCATION Montgomery Co., MD Farm 2164, Tract 742 DATE 8/4/88 EVALUATOR Anne Lynn

HYDRIC UNIT NAME Bibb TRANSECT NO. 1

Plant Species	Frequency of Occurrence Total for Each Species	F_o Obligate	F_{fw} Facult. Wet.	F_f Facult.	F_{fu} Facult. Upland	F_u Upland
		Frequency of Occurrence of Identified Plants with Known Indicator Status				
Liriodendron tulipifera	13				13	
Platanus occidentalis	20		20			
Acer rubrum	8			8		
Hedera helix	1					
Alnus serrulata	2	2				
Podophyllum peltatum	3					
Liquidambar styraciflua	2			2		
Galium asperellum	2	2				
Lindera benzoin	3		3			
Lonicera japonica	5			5		
Toxidendron radicans	5			5		
Viburnum recognitum	2		2			
Arisaema triphyllum	4		4			
Carpinus caroliniana	2			2		
Ilex opaca	12				12	
Thelypteris noveboracensis	2			2		
Total occurrence for all plant species	86					
Total occurrences ID'd with known indicator status	82	4	29	24	25	
E.I. value		1	2	3	4	5

$$\frac{\text{Total occurrences identified with known indicator status}}{\text{Total occurrence for all plant species}} = \text{\% valid occurrences} = 100 \times \frac{82}{86} = 95\%$$

$$PI_i = \frac{(1F_o) + (2F_{fw}) + (3F_f) + (4F_{fu}) + (5F_u)}{(F_o + F_{fw} + F_f + F_{fu} + F_u)}$$

COMPUTATIONS

1. Computation of prevalence index (PI) for transect #1:

$$PI_i = \frac{(1F_o) + (2F_{fw}) + (3F_f) + (4F_{fu}) + (5F_u)}{(F_o + F_{fw} + F_f + F_{fu} + F_u)}$$

$$PI_1 = \frac{(1x4) + (2x29) + (3x24) + (4x25)}{4 + 29 + 24 + 25} = \frac{234}{82} = 2.85$$

where:

PI_i = Prevalence index for transect i
F_o = Frequence of occurrence of obligate wetland species
F_{fw} = Frequency of occurrence of facultative wetland species
F_f = Frequency of occurrence of facultative species
F_{fu} = Frequency of occurrence of facultative upland species
F_u = Frequency of occurrence of upland species

2. Computation of mean prevalence index (PI_M) for three transects:

$$PI_M = \frac{PI_T}{N}$$

where:

PI_M = Mean prevalence index for transects
PI_T = Sum of prevalence index values for all transects
N = Total number of transects

For example: PI for Transect 1 = 2.85
PI for Transect 2 = 3.16
PI for Transect 3 = 2.93

$$PI_M = \frac{2.85 + 3.16 + 2.93}{3} = \frac{8.94}{3} = 2.98$$

3. Computation of standard deviation (s) for prevalence index (PI):

$$s = \sqrt{\frac{(PI_1 - PI_M)^2 + (PI_2 - PI_M)^2 + (PI_3 - PI_M)^2}{N - 1}}$$

For example:

Transect	PI_i	PI_M	$(PI_i - PI_M)$	$(PI_i - PI_M)^2$
1	2.85	2.98	–0.13	0.0169
2	3.16	2.98	0.18	0.0324
3	2.93	2.98	–0.05	0.0025
				0.0518

$$s = \sqrt{\frac{0.0518}{3 - 1}} = \sqrt{\frac{0.0518}{2}} = \sqrt{0.0259} = 0.161$$

4. Computation of standard error ($s\bar{x}$) of the prevalence index:

$$s\bar{x} = \frac{s}{\sqrt{N}} = \frac{0.161}{\sqrt{3}} = \frac{0.161}{1.73} = 0.093$$

Since 0.093 does not exceed 0.20, no additional transects are needed.

5. Record mean prevalence index value.

$PI_M = 2.98$

Since 2.98 is less than 3.0, the area has hydrophytic vegetation. If the wetland hydrology criterion is met, then the area is a wetland.

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