ENVIRONMENTAL SCIENCES DIVISION

IDENTIFICATION AND CHARACTERIZATION OF WETLANDS
IN THE BEAR CREEK WATERSHED

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Environmental Sciences Division
Publication No. 4075

Date Published—October 1993

Prepared for
Environmental Management Department
Health, Safety, Environment
and Accountability Division
Oak Ridge Y-12 Plant
(Activity No. 72 22 11 96 1)

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6286
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

MASTER

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ACRONYMS

BC	Bear Creek
BCFP	Bear Creek floodplain
DOE	Department of Energy
ESD	Environmental Sciences Division
ET	east tributary
GIS	Geographic Information System
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NT	north tributary
ORR	Oak Ridge Reservation
ORRSF	Oak Ridge Reservation Storage Facility
PEM	Palustrine Emergent Wetland
PFO1	Palustrine Broad-leaved Deciduous Forested Wetland
PSS1	Palustrine Scrub/Shrub Wetland
ROW	right-of-way
SS	south spring
ST	south tributary
TDEC	Tennessee Department of Environment and Conservation
USACOE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
WAG	Waste Area Grouping
WT	west tributary
WWSY	White Wing Scrap Yard

ACKNOWLEDGMENTS

We thank Richard Winterfield for digitizing the wetlands from our sketches and notes into the Geographic Information System data base and for producing the wetland map for this project. We also thank Mark Peterson and Bill Sanford for their critical reviews of this manuscript.

This work was funded by the Oak Ridge Y-12 Plant Department of Environmental Management; Health, Safety, Environment, and Accountability Division. The Y-12 Plant and ORNL are managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy under contract DE-AC05-84OR21400. The research was conducted on the Oak Ridge National Environmental Research Park.

EXECUTIVE SUMMARY

The Bear Creek watershed from the west end of the Oak Ridge Y-12 Plant to the confluence of Bear Creek with East Fork Poplar Creek was surveyed for the presence of wetlands. The wetlands were identified according to U.S. Army Corps of Engineers methodology (USACOE 1987). The approximate location and boundaries of all identified wetlands were digitized in the Environmental Sciences Division (ESD) Geographic Information System (GIS) data base. The wetlands were initially classified according to the Cowardin et al. (1979) system; however, site-specific modifiers based on vegetation successional stage, topographic position, and degree of disturbance were added to this initial classification system resulting in the identification of nine wetland categories in the Bear Creek watershed. The wetland category that occurs most frequently is palustrine forested wetland in wide stream bottoms, followed by palustrine emergent wetlands in disturbed areas.

Most of the wetlands are less than 0.4 ha (1 acre) in size, with many in upstream reaches of tributaries being less than 0.1 ha (0.25 acres) in size. The largest wetland is the palustrine forested wetland in the Bear Creek floodplain west of Route 95. The Hembree Marsh wetland, with its emergent-to-forested wetland gradient; deep, organic soils; and permanent saturation, is unique in the Bear Creek watershed and is an uncommon wetland type on the Oak Ridge Reservation. Hembree Marsh and the Bear Creek floodplain wetland are known habitat for two rare plant species and are registered Tennessee Natural Areas.

There are several woody and herbaceous species that are common to almost all of the wetlands. These species include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), green ash (*Fraxinus pennsylvanica*), ironwood (*Carpinus caroliniana*), and microstegium (*Eulalia viminea*). Plant species diversity and abundance, determined by visual estimate, appeared to be highest in the emergent wetlands in power-line rights-of-way, in Hembree Marsh, and in the large Bear Creek floodplain wetland.

Most of the wetlands had ponded water and/or saturated soils within 30.5 cm (12 in) of the surface during the 1992 growing season. The presence of a shallow water table in these areas, in spite of their small drainage areas and the below-normal precipitation for the year, suggests that these areas remain saturated or saturated near the soil surface throughout most years and that groundwater and/or shallow subsurface flow are the primary sources of moisture.

Soils in the wetlands have low chroma colors, gleying, mottles, organic accumulations, and manganese and iron concretions. A qualitative comparison of wetland location to soil map units (Lietzke and Lee 1990) indicated no clear correlation between soil units and the presence or absence of wetlands. The soils that were mapped most frequently in wetland areas are classified as Typic and Aeric Fluvaquents and have formed or been derived from the Conasauga Alluvium and the Rome and Pumpkin Valley Formations. However, these soils taxa do not support wetlands in all locations where they are mapped. Other factors, such as past land uses and soil and streambank erosion, may exert a strong influence on the establishment of wetlands.

The hydrologic regimes and biogeochemical characteristics of the wetlands in the Bear Creek watershed are not well understood. In addition, the potential hydrologic, chemical, and biological linkages between the wetlands, the tributary streams, and the main stem of Bear Creek are not known.

1. INTRODUCTION

1.1 OBJECTIVES

The primary objective of this study was to identify, characterize, and map the wetlands in the Bear Creek watershed. A preliminary wetland categorization system based on the Cowardin classification system (Cowardin et al. 1979) with additional site-specific topographic, vegetation, and disturbance characteristic modifiers was developed to characterize the type of wetlands that exist in the Bear Creek watershed. An additional objective was to detect possible relationships among site soils, hydrology, and the occurrence of wetlands in the watershed through a comparison of existing data with the field survey. Research needs are discussed in the context of wetland functions and values and regulatory requirements for wetland impact assessment and compensatory mitigation.

2. SURVEY METHODS

2.1 FIELD METHODOLOGY

A field survey was conducted from August to October 1992 to identify wetlands in the Bear Creek watershed on the Department of Energy (DOE) Oak Ridge Reservation (ORR), Roane County, Tennessee. Wetlands were identified according to the U.S. Army Corps of Engineers criteria for wetlands delineation (USACOE 1987).

During the survey, the vegetation and soils were examined to determine the presence of wetlands in all of the drainages in the Bear Creek watershed [excluding north tributaries (NTs) 1 through 5], including the main stem Bear Creek floodplain, tributaries, and subtributaries. The tributary drainages in the Bear Creek watershed are NTs 1 through 15; east tributaries (ETs) 1 through 4; west tributaries (WTs) 1 through 4, and; south tributaries (STs) 1 through 4 (Fig. 1). The areas identified as wetlands during the field survey were digitized into the Environmental Sciences Division (ESD) Geographic Information System (GIS) and are presented in Fig. 1. The areal size, boundaries, and locations of the identified wetlands are approximate. Accurate determination of wetland size and location would require field delineation of the wetland boundary. Field delineation may be required if project activities are proposed in an area containing wetlands.

The wetlands and subtributaries in the drainages of NT1 through NT5 were delineated at the proposed site of the Oak Ridge Reservation Storage Facility (ORRSF) to comply with National Environmental Policy Act (NEPA) requirements and regulations promulgated under the Federal Water Pollution Control Act (FWPC 1992) and the Tennessee Water Quality Control Act (TDEC 1987). The digitized wetland boundaries for these tributaries were provided by the engineering firm of Barge, Waggoner, Sumner, and Cannon (BWSC), which performed the engineering survey of the delineated wetland boundaries, and were transferred to the ESD GIS data base. These areas are described in the Wetland and Open Water Delineation Report (Rosensteel, 1992, unpublished data) prepared for the ORRSF project, portions of which are included in Appendix A of this report.

In most cases, the entire length of the tributary was investigated. However, on a few tributaries only the downstream sections were surveyed because of either

- the presence of contaminated areas upstream [NT7 and NT8 (Bear Creek Burial Grounds) and ET3 and ET4 (White Wing Scrap Yard)];
- the presence of physical evidence, including high banks and dry streambeds, in the downstream sections to suggest that no wetlands would be found in upstream sections (WT1); or
- if the tributary was not found (WT3 and WT4).

However, the omission of these areas from the current survey for these reasons should not be taken as verification that no wetlands are present. Areas surrounding the perennial springs on the north-facing slope of Chestnut Ridge were also examined for the presence of wetlands and are referred to herein as south springs (SS).

1 Forested Wetlands in Tributary Bottoms - Open Understory	5 Forested Wetlands in Depn
1A - Broad, level bottoms	6 Emergent Scrub/Shrub: Fores
1B - Benches and depressions in narrow bottoms	7 Forested Wetlands in Bear
2 Forested Wetlands in Tributary Bottoms - Dense Understory	8 Floodplain Forested Wetlan
3 Emergent Wetlands in Forested Areas in Upstream Reaches	9 Wetlands at South Springs
3A - Groundwater seeps on slight slopes	
3B - Narrow, sloped bottoms at headwall springs	
4 Disturbed Area Wetlands	
4A - Road and utility rights-of-way	Roads
4B - Unmaintained scrub/shrub areas	Streams

Fig. 1. Approximate locations and class

Discharges at Tributary Heads

Transmission lines

Wetland Complex

Creek Floodplain Backwater Areas

Wetlands on Mainstream Bear Creek

(SS)

Coordinate System: ORNL
5,000 foot grid tics

Sources of Mapped Data:

Base data- TVA S-16A. December, 1987.

Stream updates- Barge, Waggoner, Sumner &
Cannon. August, 1992.

- B.A. Rosensteel & C.C. Trettin

Prepared by: RF Winterfield

Classification of wetlands in Bear Creek Valley.

2.2 WETLAND IDENTIFICATION METHODOLOGY

The USACOE (1987) defines wetlands as

Those areas that are inundated or saturated by surface or ground water 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.

In accordance with the USACOE method, the following three characteristics are diagnostic of wetlands:

1. The prevalent vegetation consists of macrophytes typically adapted to wetland soil and hydrological conditions.
2. The substrate is undrained hydric soil.
3. The area is inundated either permanently or periodically at depths < 2 m (< 6.6 ft), or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.

Hydrophytic vegetation is defined as "the sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present" (USACOE 1987). The U.S. Fish and Wildlife Service (Reed 1988) has developed a classification system that assigns species to wetland indicator classes according to the range of estimated probabilities, expressed as a percentage of occurrence, of a species occurring in a wetland. Table 1 shows the indicator classifications with their corresponding percentages of occurrence.

Table 1. Plant indicator classifications and percentage occurrence in wetlands (Reed 1988)

Classification	Occurrence in wetlands (%)
Obligate (OBL)	>99
Facultative wetland (FACW)	67-99
Facultative (FAC)	34-66
Facultative upland (FACU)	1-33
Upland (UPL)	<1

If greater than 50% of the dominant species in each strata in the plant community have an indicator status of OBL, FACW, and/or FAC, the vegetation community is hydrophytic.

Hydric soils are soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in a major part of the root zone. Indicators of hydric soils are low chroma colors [chroma 1 or 2 as indicated on Munsell Soil Color Charts (Kollmorgen Corporation 1990)], gleying, mottling, iron and manganese concretions, and organic accumulations. Low chroma numbers are an indication of the degree of soil reduction as a result of anaerobic soil conditions. Gleyed soils are gray, bluish, or greenish and are an indication of highly reduced soil. Soils that have brightly colored mottles and a low-matrix chroma are indicative of a fluctuating water table (USACOE 1987). During the oxidation-reduction process, iron and manganese in suspension are sometimes segregated as oxides into concretions that show up as black or red structures in the soil.

Of the three technical criteria, wetland hydrology is generally the least exact and most difficult to establish in the field. Indicators of wetland hydrology include recorded data (e.g., aerial photographs, soil surveys, and floodplain delineations) and field data. Field data includes morphological plant adaptations, oxidized root channels, water marks, and surface scouring.

2.3 WETLAND CATEGORIES

Cowardin et al. (1979) developed a hierarchical wetland classification system. Under this system, the wetlands found in the Bear Creek watershed defined to the subclass level are:

1. palustrine, forested, broad-leaved, deciduous (PFO1),
2. palustrine emergent (PEM); and
3. palustrine scrub/shrub broad-leaved deciduous (PSS1).

These classifications may be further distinguished by modifiers that include dominance type (the dominant vegetation species), water regime, water chemistry, and soil type. To better describe the difference between wetlands in the Bear Creek watershed, extra modifiers were used in addition to the Cowardin modifiers. Nine categories were established that classify first to the subclass level in the Cowardin system and, secondarily, according to the site-specific modifiers of size, vegetation density, successional stage, disturbance history, and landscape position. It is possible that these variations among the wetlands may be related to differences in soils, geomorphology, hydrology, or past land-use practices in the watershed, which in turn may be related to differences in wetland function through their effects on specific processes (i.e., evapotranspiration, biogeochemistry, and sedimentation). The nine categories are listed in Table 2.

Table 2. Wetland categories in the Bear Creek watershed classified to subclass (Cowardin et al. 1979^a) and by site-specific modifiers

Category	Description
1	Palustrine forested wetlands (PF01) in tributary bottoms: open understory
2	Palustrine forested wetlands (PF01) in tributary bottoms: dense understory
3	Palustrine forested wetland (PF01) along upstream reaches of tributaries
4	Wetlands in disturbed areas
5	Palustrine forested wetlands (PF01) at or upslope of tributary heads
6	Palustrine emergent/scrub-shrub/forested wetland complex
7	Palustrine forested wetlands (PF01) in backwater areas in the Bear Creek floodplain
8	Palustrine forested wetlands (PF01) in the downstream Bear Creek floodplain

^aCowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. U.S. Fish and Wildlife Service. Washington, D.C.

3. BEAR CREEK WETLANDS VEGETATION, SOILS, AND HYDROLOGY

3.1 VEGETATION

A list of the dominant species found in the wetlands and their indicator classifications (Reed 1988) are presented in Table 3. The vegetation in the Bear Creek wetlands is classified as hydrophytic because each strata is dominated by species that are facultative, facultative wetland, or and/or obligate.

The wetlands in the Bear Creek watershed share many of the same vegetation species, but there is a difference in species richness and community structure between the wetland types. Red maple, sweetgum, green ash, slippery elm (*Ulmus rubra*), ironwood, silky dogwood (*Cornus amomum*), and spicebush (*Lindera benzoin*) are common woody species dominant in almost all of the wetland types. Herbaceous species that are found in almost all of the wetlands include microstegium, Virginia knotweed (*Tovara virginiana*), cardinal flower (*Lobelia cardinalis*), and false nettle (*Boehmeria cylindrica*). Dotted smartweed (*Polygonum punctatum*), hog peanut (*Amphicarpaea bracteata*), bugleweed (*Lycopus americanus*), and sedge (*Scirpus* sp. and *Carex* sp.) were also common in most wetlands. The emergent wetlands, including Hembree Marsh (see Sect. 3.3.6.), and disturbed area wetlands, which appeared from visual estimation to have the highest species diversity and abundance of all the Bear Creek wetlands, support herbaceous species, including woolgrass (*Scirpus cyperinus*), cattail (*Typha latifolia*), fox sedge (*Carex vulpinoidea*), water hemlock (*Cicuta maculata*), New York ironweed (*Vernonia noveboracensis*), and green bulrush (*Scirpus atrovirens*), that are generally not found in the forested wetlands. The riparian, forested wetlands in the upstream sections of the tributary drainages appeared, in comparison with the other wetlands, to have a lower species diversity, with a high abundance of certain species such as sweetgum, ironwood, and microstegium.

3.2 WETLAND SOILS AND HYDROLOGY

Certain hydric soil characteristics (low chroma, mottling, and iron and manganese concretions) were similar among the wetlands. The soils in most of the wetlands are dark gray to brownish-gray, with reddish-brown and yellowish-brown mottles and manganese concretions. Soil textures included silts, clays, silt and clay loams, and sandy loams. Soils were examined primarily for hydric characteristics and texture for the purposes of this initial characterization. For further information the reader is referred to Lietzke and Lee (1990), which provides a detailed description of the geology, geomorphology, and soils in portions of the Bear Creek watershed.

Specific areas within wetlands that may be saturated for most or all of the year include areas found immediately upstream of the Bear Creek Haul Road and powerline right of way (ROW); at springs and seeps at the base of Pine Ridge and Chestnut Ridge; seeps in the large, forested wetland in Bear Creek floodplain west of Route 95; and the emergent/scrub-shrub sections of the Hembree Marsh wetland (see Sect. 3.3.8 and Fig. 1). The soils in these areas are bluish-gray and greenish-gray and have fewer mottles. This gleying indicates highly reduced soil conditions and little fluctuation in the seasonal water table. These soils have organic accumulations in the surface layer that range in depth from several inches to over a foot.

Table 3. Partial list of plant species in wetlands in the Bear Creek watershed and their indicator classification

Common name	Scientific name ^a	Indicator classification ^b
Herbaceous species		
Carolina quillwort	<i>Isoetes caroliniana</i>	OBL
Sensitive fern	<i>Onoclea sensibilis</i>	FACW
Royal fern	<i>Osmunda regalis</i>	OBL
Cinnamon fern	<i>Osmunda cinnamomea</i>	FACW+
Lady fern	<i>Athyrium filix-femina</i>	FAC
Soft rush	<i>Juncus effusus</i>	FACW+
Leathery rush	<i>Juncus coriaceus</i>	FACW
Sallow sedge	<i>Carex lurida</i>	OBL
Fox sedge	<i>Carex vulpinoidea</i>	OBL
Bailey's sedge	<i>Carex baileyi</i>	FACW
Frank's sedge	<i>Carex frankii</i>	OBL
Bladder sedge	<i>Carex intumescens</i>	FACW
Fringed sedge	<i>Carex crinita</i>	FACW+
Leafy bulrush	<i>Scirpus polyphyllus</i>	OBL
Bulrush	<i>Scirpus</i> sp.	OBL
Woolgrass	<i>Scirpus cyperinus</i>	OBL
Spikerush	<i>Eleocharis</i> sp.	DS
Grass	<i>Chasmantheium laxum</i> or <i>C. sessiliflorum</i>	FACW- FAC+
Woodreed	<i>Cinna arundinacea</i>	FACW
Fowl manna grass	<i>Glyceria striata</i>	OBL
Rice cutgrass	<i>Leersia oryzoides</i>	OBL
Microstegium	<i>Eulalia viminea</i>	FAC+
Virginia knotweed	<i>Tovara virginiana</i>	FAC
Dotted smartweed	<i>Polygonum punctatum</i>	FACW+
Arrowleaf tearthumb	<i>Polygonum sagittatum</i>	OBL
Cardinal flower	<i>Lobelia cardinalis</i>	FACW+
Great lobelia	<i>Lobelia siphilitica</i>	OBL
Jewelweed	<i>Impatiens capensis</i>	FACW
Water hemlock	<i>Cicuta maculata</i>	OBL
Monkeyflower	<i>Mimulus ringens</i>	OBL
Bugleweed	<i>Lycopus</i> sp.	OBL
St. Johnswort	<i>Hypericum mutilum</i>	FACW
Buttonweed	<i>Diodia virginiana</i>	FACW
False nettle	<i>Boehmeria cylindrica</i>	FACW+

Table 3. Partial list of plant species in wetlands in the Bear Creek watershed and their indicator classification (continued)

Common name	Scientific name ^a	Indicator classification ^b
Herbaceous species (continued)		
Bulbous bittercress	<i>Cardamine bulbosa</i>	OBL
Hedgehyssop	<i>Gratiola neglecta</i>	OBL
Seedbox	<i>Ludwigia</i> sp.	OBL
Cattail	<i>Typha latifolia</i>	OBL
Bedstraw	<i>Galium</i> sp.	DS
New York ironweed	<i>Vernonia noveboracensis</i>	FAC+
Boneset	<i>Eupatorium perfoliatum</i>	FACW+
Peppermint	<i>Mentha X piperita</i>	FACW
Horsetail	<i>Equisetum</i> sp.	FAC or FACW
Water plantain	<i>Alisma</i> sp.	OBL
Arrowhead	<i>Sagittaria</i> sp.	OBL
Tubercled rein orchid ^c	<i>Platanthera flava</i> var. <i>herbiola</i>	FACW
Purple fringeless orchid ^c	<i>Platanthera peramoena</i>	FACW
Fen orchid ^c	<i>Liparis loeselii</i>	NL
Sweetflag	<i>Acorus calamus</i>	OBL
Canada lily ^c	<i>Lilium canadense</i>	FAC
Woody vines		
Poison ivy	<i>Toxicodendron radicans</i>	FAC
Japanese honeysuckle	<i>Lonicera japonica</i>	FAC-
Virginia creeper	<i>Parthenocissus quinquefolia</i>	FAC
Hog peanut	<i>Amphicarpaea bracteata</i>	FAC
Trees and shrubs		
Silky dogwood	<i>Cornus amomum</i>	FACW+
Brookside alder	<i>Alnus serrulata</i>	FACW+
Silky dogwood	<i>Cornus amomum</i>	FACW+
Flowering dogwood	<i>Cornus florida</i>	FACU
Buttonbush	<i>Cephalanthus occidentalis</i>	OBL
Ironwood	<i>Carpinus caroliniana</i>	FAC
Black willow	<i>Salix nigra</i>	OBL
Slippery elm	<i>Ulmus rubra</i>	FAC

Table 3. Partial list of plant species in wetlands in the Bear Creek watershed and their indicator classification (continued)

Common name	Scientific name ^a	Indicator classification ^b
Trees and shrubs (continued)		
American elm	<i>Ulmus americana</i>	FACW
Tulip poplar	<i>Liriodendron tulipifera</i>	FAC+
Box elder	<i>Acer negundo</i>	FACW
Red maple	<i>Acer rubrum</i>	FAC
Sweetgum	<i>Liquidambar styraciflua</i>	FAC+
Green ash	<i>Fraxinus pennsylvanica</i>	FACW
Sycamore	<i>Platanus occidentalis</i>	FACW-
Basket oak	<i>Quercus michauxii</i>	NI

^aSpecies are not listed taxonomically.

^bDefined by Reed (1988):

- OBL - obligate wetland
- FACW - facultative wetland
- FAC - facultative
- DS - indicator depends on species
- NI - no indicator classification
- +
-
- more frequently found in wetlands
- less frequently found in wetlands

^cSpecies listed as threatened or endangered by the state of Tennessee.

[Tennessee Department of Environment and Conservation (TDEC). Ecological Services Division. 1991a. Rare and endangered plant listing. Nashville, Tenn.]

Most of the wetlands along the north, east, and south tributaries and SS had ponded water and/or soils saturated to the surface during the late summer months, when precipitation, surface runoff, and stream discharge are typically at their lowest levels. This suggests that groundwater is the major hydrologic component of the wetlands in the summer. Precipitation-driven shallow subsurface flow may be an important input to the wetland water budget in fall, winter, and spring. Subsurface flow is also referred to as subsurface stormflow and throughflow. These terms refer to the downslope flow of water or movement of subsurface stormwater within the soil profile, usually under unsaturated conditions. It is an intermediate component of runoff made up of subsurface flow that returns to form surface runoff without reaching the water table (Chorley 1980).

3.3 WETLAND CATEGORIES

The approximate locations and the given category of the wetlands identified during this field survey and the ORRSF wetland delineation are presented in Fig. 1 and in Fig. A.1, respectively. Several of the categories, notably those classified as palustrine forested wetlands and disturbed area palustrine emergent wetlands, are well represented in the Bear Creek watershed. Scrub/shrub and undisturbed emergent wetlands do not occur frequently. Wetlands are listed by category and tributary or floodplain location in Table 4.

3.3.1 Category 1—Palustrine Forested Wetlands (PFO1) in Tributary Bottoms: Open Understory

The vegetation community in this category consists of an immature hardwood forest canopy with a comparatively open understory and abundant ground cover. The dominant canopy and subcanopy species are sweetgum, red maple, slippery elm, green ash, and ironwood. Sycamore (*Platanus occidentalis*) and tulip poplar are also common in some of these wetlands. Shrubs and saplings are more likely to be located along the wetland margin or to occur in clumps or as scattered individuals throughout the wetland. The shrub layer includes silky dogwood, brookside alder (*Alnus serrulata*), and spicebush. The herbaceous layer is often dominated by microstegium, an invasive introduced species; however, cardinal flower, hog peanut, false nettle, bugleweed, dotted smartweed, rushes (*Juncus* spp.), and sedges (*Scirpus* spp.) are also common. There is some variation within and among the wetlands in the composition of the groundcover community. In wetter areas cutgrass (*Leersia oryzoides*), leafy bulrush (*Scirpus polyphyllus*), monkeyflower (*Mimulus ringens*), fringed sedge (*Carex crinita*), fowl manna grass (*Glyceria striata*), woodreed (*Cinna arundinacea*), and jewelweed (*Impatiens capensis*) form a dense herbaceous layer.

Two subcategories divide the wetlands by areal size and/or by location on the tributary. The first subcategory (C1A) includes palustrine forested wetlands in broad, level bottoms, which are usually located in the downstream sections of the tributary. Many of the NTs have this type of wetland located immediately north of the Haul Road or power-line ROW. On a few of the NTs, C1A wetlands are located in the reach between the Haul Road and Bear Creek. From observations of these areas on several dates from spring to late summer, it appears that they are saturated throughout the growing season. Twelve C1A wetlands were identified in nine tributary drainages. All except one, located along ET4, are in the NT drainages (NT 1, 2, 3, 6, 8, 9A, 10 and 10A, 11, and 13C) (Fig. 1).

Table 4. Occurrence of specific wetland categories in the Bear Creek floodplain and tributaries

[illegible]

Table 4. Occurrence of specific wetland categories in the Bear Creek floodplain and tributaries (continued)

Tributary	Wetland category ^a											
	1A	1B	2	3A	3B	4A	4B	5	6	7	8	9
NT13B		X										
NT13C	X					X						
NT14			X			X						
NT14A		X										
NT15			X			X						
NT15A		X			X							
NT15B			X									
ET1 ^c												
ET1A								X				
ET1B				X	X							
ET1C			X									
ET2 ^c												
ET3									X ^d			
ET4	X											
WT1 ^c												
WT2		X	X									
WT3 ^c											X	
WT4 ^c											X	
ST1 ^c												
ST2		X										
ST3		X				X						
ST4 ^c												
BCFP ^f							X			X		X ^d

Table 4. Occurrence of specific wetland categories in the Bear Creek floodplain and tributaries (continued)

Tributary	Wetland category ^a											
	1A	1B	2	3A	3B	4A	4B	5	6	7	8	9
SS2												X
SS3												X
SS4												X
SS8												X

^aCategory Description:

C1—Paulstrine Forested Wetlands in Tributary Bottoms: Open Understory

C1A—Broad, level bottoms

C1B—Benches or depressions in narrow bottoms

C2—Paulstrine Forested Wetlands in Tributary Bottoms: Dense Understory

C3—Paulstrine Emergent Wetlands In Forested Areas In Upstream Reaches

C3A—Groundwater seeps on slight slopes

C3B—Narrow, sloped bottoms at headwall springs

C4—Disturbed Area Wetlands

C4A—Road and utility rights-of-way

C4B—Unmaintained scrub/shrub areas

C5—Paulstrine Forested Wetlands in Depressions at Tributary Heads

C6—Paulstrine Emergent:Scrub/Shrub:Forested Wetland Complex

C7—Paulstrine Forested Wetlands in BCFP Backwater Area

C8—Paulstrine Floodplain Forested Wetlands on Mainstem Bear Creek

C9—Wetlands at Chestnut Ridge Springs

^bTributary IDs are from Southworth et al. (1992). (Southworth, G. R., J. M. Loar, M. G. Ryon, J. G. Smith, A. J. Stewart, and J. A. Burris. 1992. Ecological effects of contaminants and remedial actions in Bear Creek. ORNL/TM-11977.)

^cNo wetlands identified.

^dThese wetlands are registered Tennessee Natural Areas and are habitat for rare plant species.

^eWithin Bear Creek floodplain C1A wetland.

^fBCFP = Bear Creek floodplain.

The second subcategory (C1B) includes small, palustrine forested wetlands located on low-elevation benches or depressions adjacent to the stream. These wetlands are usually found in narrow-bottomed upstream sections of the drainage and where the microtopography of the riparian zone leads to an interspersed higher-elevation, moderately well-drained sites and lower-elevation, poorly drained sites that have a seasonal or perennial high water table. Because of their location in upstream areas on higher-elevation benches adjacent to the stream, the soils in these wetlands may not be saturated throughout the growing season to the degree found in the larger, downstream C1A wetlands. C1B wetlands were identified in eleven tributary drainages. Although they are primarily located on NTs and subtributaries (NT 1A, 2, 3, 6, 9, 12A, 13B, 14A, 15A) (Fig. 1), a long, narrow C1B wetland is located along the length of ST2 and a very small C1B wetland is located adjacent to ST3.

3.3.2 Category 2—Palustrine Forested Wetlands (PFO1) in Tributary Bottoms: Dense Understory

Category 2 wetlands are located on level, narrow or wide benches and depressions immediately adjacent to the stream and on slight slopes upslope of the stream heads. The topographic positions and the soil and hydrologic characteristics of these wetlands are the same as category 1 wetlands. The primary difference is the dense understory, which may be the result of more recent disturbance or represent an early successional stage. Although the tree and shrub species composition is the same, the subcanopy and shrub layer forms dense thickets instead of the more open arrangement of category 1 wetlands. Ironwood, slippery elm, green ash, and spicebush are among the dominant sapling and shrub species. The groundcover layer consists primarily of scattered patches of microstegium, false nettle, and sedges. Poison ivy (*Toxicodendron radicans*), hog peanut, and greenbrier (*Smilax* sp.) vines are abundant throughout the sapling/shrub layer.

The hydrology of these wetlands is similar to the C1B wetlands. Some sections of these wetlands did not have soil saturation near the surface during the late-summer survey. Possible explanations include differences in elevation, soil type, seasonal depth to the high water table, and/or evapotranspiration rates.

Category 2 wetlands are found in the NT4, NT5, NT12, NT14, NT15, and NT15B drainages. Two very small [< 0.04 ha (< 0.10 acre)] C2 wetlands were identified on a subtributary of ET1 (ET1C) and on W2.

3.3.3 Category 3—Palustrine Forested Wetlands (PFO1) Along Upstream Reaches of Tributaries

These wetlands occur in the upper reaches of most of the north and one of the east (ET1) tributaries. There are two subcategories that are separated on the basis of location along the stream and wetland shape. Subcategory 3A wetlands occur at groundwater seeps on slight slopes and on apparent perched water tables downslope of seeps. The seeps are usually not located at the bottom of north-south trending sideslopes as in the categories 1 and 2 wetlands but occur in areas near the base of the south-facing slopes of Pine Ridge. Six C3A wetlands were identified in five drainages (NT2C and NT2B, NT3, NT6, NT13A, and ET1B).

Subcategory 3B wetlands are located on slight slopes adjacent to the stream in the narrow, deeply incised areas downslope of the headwall springs. Thirteen C3B wetlands were identified in twelve drainages. All of the C3B wetlands are located at the base of the upper

slopes of Pine Ridge along the following tributaries: NT1, NT2B and NT2C, NT4, NT9A, NT10, NT11, NT12, NT13B, NT15A, and ET1B.

C3B wetlands do not usually have canopy species but are shaded by overhanging canopy trees that grow in the surrounding uplands. Both C3A and C3B wetlands support spicebush, flowering dogwood, and ironwood as common understory species. Microstegium, leafy bulrush, fowl manna grass, cutgrass, Virginia knotweed, monkeyflower, false nettle, and cardinal flower are among the dominant groundcover species. Soil borings from these areas had saturated soils and free water during the August and September survey.

3.3.4 Category 4—Wetlands in Disturbed Areas

Category 4 wetlands are those that have developed or increased in size as a result of land disturbance and alteration. Included are palustrine emergent and scrub/shrub wetlands on the upstream side of roads and in utility ROWs and palustrine scrub/shrub wetlands where the disturbance has not occurred recently.

There are two subcategories. Most of the C4 wetlands are in the first subcategory, 4A, which defines the wetlands in partially blocked drainages upstream of roads and in ROWs. These wetlands are dominated by black willow (*Salix nigra*), brookside alder, and a large assortment of herbaceous species. The shrubs and saplings occur singly or in patches, and herbaceous vegetation dominates. Palustrine emergent and scrub/shrub wetlands in small areas on the upstream side of the Bear Creek Haul Road on NT3 through NT12 appear to be expansions of existing wetland areas that were formerly forested. In the cleared Bear Creek power-line ROW along NT1, NT2, and the NT13 through NT15 drainages, palustrine emergent and scrub/shrub wetlands have developed in areas that formerly may have been forested wetlands. C4A wetlands were identified along twenty-two (22) tributaries and subtributaries; however, this includes only sixteen (16) C4A wetlands because several of these wetlands encompass two stream channels within the ROW. All except one of the fifteen are located along the NTs. The exception is located along ST3 in a different power-line ROW.

Subcategory 4B includes those scrub/shrub thickets in areas that have been disturbed in the past and for which the disturbance conditions are not being maintained (as, for instance, are ROWs through mowing and herbicides). These areas are classified as disturbed area palustrine scrub/shrub wetlands based on the general appearance of the landscape and some of the dominant vegetation species. The landscape evidence includes either old soil piles and berms, tree stumps and slash, and traces of roads. The vegetational evidence is the dominant plant community, which consists of a sapling/shrub/vine thicket representing a possible middle stage of deciduous forest vegetational succession. The disturbance in both of the C4B wetlands identified may be related to past forestry management. Both areas are adjacent to pine plantations.

One C4B wetland has developed on the western side of NT12 downstream of the Haul Road. The vegetation consists of a shrub/sapling thicket dominated by ironwood, dogwood, spicebush, alder, blackberry (*Rubus* sp.), climbing vines of Japanese honeysuckle (*Lonicera japonica*), poison ivy, greenbrier, and microstegium. There is a widely spaced canopy of sweetgum and green ash. A pine plantation is immediately adjacent to this area.

The second C4B wetland is located in a block of land bounded approximately by Bear Creek, WT2, and a power-line ROW. It is indicated on Fig. 1 as occurring adjacent to the downstream portion of WT1, although the wetland may not extend this far to the south. The extent of this wetland or its hydrology was not determined. Within this area are stands of dead trees (mostly pines) with elm and red maple saplings and silky dogwood in the

understory. The groundcover includes water-tolerant species such as sedges, bugleweed, and false nettle. Aerial photos from 1981 show part of this area to be cleared. This area should be surveyed again to better determine the type, extent, and hydrology of this wetland.

3.3.5 Category 5—Palustrine Forested Wetlands (PFO1) at or Upslope of Tributary Heads

These wetlands occur in level areas upslope of or surrounding the upper reaches of the headwater tributaries. They are in topographic depressions surrounded by moderate slopes or low banks from which they receive surface runoff. Groundwater discharge is probably the dominant water source. The water appears to be perched above impermeable soil layers, and the topography probably prevents rapid runoff of precipitation. Evidence of ponded water and surface flow includes bare, unvegetated soils with no leaf litter; a compressed, water-stained layer of leaf litter; and small drift lines. The trees and larger shrubs grow on small hummocks, and the roots are shallow and exposed at the surface, which indicates a gradual erosion of the soils from around the trees and prolonged inundation or saturation.

There are two wetlands of this type in the Bear Creek watershed; these are located on subtributaries of NT3 and ET1. On the day of the survey, the soil in the ET1 wetland was not saturated. In an October visit to NT3, there also was no standing water and the soil was dry. However, this wetland, which appears to be very similar in landform, vegetation, and soils to the ET1 wetland, was observed to have standing water to a depth of several inches in the spring and early summer.

The vegetation community in the C5 wetland on NT3 includes at least two species that are obligate wetland species—the clammy hedge hyssop (*Gratiola neglecta*) and Carolina quillwort (*Isoetes caroliniana*). The Carolina quillwort is a newly identified species that is uncommon on the Oak Ridge Reservation (ORR) and may in the future be considered for state or federal rare plant status (L. Pounds, Environmental Sciences Division, Oak Ridge, personal communication to B. Rosensteel, June 1992).

3.3.6 Category 6—Palustrine Emergent/Scrub-Shrub/Forested Wetland Complex

This category comprises wetlands that extend through an elevation and moisture gradient from emergent through scrub/shrub to forested wetland. The one example of this wetland category in the Bear Creek watershed is Hembree Marsh located adjacent to ET2. Hembree Marsh was designated as a Research Park Reference Area (RA5) because of its unique biotic features (Parr and Pounds 1987). More recently, it has been designated as a Research Park Natural Area (NA24) because of the presence of the fen orchid (*Liparis loesilii*) listed by the state of Tennessee as an endangered species (TDEC 1991).

Hembree Marsh is located between the base of a pine-dominated sideslope and ET2. The palustrine emergent wetland has a diverse herbaceous assemblage, which includes tearthumb (*Polygonum sagittatum*), boneset (*Eupatorium perfoliatum*), jewelweed, peppermint (*Mentha piperita*), cattail, dotted smartweed, great lobelia (*Lobelia siphilitica*), cardinal flower, bedstraw (*Galium* sp.), leafy bulrush, and an assortment of sedges. Shrubs and saplings grow most abundantly in the margins of the emergent area. Species include green ash, black willow, alder, silky dogwood, and sweetgum. The emergent and shrub community grades into a palustrine forested wetland dominated by sweetgum, red maple, black willow, and green ash.

The soils in this wetland differ from the other wetland types identified in the Bear Creek watershed. There is a deep organic layer ranging in depth from at least 15 to 46 cm (6 to 18 in.). This is underlain by gleyed silt.

This wetland appears to receive most of its water from groundwater sources. The stream (ET3) that flows along one edge of the wetland has a deep channel, and stream overflow is probably not common. However, the soil and vegetation characteristics indicate that this area is permanently saturated. Therefore, groundwater seepage and subsurface flow must be the primary water sources. The volume and flow of water in the wetland and downstream reaches of the stream appeared to be higher than that of the reach upstream of the wetland.

3.3.7 Category 7—Palustrine Forested Wetlands (PFO1) in Backwater Areas in the Bear Creek Floodplain

Only one wetland of this type was identified. It is located immediately upstream of the one-way access road to Route 95 from Bear Creek Road. Upstream of this wetland no wetlands were identified in the Bear Creek bottomlands, except for those that are more closely associated with the hydrological characteristics of NT15, NT14, NT12, NT11, NT8, and NT6 drainages, rather than with Bear Creek hydrology. The lack of backwater areas, wetlands, and other hydrological and morphological evidence for flooding suggests that Bear Creek does not routinely overflow its banks in most upstream sections.

The backwater-area palustrine forested wetland is characterized by surface drainage patterns, soil scoured from around woody vegetation, surface and exposed roots, depressions interspersed with low hummocks; hydrophytic vegetation; and low chroma, heavily mottled soils. The soils were not inundated or saturated on the day of the survey. The timing and duration of saturation and inundation in this area appears to be primarily dependent on flood events instead of groundwater and subsurface runoff, as is evident in the other wetlands in the watershed. Hydrologic data collected at the U.S. Geological Survey (USGS) gauging station (Flohr et al. 1991 and Mercer et al. 1992) located at Bear Creek kilometer (BCK) 4.55 (a short distance downstream of the wetland) provide evidence that the wetland area is either inundated or saturated during the growing season (see Section 4.2). In drought years or at certain times of year, a backwater area such as this might not have directly observable wetland hydrology; however, in years of normal or above-normal precipitation, it is highly probable that wetland functions such as flood storage, stormflow alteration, and sediment retention would resume.

3.3.8 Category 8—Palustrine Forested Wetlands (PFO1) in the Downstream Bear Creek Floodplain

A large palustrine forested wetland is located on the west and east floodplains of Bear Creek west of Route 95. It is the largest wetland area in the Bear Creek watershed and contains elements of the C1A, C2, and C7 wetlands. Similar to C1A and C2 wetlands, it is a broad floodplain bottom with areas of both open and dense understory and receives a substantial percentage of its water from groundwater seeps located at the base of Pine Ridge and from a high water table. It may also, like the C7 wetland, receive floodwaters from Bear Creek.

This wetland has been designated a Research Park Reference Area (RA4) because of unique biotic features and a Research Park Natural Area (NA4) because of the presence of the tubercled rein orchid (*Platanthera flava* var. *herbiola*) (Parr and Pounds 1987), a species listed by the state of Tennessee as threatened [TDEC 1991(a)]. This wetland area, along with the nearby Hembree Marsh, is a registered Tennessee Natural Area (Parr and Pounds 1987). The wetland has a diverse vegetation community, which includes all of the woody and

herbaceous plant species identified in the other Bear Creek wetlands during this survey. In addition to the species found in other Bear Creek wetlands, the plant list for this wetland includes horsetail (*Equisetum* sp.), which grows as a dense groundcover in the east floodplain, and water plantain (*Alisma* sp.) and arrowhead (*Sagittaria* sp.), which grow in the seep areas.

The A soil horizon is a gray, mottled, gravelly sandy loam with many coarse fragments. The B soil horizon has similar hydric characteristics but is a sandy clay loam. At the seeps, there is a deep, black, organic surface soil layer.

Palustrine forested wetlands were identified near the confluence of Bear Creek with East Fork Poplar Creek (EFPC). These areas are in the EFPC floodplain and are more closely associated with ecological processes occurring in the EFPC drainage. Therefore, these wetland areas are not included in this discussion of Bear Creek watershed wetlands and are not shown on Fig. 1.

3.3.9 Category 9—Wetlands at South Springs

These wetlands have been included in a separate category to differentiate them from the stream-associated wetlands. The spring areas are similar in vegetation and hydric soil characteristics to category 1 or 3 wetlands but have been disturbed in the past because of their proximity to Bear Creek Road and other activities.

The wetlands surrounding SS2 and SS3 formed in slightly sloping depressions that lie between the springs discharge and Bear Creek Road. In the SS2 wetland, the vegetation consists primarily of herbaceous species such as New York ironweed, sedges, Virginia knotweed, lobelia, rushes, and microstegium. The SS3 wetland also supports green ash, red maple, sweetgum, and tulip poplar, which form an immature canopy and understory.

The SS2 area consists of two springs that flow into a very short stream channel. The stream is culverted under Bear Creek Road. SS3 feeds a small stream that flows ~75 to 90 m (~250 to 300 ft) before flowing through a culvert under Bear Creek Road.

SS4 was issuing from a gap in rocks in the bank of a roadside channel. The spring and the shallow stream channel it flows into lie within 8 to 9 m (25 to 30 ft) of Bear Creek Road. The stream flows parallel to Bear Creek Road for ~30 m (~100 ft) before flowing through a culvert under the road. Low-elevation benches on either side of the channel have hydric soils and support hydrophytic vegetation.

SS8 and SS7 are located in a triangle of land bounded by Bear Creek Road, Route 95, and the one-way Route 95 access from Bear Creek Road. The SS8 wetland is in a level depression on the south side of Bear Creek near the BCK 4.55 gauging station. The spring feeds a slow-moving shallow stream that flows through the wetland. The vegetation species include immature green ash, box elder (*Acer negundo*), brookside alder, silky dogwood, bugleweed, water plantain (*Alisma* sp.), watercress (*Nasturtium officinale*), leafy bulrush, microstegium, and woodreed. No wetlands were found at SS7, although the slow-flowing water supports the growth of watercress and another aquatic species (possibly *Sparganium* sp.) within the stream channel.

SS5 and SS6 are on the south side of Bear Creek. Wetlands were not found at SS5, which issues into a short stream channel and a deep pond and then through a culvert under Bear Creek Road. SS6 was not visited during this survey.

3.4 STREAM HYDROLOGY

3.4.1 North Tributaries

Many of the NTs and subtributaries had baseflow during August through early October. The upstream reaches of most of the NTs and subtributaries, from the headwall springs or seeps almost to Bear Creek, had flowing water. For many of the tributaries, especially the upstream NTs, this baseflow did not reach Bear Creek via surface flow, apparently because of the loss of surface water to the solution cavity system associated with the underlying Maynardville Limestone (Southworth et al. 1992) that occurs mostly in the floodplain and low terraces of Bear Creek (Lietzke and Lee 1990). The reaches in which water was lost to the subsurface on most of these streams appeared to occur a short distance upstream from the Bear Creek confluence. On at least one tributary (NT6), the stream channel contained flowing water and the adjacent wetland soils were saturated to the surface in the tributary reach located within a few hundred feet of the Bear Creek confluence, where both tributary and Bear Creek were dry.

The depths of the NT and subtributary channels ranged from ~15 cm to 2 m (~6 in to 6 ft). Over half of the NT reaches downstream of the Haul Road and power-line ROW are steep-banked and deeper than are upstream reaches. This stream morphology is probably the result of erosion, scouring, and stream channelization from past and current land use and land management. With a few exceptions, wetlands do not occur along these reaches. NT6, NT8, NT12, and NT14 have riparian wetlands between the Haul Road ROW and Bear Creek. Of these tributaries, NT12 and NT14 have steep-banked channels and NT6 and NT8 have shallow-banked channels. NT7, NT9, and NT10 have no wetlands, and NT11 and NT15 have only small wetlands between the Haul Road ROW and Bear Creek. This wetland survey did not cover the downstream reaches of NT3, NT4, and NT5; therefore, we do not know if wetlands are present or whether surface water entered Bear Creek from these tributaries on the dates of our field investigation.

The morphology and hydrology of NT14 differs from all of the other NTs in its morphology and flow characteristics and more closely resembles the McNew Hollow tributary (ET2). NT14 had no flowing water (September observation); a deep, steep-banked channel; and no wetlands along the main channel upstream of the power-line right-of-way. Small wetland areas were identified along a shallow-banked subtributary.

3.4.2 South Tributaries

The STs had baseflow only in the downstream reaches. It is assumed this water reaches Bear Creek as surface flow, although the farthest downstream reaches of the streams (at Bear Creek Road) have been piped and the confluences with Bear Creek were not observed during this survey. All of the SSs that were observed (SS3, SS4, SS5, SS7, and SS8) were flowing. Southworth et al. (1992) concluded that the SSs contributed most of the flow to Bear Creek during periods of low rainfall.

3.4.3 East Tributaries

ET1 and ET2 (McNew Hollow) did not have baseflow on the dates of the September survey. There were no wetlands found along the main stem of ET1, although there are small

areas of wetlands and water in two of its subtributaries. The banks of ET1 are steep, and the channel is several feet deep.

McNew Hollow (ET2) had only a few ponded areas along its entire length and no flowing water until the farthest downstream section near Bear Creek. The ET2 stream channel is deep [-2 to 3 m (~6 to 9 ft)] and has extremely eroded, steep banks. There were no groundwater seeps at the base of the drainage sideslopes nor in the stream, and no wetlands were identified anywhere in this drainage.

ET3 and ET4 had baseflow in their downstream reaches from Bear Creek upstream to at least the boundaries of White Wing Scrap Yard [WWSY, Waste Area Grouping 11 (WAG 11)]. The upper reaches within the WWSY were not walked because of restricted access to this area. However, a wetland survey conducted in the WWSY in Spring 1992 resulted in the identification of scrub/shrub wetlands in previously disturbed areas adjacent to ET3 (Internal Memo to Frank Kornegay from B. Rosensteel, ESD, March 1992, in Appendix B). No wetlands were identified along ET4 within the WWSY during the March 1992 survey.

3.4.4 West Tributaries

WT1 had areas of ponded water, but no flowing water, in the reach upstream of the utility ROW. The stream banks are steep, and the channel is ~1 to 2 m (~4 to 6 ft) deep. No wetlands were identified along WT1; however, a scrub/shrub wetland was identified in the Bear Creek floodplain near the WT1 confluence. It is not clear if there is a hydrologic connection between WT1 and this wetland. The upstream reaches of WT1 and its subtributaries were not investigated during the current survey. A spring is shown on a WT1 subtributary on the ORR S-16A map. There may be wetlands at this spring.

WT2 also has a deep, steep-banked channel. However, unlike WT1, flowing water was present in the upstream reach of WT2 and in subtributaries flowing from the south slopes of Pine Ridge. WT1 is located in a broad area of moderately level topography between Chestnut and Pine ridges, whereas WT2 is located in a saddle on the lower slopes of Pine Ridge. The differences in geology and topographic position between these two tributaries may help to explain the differences in flow.

WT3 and WT4 were not found during this survey. The S-16A map shows that at least half the length of each of these tributaries is located within the large wetland (C8 of Fig. 1) in the Bear Creek floodplain. The channels may be shallow and braided through the wetland and, therefore, not easily observed.

There is an unnamed tributary that is located to the southeast of WT1 on the lower slopes of Chestnut Ridge. This tributary begins on Chestnut Ridge east of Route 95, is culverted under, and then flows parallel to Route 95. On the day of the survey, this stream had baseflow in its midsection reach. However at a small, deep pool located in the reach paralleling Route 95, the water flows over a large boulder and flows underground. The stream was dry from that point downstream to Bear Creek and in its upstream reach east of Route 95.

3.4.5 Bear Creek

The main stem of Bear Creek had dry reaches in the upstream part of the watershed. Although the location and extent of these reaches were not documented during this survey, it is likely that they coincide with those dry reaches identified in Southworth et al. (1992). Flow was present in all downstream reaches of Bear Creek from BCK 4.7 to the confluence with East Fork Poplar Creek during the low rainfall months (August and September) in 1992.

4. RELATIONSHIP OF WETLANDS TO SOILS AND HYDROLOGY

4.1 SOILS

The relationship between the location of wetlands and soil map units was investigated by comparing the wetlands identified in this survey with the soil survey of the ORR (Lietzke and Lee 1990). Map units for the soil survey of the ORR were developed on the basis of geologic formation, geomorphology, soil taxa, slope, and erosion class. However, map units for those portions of the reservation in Anderson County were based Soil Conservation Service survey and hence do not reflect the geology and landform parameters that were incorporated into the survey Roane County. Therefore, the soil maps for wetlands occurring in Anderson County (e.g., NT1 through NT8, ST1, and SS2, SS3, and SS4) are not comparable to those in Roane County. A five digit code was developed to identify the map units, and they were delineated at a scale of 1:10,000 (Lietzke and Lee, 1990). At that scale the width of the line delineating the soil map unit equals approximately 10 feet; accordingly, the relatively small scale of the soil maps and the inherent variability in the composition of soil maps limits the viability of using the published soil survey to locate wetlands. Lietzke and Lee (1990) recommend very large scale mapping (e.g., 1:1,200 or 1:2,400) for site-specific assessments.

The soils that occurred most frequently in wetland-containing floodplains and stream drainages in the Bear Creek Valley were (by code) 97111, 96211, 12131, 10361, and 96021. Although the 30951 and 98041 soil units occur infrequently and appear to be limited to the ST2 drainage on the north-facing slope of Chestnut Ridge, they are discussed because narrow, riparian wetlands were identified adjacent to this tributary. The 90711 and 97021 soil units are the dominant soil units in the Bear Creek floodplain east of Route 95. Those soil map units and their occurrence in Bear Creek drainages and floodplains are discussed below. All soil unit descriptions are from Lietzke and Lee (1990).

4.1.1 Soil Unit 97111

This soil and the 96211 soil unit discussed in the next section were both formed on Recent Alluviums. Recent Alluviums are considered to be less than 300 years old and are the result of anthropogenically accelerated erosion from clearing and agricultural activities of early settlers.

The 97111 unit soils are somewhat poorly drained and occur in nearly level drainageways within areas of Rogersville, Maryville, and Nolichucky soils. Most areas in these soils contain springs or seepage zones or do not have a defined channel and remain wet most of the year (Lietzke and Lee 1990). The soils are classified as Typic and Aeric Fluvaquents, either fine-silty or coarse-silty.

These soils are mapped in sections of the NT1, NT5, NT6, NT11, NT13, and NT15 drainages and the WT1 drainage. Wetlands are found in all of the NT drainages where these soils are mapped, except for NT13; however, wetlands were not found in all areas where these soils were mapped in the Bear Creek watershed. No wetlands were identified along WT1 on this soil unit.

4.1.2 Soil Unit 96211

These soils consist of mostly wet soils on nearly level floodplains of drainageways that have their source in the Rome and Pumpkin Valley Formations. These areas contain springs and seepage zones that keep them wet most of the time, or they lack a defined channel that allows water to flow slowly across the area, thereby keeping the soils wet. Large amounts of manganese may be brought up by upwelling groundwater. The soils are classified as Typic and Aeris Fluvaquents, either coarse or fine-loamy. Most areas of these soils have hardwood vegetation and groundcover vegetation that can tolerate prolonged wetness.

This soil map unit is delineated in the drainages of WT1, WT2, ET3, NT8, NT10, and NT10A and is the primary soil unit in the Bear Creek floodplain in the area located west of Route 95 and south of the Oak Ridge Highway. Wetlands were identified on some, but not all areas of this soil map unit. Category 1A wetlands were identified in the NT8, NT10, and NT10A drainages. A large, forested wetland (C8), a scrub/shrub wetland (C4B), and a smaller forested wetland (C2) are located on these soils in the Bear Creek floodplain and in the area of the WT2 and WT1 confluences with Bear Creek. There were no wetlands identified with WT1 (to the survey boundaries) and only two, small wetlands associated with WT2 upstream of the C2 and C4B wetlands near the Bear Creek confluences. These soils are mapped along almost the entire length of ET3; however, the only wetland that occurs along this stream, downstream of WWSY, is the permanently saturated, emergent-scrub/shrub wetland (C6). Although the vegetation communities and hydrology of the C8 and the C6 wetlands are in concurrence with the general description given for these two parameters in the soil unit description, those of the C4B and C2 wetlands are not.

4.1.3 Soil Unit 12131

This soil unit formed in a mixture of Pumpkin Valley and Rome colluvial materials. Discontinuities in these soils produce conditions for temporary water perching and for the lateral subsurface transmission of water. These soils are Typic Hapludults located on doubly concave footslopes (5 to 12% slopes). The 12131 soil unit is mapped in the uppermost reaches of the drainages on NT2, NT3, NT4, NT5, and NT6. Wetlands were identified in these locations and are probably occurring in the areas of soil discontinuities. Because of the scale of the soils map (1:10,000), the mapping does not differentiate between the soils on sideslopes and those in the deeply incised drainages where the narrow wetlands are found at springs and seeps.

4.1.4 Soil Unit 10361

These soils formed in the lower Pumpkin Valley Formation, where they occupy steep to very steep sideslopes of drainageways cutting headward into and through the Pumpkin Valley Formation on the south side of Pine Ridge. The soils in this unit classify as Typic Dystrochrepts, loamy-skeletal, mixed (glaucous), and thermic. These soils are hydrologically important because they generate rapid overland or near-surface lateral flow during storm events.

This soil mapping covers the upstream reaches of NT10, NT11, NT12, NT15, and ET1. Narrow, riparian wetlands were identified at headwall springs in drainageways with steep sideslopes along NT10 and NT11 and subtributaries NT15 and ET1. No wetlands were found along NT12 on this soil unit. The hydric soils identified in the wetlands at the bottom of the

steep slopes are not mentioned in the 10361 soil description; however, these drainageway soils may represent an inclusion of a hydric soil phase that is too small in area to map separately. The hydrologic characteristics of the 10361 soil unit probably have an important role in the formation and continued presence of these wetlands.

4.1.5 Soil Unit 96021

These soils formed in Recent Alluvium. They occur along drainageways with well-defined channels and are well or moderately well drained as a result. However, they may frequently flood for periods of short duration as a result of storm events that produce overland runoff.

This soil unit occurs in the upstream reaches of WT2 and most of the length of ET2. No wetlands were identified in these drainages, both of which have deep, steep-banked stream channels. Forested wetlands were identified along ET4, but the soils were not saturated during the late-summer survey, and the soils appeared less strongly hydric [i.e., matrix chromas of 2 or between 2 and 3 (Kollmorgen Corp. 1990)] than in the other C1A wetlands and the Bear Creek forested wetland (which occur on different soil units).

4.1.6 Soil Units 30951 and 98041

Soil units 30951 and 98041 are mapped along the lower and upper reaches, respectively, of ST2. The 30951 soil unit consists of residuum of the Conasauga-Nolichucky/Maynardville geologic formations located on 25 to 45% slopes and is classified as an Aquic Udifluent.

The 98041 soil unit is part of a complex of Udifluent-Hapludult-Fragiudult soils. The 98041 unit occurs in floodplains and narrow bottoms. Rainfall and runoff water from higher slopes infiltrates and flows downward and laterally in these soils. As a consequence, these soils tend to become filled with water during wet periods.

Although most of the soils in the 30951 and 98041 units are well-drained, areas where small seeps and springs occur are wet. These soils have a tendency to become filled with water during wet periods. Water also perches at discontinuities. This description of the landform and hydrologic characteristics are in agreement with our field findings on ST2, where forested wetlands were identified on low-elevation benches along most of this narrow bottomland.

4.1.7 Soil Units 97011 and 97021

These soils formed in Conasauga (Recent) Alluvium. They are in narrow drainageways in areas of Rogersville, Maryville, and Nolichucky soils. They are well-drained and moderately well-drained soils. Most areas of these soils have a well-defined and entrenched channel. The largest areas occur on the floodplain and low terraces of Bear Creek. The soils are classified as Typic and Aquic Udifluents, either coarse-silty or fine-silty.

Soil unit 97011 is mapped in the upper Bear Creek floodplain and in the NT2 drainage. With the exception of a portion of the C7 wetland, which is subject to periodic flooding, and a small wetland [< 0.004 ha (< 0.01 acre)] adjacent to NT15, no wetlands were identified in the Bear Creek floodplain on this soil unit. Narrow-width riparian wetlands were identified in the NT2 drainage.

Soil unit 97021 is mapped in the Bear Creek floodplain and in a small portion of the NT15 drainage. A wetland was identified along NT15 on this soil unit but represents only

a small portion of the total area mapped in this unit in the NT15 drainage. No wetlands were found along Bear Creek where this soil unit is mapped.

4.1.8 Other Soil Units

The list of soil units that appear to correspond with wetland presence in only one location is long and includes: 10251, 12142, 12222, 20061, 20533, 20541, 20551, 22121, 22131, 30133, 30951, 96121, 97211, 98031, 98041, and 99511. Because these soils support wetlands on only a small percentage of their total area in the watershed and, therefore, would be poor indicators of the general presence or absence of wetlands, they are not described in this report. For more information on these soils, refer to Lietzke and Lee (1990).

4.1.9 Soil Unit–Wetland Relationship

The correspondence between wetlands and soil map units is constrained by the inherent definitions of the map units and the scale of mapping. There was some correspondence between the presence of wetlands and soil units that are either formed in Recent Alluvium, have rapid near-surface lateral flow, or have areas of soil discontinuities in incised drainageways. Based on this wetland survey in the Bear Creek watershed and other wetland surveys (Rosensteel, unpublished data) in selected areas of Bethel Valley (south slope of Chestnut Ridge) and Melton Valley (south slope of Haw Ridge and north slope of Copper Ridge), an apparent relationship between the geologic setting and the presence of wetlands is evident. A principal difference between these ridges is their geologic characteristics. The rock formations underlying Pine and Haw ridges are the Rome Formation on the ridges and the Conasauga Group on the lower slopes and in the valleys. The principal rock formation underlying Chestnut Ridge and Copper Ridge is the Knox Group. In general, there appear to be more numerous and larger individual and cumulative areas of wetlands on the south slopes of Pine Ridge and Haw Ridge, on the Rome Formation and Conasauga Group, than in drainages on the north and south slopes of Chestnut Ridge and the north slope of Copper Ridge, on the Knox Group.

The soil map units that are the most widespread and common wetland-supporting units in the Bear Creek watershed occur on nearly level drainageways and floodplains of drainageways, are formed on Recent Alluvium, and are classified as Typic and Aeric Fluvaquents (soil units 96211 and 97111). These soils occur primarily on the south- and west-facing (north and east tributaries) drainageways of Pine Ridge and in the Bear Creek floodplain west of Route 95. However, not all areas mapped in these soil units contain wetlands. For example, the 96211 and 97111 soils are also mapped along ET3, although wetlands occur only in the Hembree Marsh in this drainage, and along ET1, which has wetlands only on the upper reaches of its subtributaries.

The 97011, 97021, and 96021 soil units are also formed from Recent Alluvium; yet no, or only a few, small wetlands were identified in these areas. The apparent unpredictability of wetland presence or absence on these soils could be related to their formation in Recent Alluviums, land use changes, or limitations in the soil map scale or map unit composition.

Wetlands were also identified in areas of colluvial soils classified as Typic Hapludults and Typic Dystrochrepts. These are well-drained soils on slopes; however, wetlands can occur at the bottom of incised drainages at springs and seeps. Lietzke and Lee (1990) did not delineate these areas of minor soils, including those in the areas of wetland-supporting springs

and seeps, because of the small scale (1:10,000), although the wetland soils were considered inclusions within the soil map unit.

Wetlands are a minor component of the landscape in the north-facing drainages (STs) of Chestnut Ridge. They occur primarily in the depressions around springs and in the narrow ST2 drainage. The riparian wetland in the ST2 drainage is associated, in part, with soils classified as Aquic Udifluvents derived from the Conasauga-Nolichucky/Maynardville Formations. This soil unit does not occur frequently on Chestnut Ridge or in the Bear Creek watershed.

4.2 HYDROLOGY

Most of the wetlands are adjacent to first-order streams in small, forested, headwater catchments and, therefore, receive a comparatively smaller volume of runoff than do wetlands in downstream areas or in deforested catchments. If surface runoff were a primary hydrologic input to these wetlands, finding sustained, saturated and ponded conditions in late summer, when precipitation is low and evapotranspiration rates are high, would not be expected. On the tributaries the contribution of stream overflow to wetland hydrology probably has a minor role since headwater wetlands are commonly flow-through-dominated systems (Roulet 1990). Flow-through systems occur in sloping terrain or on terraces where runoff from adjoining upland and groundwater passes through the wetland before entering the stream; in these systems overbank flooding is relatively rare. During the field investigation, there was no morphological or hydrological evidence, such as drift lines, flattened vegetation, and scouring in the tributary wetlands to indicate that flooding occurs.

In contrast, the backwater forested wetland in the Bear Creek floodplain is a flood-dominated system. It receives flood waters from the stream as well as surface runoff. On December 17, 1992, the backwater area was flooded with rapidly flowing water that had overflowed the banks of Bear Creek in at least two locations. The water level at the staff gauge was at 1.54, which corresponds to a discharge of 54.87 cfs. Records from the Route 95 station indicate that discharges equal or greater than 54 cfs occurred on 10 days in water year 1990 (Flohr et al. 1991). On March 26, 1993, flooding was observed in the wetland at a staff gauge height of 1.10, corresponding to a 20.5 cfs discharge. The depth and velocity of the floodwaters were lower at this discharge rate but covered most of the backwater wetland area. The lowest staff gauge reading at which flooding was observed was 0.91 (10.2 cfs). At this discharge rate, the floodstage was receding and only two surface channels through the wetland contained flowing water but the soils were saturated and many ponded areas remained. Therefore, at an as yet undetermined discharge between 10.2 and 20.5 cfs as observed at the downstream gauging station, flooding of the backwater area begins. Discharges greater than 0.91 occurred on 106 and 79 days in water years 1990 (Flohr et al. 1991) and 1991 (Mercer et al. 1992), respectively. Of these discharges, 41% for 1990 and 43% for 1991 occurred between the growing season months of March through September, inclusively. Discharges greater than 20.5 cfs occurred on 39 (31% growing season) and 33 (30% growing season) days during water years 1989-1990 and 1990-1991, respectively.

The relative contributions of groundwater and surface water to the large Bear Creek forested wetland west of Route 95 (the C8 wetland) are not known. It is likely that this area is periodically flooded by Bear Creek stormflows, although there was no strong evidence to suggest that floods occur frequently. The entire area was very wet in late summer during a period of very low precipitation and low streamflow. Groundwater, subsurface runoff, and/or

a perched water table are the major hydrologic components of this wetland. In comparison, the backwater forested wetland has an entirely different hydrologic regime in which groundwater has a small role. This wetland did not have ponded water or saturated soils on the day of the survey, which suggests that the water regime is highly seasonal. This backwater area may have a seasonal high water table, but only one groundwater seep was evident, and it appears that the primary water input is stream overflow and surface runoff. Shallow drainage channels, drift lines, and areas of unvegetated soil, which are indicative of flooding, are common in this wetland. In addition, the hydric characteristics of the soils were not as pronounced as those in the Bear Creek forested wetland, which indicates a shorter period of inundation and saturation.

On all north and south tributary reaches with adjacent wetlands, the baseflow elevation in the stream channels was lower than the elevation of the water table in the adjacent wetlands. This suggests that these wetlands may be important in regulating stormflows and baseflows in the watershed by slowing the rate of surface and subsurface runoff and groundwater flows throughout the year.

In addition to groundwater, an important component of wetland and tributary hydrology in the Bear Creek watershed could be subsurface flow. In a study of groundwater flow in the Oak Ridge National Laboratory area, Moore (1988) concluded that 90 to 95% of all groundwater flow to discharge points at nearby springs and streams occurred in the "stormflow zone", which is a 1- to 2-m-thick zone just beneath the land surface. The stormflow was transient, lasting for a few days to a few weeks after precipitation, and continued longer near valleys than on hills and ridges.

The importance of subsurface flow to storm runoff and stream hydrographs is not a new concept as is evidenced by the following examples cited in Chorley (1980). Hursh and Brater (1941) suggested that in small forest catchments in the southern Appalachians, subsurface stormflow plus groundwater movement near stream channels could account for a major portion of the hydrograph peak. Whipkey (1965) found that long-continued throughflow from deep, coarse-textured soils contributed to baseflow. In a study in Somerset, England, throughflow in lower, stony C horizon soils appeared to provide all the baseflow for a stream, even after 40 rainless days (Weyman 1970).

5. FUTURE RESEARCH

5.1 WETLAND FUNCTIONS AND IMPACT ASSESSMENT

The functions of wetlands identified in the Bear Creek watershed may include flood storage and/or flood flow alterations, biogeochemical cycling, contaminant removal and retention, and ecological functions such as providing wildlife habitat and food web support, among others. The importance of understanding the functions and values of wetland systems on the ORR is underscored by the requirements of federal law (USACOE 1992), NEPA (DOE 1990), and Executive Order 11990 (Protection of Wetlands). Under the regulations promulgated by DOE to implement Executive Order 11990, if a proposed DOE action may directly or indirectly affect wetlands, an assessment of impacts must be conducted (DOE 1979). There is a need to provide an empirical basis for the environmental assessments, wetland impact assessments, environmental impact statements, and compensatory wetland mitigation [Federal Water Pollution Control Act, 1992 and TDEC 1991(b)] that are required for projects and other land uses on the ORR.

5.1.1 Flood Storage, Flow Alteration, and Water Quality

Flood storage and flow attenuation capabilities in the Bear Creek drainage are affected by the forest cover characteristics; surface water, subsurface water, and groundwater flow patterns and rates; and the location and physical characteristics of the wetlands. The wetlands in the floodplain of Bear Creek probably provide a larger flood storage and flow alteration function than the headwater tributary wetlands because of their downstream watershed location and larger size. The tributary wetlands probably do not contribute significantly to flood storage because of their headwater location (Roulet, 1990).

An important wetland function is the removal or transformation of particulates and dissolved constituents in the incoming water through various biogeochemical and physical processes. This function is important in such ecosystem-level processes as carbon and nitrogen cycling and energy flux from uplands to aquatic systems. Several studies have illustrated that riparian transport is the major pathway by which non-point-source pollutants are transported to floodplain surfaces and that floodplain zones are highly effective at removing and transforming nutrients and sediments (Peterjohn and Correll 1984, Simmons et al. 1992). Brinson (1993) determined that, for a given area of disturbance, floodplains of low order streams will be affected proportionately more than floodplains of higher order streams. He suggested that for water quality improvement greater emphasis should be placed on maintaining the integrity of first and other low order riparian environments. Forest clearing, construction activities, and other point and non-point discharges may have an adverse impact of this wetland function through sedimentation, alterations of hydrologic characteristics, or by exceeding the assimilative capacity of the wetland. The extent to which Bear Creek watershed wetlands can absorb and assimilate the potential increases in material inputs or water losses resulting from changes in land use or how these changes may affect the existing biogeochemical processes of the wetlands or the biota of Bear Creek and its tributaries is not known.

5.1.2 Ecological Functions

Ecological functions of wetlands include provision of wildlife habitat and biological and landscape diversity. The wetlands and riparian areas of streams contain numerous plant species that are common in these habitats throughout the ORR but that will not usually be found in the surrounding upland habitats. These species include several of the sedges and grasses, cardinal flower, monkeyflower, green ash, alder, and bittercress. The wetland and riparian areas, therefore, provide plant and habitat diversity on the ORR. In addition, several plant species with state and/or federal rare plant status have been identified in wetlands and riparian areas on the ORR (Parr and Pounds 1987). The rare species that have been identified in the Bear Creek watershed are Carolina quillwort (*Isoetes caroliniana*), fen orchid (*Liparis loeselii*), tubercled rein orchid (*Platanthera flava* var. *herbiola*), and the purple fringeless orchid (*Platanthera peramoena*).

Fish, including the Tennessee dace (*Phoxinus tennesseensis*), listed as a Species in Need of Management by the state of Tennessee (Tennessee Wildlife Resources Commission 1990); some amphibians; and certain insects are entirely dependent on the streams in the Bear Creek watershed. Because of the vegetation and biogeochemical cycling provided by adjacent wetlands, the vigor and survival of tributary populations of these species may also be strongly dependent on these wetlands. Other wildlife species, including deer, raccoons, and numerous bird species, are not entirely dependent on wetlands and streams, but field evidence (track and bird observations) suggests that they do use the wetlands and streams on a regular basis. The extent, timing, and type of use of ORR wetlands and streams by terrestrial wildlife has not been investigated.

5.2 RESEARCH NEEDS

Riparian wetlands provide an important linkage between upland and stream ecosystems, thereby affecting the hydrology and water quality of and nutrient and energy inputs to the stream. Unfortunately, very little is known about the functions or processes of riparian wetlands that are characteristic of the region. Hence, there is little basis for assessing the potential impacts of wetland loss or disturbance of wetlands in the Bear Creek watershed, in other watersheds on the ORR, or in the region.

In 1993, field research to study and quantify selected ecological functions of riparian wetlands that may affect the hydrology and water quality of tributaries to Bear Creek will be initiated. Initial research objectives are to

1. determine how riparian wetlands affect the hydrology and water quality of tributaries to Bear Creek and
2. measure abiotic soil parameters that may affect water quality and biological productivity.

Future research objectives may include

1. determining the rate of critical processes (i.e., carbon and nitrogen cycling) that may affect water quality and site productivity,
2. determining the landscape functions of wetlands in the Bear Creek watershed, and

3. determining wildlife use of wetlands in the Bear Creek watershed.

Results from these studies will provide a basis for understanding the role of headwater riparian wetlands as they affect, and/or are affected by, the biota of Bear Creek, its tributaries, and the surrounding upland forests and for mitigating any unavoidable disturbances of wetlands within the Bear Creek watershed.

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APPENDICES

**APPENDIX A. LOCATION AND DESCRIPTION OF WETLANDS IN THE
NT1 THROUGH NT5 DRAINAGES TAKEN FROM THE WETLAND AND
OPEN WATER DELINEATION REPORT FOR THE PROPOSED
OAK RIDGE RESERVATION STORAGE FACILITY**

(Rosensteel 1992, internal report,
unpublished data)

A.1 SITE WETLAND DELINEATION AND STREAM IDENTIFICATION

A.1.1 Wetlands

Wetlands have been identified and delineated in all of the on-site drainages. Fourteen separate wetland areas were identified in five Bear Creek tributary drainages designated as North Tributaries (NTs) 1 through 5. The wetland boundaries and tributary channels were field located and mapped by the engineering firm of Barge, Waggoner, Sumner, and Cannon of Oak Ridge (Fig. A.1), except for the wetland indicated in the downstream section of NT1 for which the boundary and location are approximate. The wetlands are located along the streams and at groundwater springs and seeps and are characterized by a dominance of hydrophytic vegetation, hydric soils and saturated soils and the presence of ponded and/or flowing water.

There is little variation in the hydric characteristics of the soils found in the wetlands. The matrix colors within the top 12 in. are generally gray (10YR 4/1, 5/1, and 6/1) or grayish brown (10YR 5/2 and 6/2). The most common mottles are brown (7.5YR 5/4, 5/6, and 5/8), yellowish brown (10YR 4/6 and 5/6), and very dark gray (10YR 3/1).

The majority of the wetlands can be classified as palustrine broad-leaved deciduous, forested wetland (PFO1); however, emergent (PEM) and scrub/shrub (SSO1) wetlands (Cowardin et al. 1979) are present in the ROW and adjacent to the Haul Road.

Several of the forested wetlands widen into ponded areas at the base of the Haul Road berm where the water is detained, often for extended periods of time. As a result of the construction of the Haul Road, ponded water is common in these locations throughout most of the year, and some of the trees have died as a result of extended periods of root inundation. In these open-canopy areas, the vegetation community shifts toward shrub and herbaceous species. In addition to these ponded areas, an emergent-scrub/shrub wetland was delineated at the eastern end of the site on NT1. In this case, the water is detained behind the right-of-way fill rather than the Haul Road berm.

A.1.2 Streams

The Bear Creek tributaries and their subtributaries were flagged in the field and were located and mapped by Barge, Waggoner, Sumner, and Cannon. Only those portions of the stream that do not have adjacent wetlands are mapped. These mapped areas are referred to herein as "open water" to differentiate them from the stream sections within wetlands. The areas of the stream that fall within the wetland boundaries are included in the acreage total for the specific wetland. The total area of wetlands on-site is 1.97 ha (4.87 acres). A human-made pond is located in the powerline ROW south of proposed Site B. The pond drains off-site to a stream and forested wetland.

Fig. A.1. Wetland locations in the North Tri

Coordinate System: ORNL

Sources of Mapped Data:

Base data- TVA S-16A. December, 1987.

Stream updates- Barge, Waggoner, Sumner &
Cannon. August, 1992.

- B.A. Rosensteel & C.C. Trettin

Prepared by: RF Winterfield

Version 1 March 3, 1993.

tributary 1 through North Tributary 5 drainages.

A.2 WETLAND AND STREAM LOCATION AND DESCRIPTION

The on-site tributaries are Bear Creek headwater streams that range from ~0.5 to 1.5 m in width and several centimeters to a meter in depth. Some reaches of these tributaries may be without flow or have very low flows in late summer and early fall. An informal survey found caddisfly (*Trichoptera* sp.) eggcases and larva in the streams and numerous species of dragonflies and damselflies near all of the streams. Schools of small fish were also observed.

A.2.1 Bear Creek NT1

One wetland area (0.17 ha) was identified along NT1. NT1 begins on-site at a groundwater seep. A forested wetland extends from the seep almost to the ROW. Just upstream of the ROW, a pond has formed as a result of the past placement of fill and a culvert in the ROW. Emergent and scrub/shrub wetlands have developed on the pond margins. Species in the pond wetland include cattails, black willows, sedges, and grasses. After exiting the culvert, the stream continues across the ROW and into a wooded area. There are no wetlands adjacent to this portion of NT1. Off-site downstream areas were not investigated for the presence of wetlands.

A.2.2 NT1 Subtributary

A subtributary of NT1, which was identified by a Tennessee Department of Environment and Conservation representative but which is not mapped on the Oak Ridge Reservation S-16A topographic map, is located between NT1 and NT2. The tributary begins just inside the southern site boundary north of the ROW. The on-site portion of this drainage is encompassed within a small area of forested wetland (0.02 ha) that has been isolated from the downstream surface channel by a high berm of fill soils. The dominant species are sweetgum, red maple, ironwood, and microstegium.

Water flow appears to continue underground and resurface in the ROW. Although hydrophytic vegetation and flowing water were found along the channel in the ROW, the area did not meet the hydric soil criteria and was not identified as a wetland. There is an offsite forested wetland adjacent to the stream in the woods downstream of the ROW. This wetland was not delineated because the area is not on-site, but is included in this report because of its downstream proximity to the project site.

In the ROW to the east of this stream is a human-made pond. No emergent or submergent vegetation was observed in the shallow water of the pond margin. However, there was hydrophytic vegetation scattered on small mudflats on the ponds eastern and western margins. The pond has steep banks with little wetland vegetation development on the north and south margins. There is no surface-water inlet. The pond drains off-site into a tributary of NT1 and a forested wetland. The pond may be an important hydrologic source for the tributary and wetland; however, this possibility cannot be substantiated with our limited field observations.

A.2.3 Bear Creek NT2

NT2 flows in a northeast to southwest direction through a forested drainage, crosses the ROW east of the Haul Road, and enters a wooded area south of the ROW. NT2 has five sidechannels, only three of which are shown on Fig. A.1. Forested wetlands were identified

in the downstream portion of NT2 both north and south of the ROW, in one small location upstream, and on four side channels.

One side channel that is not shown begins in the power-line ROW and flows a short distance northwest before joining NT2. There are no wetlands along the channel. The two side channels entering NT2 from the north originate at groundwater seeps at the base of Pine Ridge. Forested wetlands dominated by sweetgum, red maple, sycamore, and poison ivy surround the upstream areas of these two channels. Herbaceous wetland vegetation, such as sedges, jewelweed, and Virginia knotweed are common within the stream banks.

The third side channel shown joins NT2 in the forested wetland south of the ROW. All of this channel and part of NT2 are encompassed by a wetland (0.51 ha) that is predominantly forested. However, scrub/shrub-emergent wetlands surround both streams in the ROW upstream of their confluence. Dominant species in the scrub/shrub-emergent wetlands include black willow, brookside alder, sallow sedge, Bailey's sedge, bulrush, cattail, fox sedge, woolgrass, and other herbaceous species.

The westernmost side channel, which is not shown on Fig. A.1, begins as a 0.04 ha emergent wetland on the northeast side of the Haul Road at the curve in the road. A portion of the water in this wetland is culverted under the Haul Road. Although there is a small area of wetland vegetation at the culvert exit, no stream channel is evident and the water appears to be piped to an off-site section of NT2. Vegetation is similar to that found in the ROW wetlands.

A.2.4 Bear Creek NT3

This tributary receives flow from three small drainages. A 0.51 ha forested wetland, which encompasses portions of all three drainages, was delineated. In addition, a 0.04 ha wetland was delineated near the head of NT3. Only NT3 has mapped open-water sections since the central and western drainage streams are encompassed within wetland boundaries. NT3 and the central drainage join immediately upstream of the Haul Road, where they form a ponded, emergent/scrub-shrub wetland before exiting the site through a culvert. The west drainage also forms a ponded, emergent wetland at the road berm and exits the site through a separate culvert; however, the confluence of the west drainage and NT3 is located off-site south of the Haul Road.

The NT3 drainage contains a total of 274 m (900 ft) of stream channel outside of wetlands and 0.55 ha of forested and emergent wetland. The dominant species in the forested wetlands include red maple, sweetgum, sycamore, ironwood, slippery elm, monkeyflower, microstegium, and poison ivy. Several species of sedges and grasses classified as OBL, FAC, or FACW are also common.

A.2.5 Wetland East of NT4

There is a 0.04 ha emergent wetland formed at the base of the Haul Road berm just east of NT4. There is no stream channel upstream of the wetland. When the water reaches a certain height it drains off-site through a culvert under the Haul Road. This wetland appears to be located at the head of a subtributary of NT4.

A.2.6 Bear Creek NT4

NT4 begins at a spring at the base of Pine Ridge. A 0.02 ha wetland was delineated in the spring area. Sweetgum and red maple are present along the wetland boundary; however, the dominant species in this wetland are microstegium, Virginia knotweed, monkeyflower, and sedges. The soil has a 10YR 5/1 (gray) chroma with mottles and was saturated to the surface on the date of the delineation (July 30, 1992).

NT4 continues for 84 m (240 ft) as an open-water stream with no adjacent wetlands before entering a forested wetland (0.22 ha). This is a narrow wetland that generally follows closely along the stream banks until it widens into a small emergent wetland at the Haul Road berm. The soils are grayish brown (10YR 5/2) or gray (10YR 5/1) silt loam or silty clay loam with brown and yellowish brown mottles. The soil was saturated to the surface on several site visits between April and late Summer, 1992.

A.2.7 Bear Creek NT5

This tributary has two branches, both of which have wetlands along their length. There is 46 m (150 ft) of open water outside of the wetland area in NT5. The wetlands in the upper reaches of the streams are forested wetlands. These areas are dominated by red maple, sweetgum, flowering dogwood, and poison ivy. Most of the wetlands in the central portion of the drainage consists of a narrow fringe of vegetated alluvial flats adjacent to and on the lower banks of the stream channel. These alluvial flats are dominated by microstegium, sedges, monkeyflower, and grasses. As with the other drainages that intersect the Haul Road, a large ponded area dominated by shrubs, saplings, and emergent vegetation has developed upstream of the road berm. The soils are grayish brown or gray silt loam and silty clay loam with mottles. Soil saturation and ponded water was observed in the wetlands on several site visits between April and late summer 1992.

APPENDIX B. DESCRIPTION OF WETLANDS IN WASTE AREA GROUPING 11

B.1 FINDINGS OF THE WETLAND SURVEY-WHITE WING SCRAP YARD WAG 11, MARCH 18, 1992

B.1.1 Site Description

The White Wing Scrap Yard is located in a forested area to the southeast of the intersection of Route 95 and Oak Ridge Turnpike. The site is bounded on the northwest by East Fork Ridge Road. Hot Yard Road runs west to east through the middle of the site. The site is bounded on its southern, eastern, western, and northeastern boundary by undeveloped forested land. Site access is via Old County Road, a gated road beginning at Oak Ridge Turnpike. A tributary of Bear Creek is located in the southeast portion of the site.

The dominant vegetation types are planted pine, pine-hardwood, early successional old field, a maintained grass field, and scrub/shrub wetland. All but the last are upland communities. The forested community is dominated by loblolly pine (*Pinus taeda*; FAC), Virginia pine (*Pinus virginiana*; not listed), white and red oaks (*Quercus alba* and *Q. falcata*; FACU), and shagbark hickory (*Carya ovata*; FACU) in the canopy, and Japanese honeysuckle (*Lonicera japonica*; FAC) in the ground cover. The old field communities include sumac (*Rhus* sp.; not listed), red cedar (*Juniperus virginiana*; FACU), blackberry [*Rubus* sp.; not identified to species (NIS)], teasel (*Dipsacus sylvestris*; not listed), and fescue (*Festuca* sp., NIS). The field is dominated by pasture grasses, primarily fescue. The scrub/shrub wetland community is described in the next section.

B.1.2 Wetland Survey Findings

The wetland survey was conducted on March 17, 1992, by Barbara Rosensteel and Rebecca Cook of the ORNL Environmental Sciences Division. No wetlands were observed in the portion of the site located to the north of Hot Yard Road.

An intermittent stream drainage is shown on topographic maps of the site. The drainage slopes in a north to south direction through the pine-hardwood forest and the old field community, and ends onsite at a Bear Creek tributary (ET3). With the exception of a portion of this drainage in the tributary floodplain, this drainage contains no hydrophytic vegetation and, on the day of the survey, contained no water or saturated soils. No indicators of wetland or intermittent stream hydrology were found in this area. Therefore, this drainage is identified as an upland area.

Scrub/shrub wetlands were identified south of Hot Yard Road in the floodplain of the tributary. A previous survey of the proposed perimeter fence line conducted in April 1991 identified wetland areas adjacent to the tributary in the southeast and southwest corners of the site. The wetlands identified during this survey are a continuation of the previously identified "southeast corner" wetlands. The "southwest corner" wetlands are separated from these wetlands by an upland area and a graveled well pad.

The dominant tree species in both of the wetland areas include sycamore (*Platanus occidentalis*; FACW) and sweetgum (*Liquidambar styraciflua*; FAC+). Silky dogwood (*Cornus amomum*; FACW+) is a common shrub species in areas of ponded water and next to the

stream. Japanese honeysuckle and a species of rose (*Rosa* sp.; NIS) are also common. Ground cover species include nepal microstegium (*Eulalia viminea*; FAC), soft rush (*Juncus effusus*; FACW+), and deertongue grass (*Dicanthelium clandestinum*; FACW).

The A and B soil horizons in both of the wetland areas have matrix chromas of 10YR 5/2 (very dark grayish brown) and 10YR 6/1 (gray) with 7.5YR 5/6 and 7.5YR 4/6 (strong brown) mottles. Manganese concretions are present.

On the day of the survey, the soils in the wetland areas were saturated at or near the surface. Ponded water was present in several locations. Hydrologic indicators of wetland hydrology included silt deposits on vegetation and leaves, and surface roots.

The intermittent stream drainage described above becomes a channel with a defined bed in the wetland area. A groundwater seep supplies water to the channel. The drainage channel forms the western boundary of this wetland. Eastward from this drainage channel to Well 1139 the area is upland. The soil matrix color in the upland area is a dark yellowish brown (10YR 4/4) and mottles are absent. The "southwest corner" wetlands continue along the tributary to the southwest of this well.

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