ERDC/EL TR-12-9

Environmental Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Wetlands Regulatory Assistance Program

Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region (Version 2.0)

U.S. Army Corps of Engineers

April 2012

ERDC/EL TR-12-9
April 2012

Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region (Version 2.0)

U.S. Army Corps of Engineers

U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report

Approved for public release; distribution is unlimited.

Prepared for Headquarters, U.S. Army Corps of Engineers
Washington, DC 20314-1000

Abstract

This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual, which provides technical guidance and procedures for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act. The development of Regional Supplements is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. This supplement is applicable to the Eastern Mountains and Piedmont Region, which consists of all or portions of the District of Columbia and 20 states: Alabama, Arkansas, Delaware, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Missouri, North Carolina, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia.

Contents

Figures and Tables

Figures

Tables

Preface

This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual. It was developed by the U.S. Army Engineer Research and Development Center (ERDC) at the request of Headquarters, U.S. Army Corps of Engineers (USACE), with funding provided through the Wetlands Regulatory Assistance Program (WRAP). This is Version 2.0 of the Eastern Mountains and Piedmont Regional Supplement; it replaces the "interim" version, which was published in May 2010.

This document was developed in cooperation with the Eastern Mountains and Piedmont Regional Working Group. Working Group members contributed their time and expertise to the project over a period of many months. Working Group meetings were held in Nashville, TN, on 4-6 November 2008 and Huntington, WV, on 10-11 March 2009. Members of the Regional Working Group and contributors to this document were:

- Jacob Berkowitz, Project Leader and Working Group Chair, Environmental Laboratory (EL), ERDC, Vicksburg, MS
- Robert Lichvar, Chair, Vegetation Subcommittee, Cold Regions Research and Engineering Laboratory, ERDC, Hanover, NH
- Chris Noble, Chair, Soils Subcommittee, EL, ERDC, Vicksburg, MS
- James Wakeley, EL, ERDC, Vicksburg, MS
- Charles Allred, U.S. Army Engineer District, Vicksburg, MS
- Jared Beard, U.S. Department of Agriculture (USDA) Natural Resources Conservation Service, Moorefield, WV
- Rodney Christensen, U.S. Army Engineer Kansas City District, Truman Satellite Office, Warsaw, MO
- Louis Clarke, U.S. Army Engineer Little Rock District, Walnut Ridge, AR
- Casey Ehorn, U.S. Army Engineer Mobile District, Birmingham, AL
- Catherine Elliott, U.S. Army Engineer Nashville District, Lenoir City, TN
- Dwayne Estes, Austin Peay State University, Clarksville, TN
- Thomas Fischer, U.S. Army Engineer Savannah District, Albany, GA
- Tammy Fudge, U.S. Army Engineer Nashville District, Grand Rivers, KY
- Justin Hammonds, U.S. Army Engineer Savannah District, Morrow, GA
- Chip Hannah, Tennessee Department of Environment and Conservation, Nashville, TN

- Jim Herrington, U.S. Environmental Protection Agency, Region 6, Dallas, TX
- Amanda Jones, U.S. Army Engineer Wilmington District, Asheville, NC
- Kathleen Kuná, U.S. Army Engineer District, Nashville, TN
- Steve Lawrence, USDA Natural Resources Conservation Service, Athens, GA
- Mike Lee, Tennessee Department of Environment and Conservation, Nashville, TN
- Todd Lutte, U.S. Environmental Protection Agency, Region 3, Philadelphia, PA
- Jerry McIntosh, USDA Natural Resources Conservation Service, Mayfield, KY
- Kathleen Mulder, U.S. Environmental Protection Agency, Region 7, Kansas City, KS
- Les Parker, U.S. Army Engineer District, Charleston, SC
- Lee Pittman, U.S. Army Engineer District, Huntington, WV
- Frank Plewa, U.S. Army Engineer Baltimore District, Carlisle, PA
- Jerry Prater, USDA Natural Resources Conservation Service, Sparta, TN
- James Robb, Indiana Department of Environmental Management, Indianapolis, IN
- Tom Roberts, Tennessee Technological University, Cookeville, TN
- Tim Scott, U.S. Army Engineer District, Little Rock, AR
- Casey Shrader, USDA Natural Resources Conservation Service, Morgantown, WV
- Eric Sinclair, U.S. Army Engineer District, Nashville, TN
- Ralph Spagnolo, U.S. Environmental Protection Agency, Region 3, Philadelphia, PA
- Ron Stouffer, U.S. Army Engineer Norfolk District, Dumfries, VA
- Jeff Thompson, Maryland Department of the Environment, Baltimore, MD
- Brian Topping, U.S. Environmental Protection Agency, Washington, DC
- Lenore Vasilas, USDA Natural Resources Conservation Service, Washington, DC
- Sam Werner, U.S. Army Engineer District, Louisville, KY
- Tim Wilder, EL, ERDC, Vicksburg, MS
- Mike Wylie, U.S. Environmental Protection Agency, Region 4, Atlanta, GA
- Mike Zeman, USDA Natural Resources Conservation Service, Nashville, TN

Technical reviews were provided by the following members of the National Advisory Team for Wetland Delineation: Steve Eggers, U.S. Army Engineer (USAE) District, St. Paul, MN; Michael Gilbert, USAE District, Omaha, NE; William James, U.S. Army Corps of Engineers, Washington, DC; Dan Martel, USAE District, San Francisco, CA; Norman Melvin, NRCS National Wetland Team, Fort Worth, TX; Paul Minkin, USAE District, New England, Concord, MA; Stuart Santos, USAE District, Jacksonville, FL; Ralph Spagnolo, U.S. Environmental Protection Agency (EPA) Region 3, Philadelphia, PA; Mary Anne Thiesing, EPA Region 10, Seattle, WA; Ralph Tiner, U.S. Fish and Wildlife Service, Hadley, MA; Katherine Trott, USAE Institute for Water Resources, Alexandria, VA; and Lenore Vasilas, NRCS, Washington, DC. In addition, portions of this Regional Supplement addressing soils issues were reviewed and endorsed by the National Technical Committee for Hydric Soils (Christopher W. Smith, Chair).

Independent peer reviews were performed in accordance with Office of Management and Budget guidelines. The peer-review team consisted of Joanne M. Barry, Chair, contractor, U.S. Army Engineer Institute for Water Resources, Alexandria, VA; John H. Brooks III, Resource International, Ltd., Ashland, VA; Thomas P. Colson, North Carolina State University, Raleigh, NC; Christopher Huysman, Strategic Natural Resources Group, Inc., Sparta, NC; Melissa McCanna, Dewberry & Davis LLC, Fairfax, VA; Richard P. Reaves, CH2M Hill, Atlanta, GA; Kevin Seaford, Timmons Group, Richmond, VA; and Michael G. Wood, The Catena Group, Hillsborough, NC.

Technical editors for this Regional Supplement were Jacob F. Berkowitz, Robert W. Lichvar, Chris V. Noble, and Dr. James S. Wakeley, ERDC. Karen C. Mulligan was the project proponent and coordinator at Headquarters, USACE. During the conduct of this work, Pat O’Brien was Chief of the Wetlands and Coastal Ecology Branch; Dr. Edmond Russo was Chief, Ecosystem Evaluation and Engineering Division; Sally Yost was Program Manager, WRAP; and Dr. Elizabeth Fleming was Director, EL.

COL Kevin J. Wilson was Commander of ERDC. Dr. Jeffery P. Holland was Director.

The correct citation for this document is:

U.S. Army Corps of Engineers. 2012. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region Version 2.0*, ed. J. F. Berkowitz, J. S. Wakeley, R. W. Lichvar, C. V. Noble. ERDC/EL TR-12-9. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

1 Introduction

Purpose and use of this regional supplement

This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual (hereafter called the Corps Manual). The Corps Manual provides technical guidance and procedures, from a national perspective, for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act (33 U.S.C. 1344) or Section 10 of the Rivers and Harbors Act (33 U.S.C. 403). According to the Corps Manual, identification of wetlands is based on a three-factor approach involving indicators of hydrophytic vegetation, hydric soil, and wetland hydrology. This Regional Supplement presents wetland indicators, delineation guidance, and other information that is specific to the Eastern Mountains and Piedmont Region.

This Regional Supplement is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. Regional differences in climate, geology, soils, hydrology, plant and animal communities, and other factors are important to the identification and functioning of wetlands. These differences cannot be considered adequately in a single national manual. The development of this supplement follows National Academy of Sciences recommendations to increase the regional sensitivity of wetland-delineation methods (National Research Council 1995). The intent of this supplement is to bring the Corps Manual up to date with current knowledge and practice in the region and not to change the way wetlands are defined or identified. The procedures given in the Corps Manual, in combination with wetland indicators and guidance provided in this supplement, can be used to identify wetlands for a number of purposes, including resource inventories, management plans, and regulatory programs. The determination that a wetland is subject to regulatory jurisdiction under Section 404 or Section 10 must be made independently of procedures described in this supplement.

This Regional Supplement is designed for use with the current version of the Corps Manual (Environmental Laboratory 1987) and all subsequent versions. Where differences in the two documents occur, this Regional Supplement takes precedence over the Corps Manual for applications in the Eastern Mountains and Piedmont Region. Table 1 identifies specific sections of the Corps Manual that are replaced by this supplement. Other guidance and procedures given in this supplement and not listed in Table 1 are intended to augment the Corps Manual but not necessarily to replace it. The Corps of Engineers has final authority over the use and interpretation of the Corps Manual and this supplement in the Eastern Mountains and Piedmont Region.

Table 1. Sections of the Corps Manual replaced by this Regional Supplement for applications in the Eastern Mountains and Piedmont Region.

Item	Replaced Portions of the Corps Manual (Environmental Laboratory 1987)	Replacement Guidance (this Supplement)
Hydrophytic Vegetation Indicators	Paragraph 35, all subparts, and all references to specific indicators in Part IV.	Chapter 2
Hydric Soil Indicators	Paragraphs 44 and 45, all subparts, and all references to specific indicators in Part IV.	Chapter 3
Wetland Hydrology Indicators	Paragraph 49(b), all subparts, and all references to specific indicators in Part IV.	Chapter 4
Growing Season Definition	Glossary	Chapter 4, Growing Season; Glossary
Hydrology Standard for Highly Disturbed or Problematic Wetland Situations	Paragraph 48, including Table 5 and the accompanying User Note in the online version of the Manual	Chapter 5, Wetlands that Periodically Lack Indicators of Wetland Hydrology, Procedure item 3(g)

Indicators and procedures given in this Supplement are designed to identify wetlands as defined jointly by the Corps of Engineers (33 CFR 328.3) and Environmental Protection Agency (40 CFR 230.3). Wetlands are a subset of the "waters of the United States" that may be subject to regulation under Section 404. One key feature of the definition of wetlands is that, under normal circumstances, they support "a prevalence of vegetation typically adapted for life in saturated soil conditions." Many waters of the United States are unvegetated and thus are excluded from the Corps/EPA definition of wetlands, although they may still be subject to Clean Water Act regulation. Other potential waters of the United States in the region include – but are not limited to – ponds; lakes; unvegetated seasonal pools; sinkholes; mud flats; and perennial, intermittent, and ephemeral stream channels. Delineation of these waters is based on the "ordinary high water mark" (33 CFR 328.3e), or other criteria and is beyond the scope of this Regional Supplement.

Amendments to this document will be issued periodically in response to new scientific information and user comments. Between published versions, Headquarters, U.S. Army Corps of Engineers, may provide updates to this document and any other supplemental information used to make wetland determinations under Section 404 and Section 10. Wetland delineators should use the most recent approved versions of this document and supplemental information. See the Corps of Engineers Headquarters regulatory web site for information and updates (http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx). The Corps of Engineers has established an interagency National Advisory Team for Wetland Delineation. The team's role is to review new data and make recommendations for needed changes in wetland-delineation procedures to Headquarters, U.S. Army Corps of Engineers. Items for consideration should include full documentation and supporting data and should be submitted to:

National Advisory Team for Wetland Delineation
Regulatory Branch (Attn: CECW-CO)
U.S. Army Corps of Engineers
441 G Street, N.W.
Washington, DC 20314-1000

Applicable region and subregions

This supplement is applicable to the Eastern Mountains and Piedmont Region, which consists of all or portions of the District of Columbia and 20 states: Alabama, Arkansas, Delaware, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Missouri, North Carolina, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia (Figure 1). The region consists of the Appalachian Mountains and associated ranges, valleys, and piedmont areas, extending generally from the line of maximum Pleistocene glacial advance in northern Pennsylvania and western New York, southwest to central Alabama. The region also includes the Ozark Plateau and Ouachita Mountains in Arkansas, Missouri, and Oklahoma, which are similar in topography, age, origin, and composition to the southern Appalachians. The two mountainous areas were likely once continuous, but are now separated by the marine sediments and recent alluvium of the Mississippi Embayment (U.S. Geological Survey [USGS] 2004).

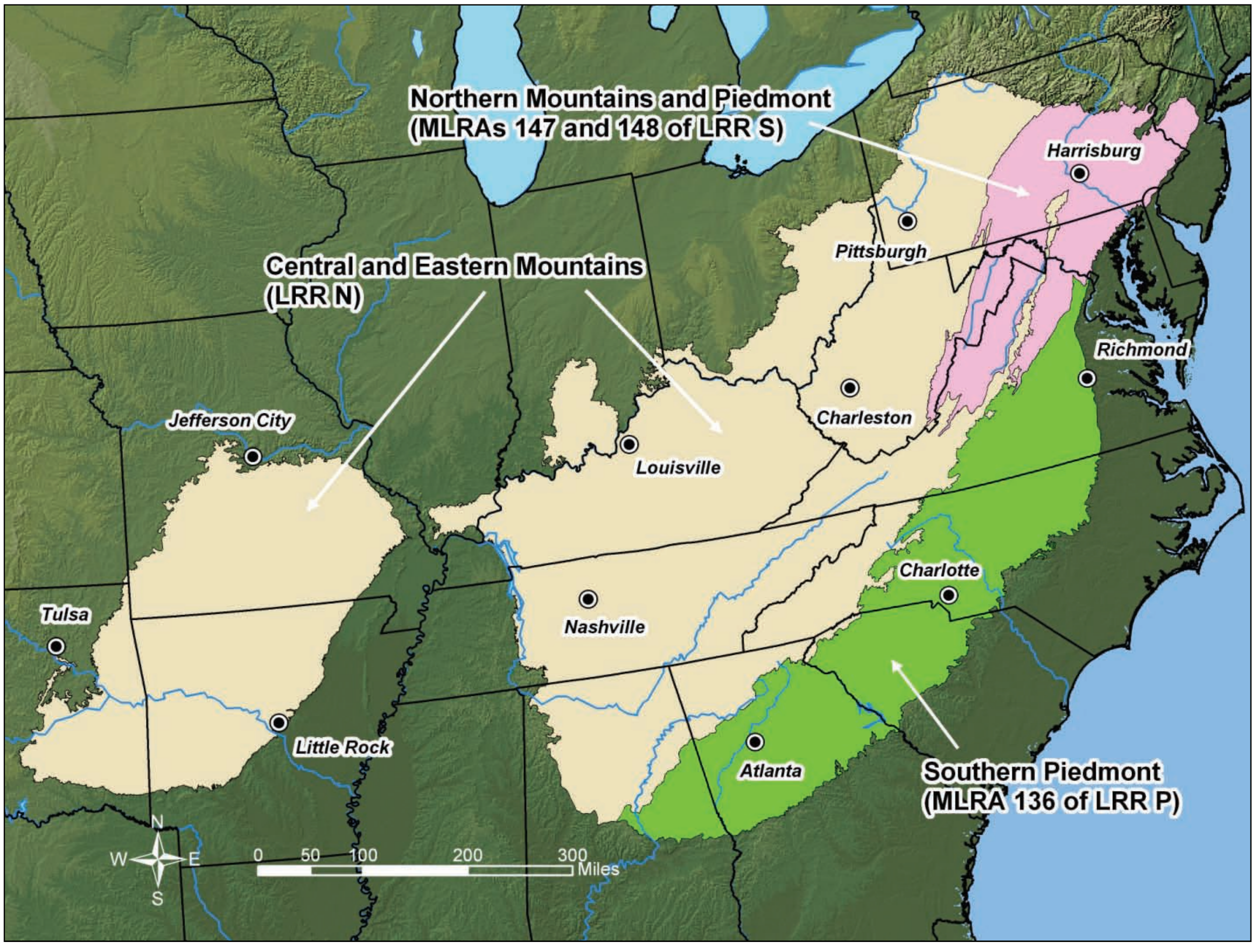

Figure 1. Approximate boundaries of the Eastern Mountains and Piedmont Region. Subregions used in this supplement correspond to USDA Land Resource Regions (LRR) and Major Land Resource Areas (MLRA). This supplement is applicable throughout the highlighted areas, although some indicators may be restricted to specific subregions or smaller areas. See text for details.

The approximate spatial extent of the Eastern Mountains and Piedmont Region is shown in Figure 1. The region map is based on a combination of Land Resource Region (LRR) N and Major Land Resource Areas (MLRAs) 136 in LRR P, and 147 and 148 in LRR S, as recognized by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (2006). Most of the wetland indicators presented in this supplement are applicable throughout the entire Eastern Mountains and Piedmont Region. However, some indicators are restricted to specific subregions (i.e., LRRs or MLRAs).

Region and subregion boundaries are depicted in Figure 1 as sharp lines. However, climatic conditions and the physical and biological characteristics of landscapes do not change abruptly at the boundaries. In reality, regions and subregions often grade into one another in broad transition zones that may be tens or hundreds of miles wide. The lists of wetland indicators presented in these Regional Supplements may differ between adjoining regions or subregions. In transitional areas, the investigator must use experience and good judgment to select the supplement and indicators that are appropriate to the site based on its physical and biological characteristics. Wetland boundaries are not likely to differ between two supplements in transitional areas, but one supplement may provide more detailed treatment of certain problem situations encountered on the site. If in doubt about which supplement to use in a transitional area, apply both supplements and compare the results. For additional guidance, contact the appropriate Corps of Engineers District Regulatory Office. Contact information for District regulatory offices is available at the Corps Headquarters web site (http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/RegulatoryContacts.aspx).

Physical and biological characteristics of the region

The Eastern Mountains and Piedmont Region is an area of hilly to mountainous terrain, ranging from near sea level to 6,684 ft (2,037 m) at Mount Mitchell in North Carolina (Bailey 1995). Due to its large size and topographic diversity, the region is climatically varied. Most of the region receives 40 to 59 in. (1,015 to 1,500 mm) of rainfall each year, but parts of the Blue Ridge in western North Carolina and Virginia receive more than 100 in. (2,540 mm) of annual rainfall. Mean annual air temperatures depend on altitude and latitude, but range from 52 to 59 °F (11 to 15 °C) across most of the region. Annual snowfall is modest in the southern and western portions of the region, but ranges up to 100 in. (2,540 mm) in northeastern portions (USDA Natural Resources Conservation Service 2006).

At the heart of the region is the Appalachian Valley-and-Ridge Province, a zone of folded and faulted Paleozoic sedimentary strata forming parallel ridges and valleys that extend approximately 900 miles (1,500 km) from New York to Alabama. Flanking this zone to the northwest is the Appalachian Plateau, a region of flat-lying but highly dissected sedimentary strata. To the southwest is the Interior Low Plateau, with its rolling terrain and moderate relief. To the east of the Valley-and-Ridge Province are the Blue Ridge Province and the Piedmont Plateau, composed mainly of highly eroded Precambrian metamorphic rocks. The Piedmont Plateau extends eastward to the Fall Line or inner edge of the Coastal Plain. At the western end of the region, the Ouachita Mountains and Ozark Plateau are similar in age and composition to the southern Appalachian range and consist largely of folded and eroded sedimentary strata and exposed older igneous and metamorphic rocks (Atwood 1940; Hunt 1974; USGS 2004). Caverns and karst features are found in marble formations in the Piedmont and in Paleozoic limestones throughout the region. Most of the Eastern Mountains and Piedmont Region remained ice-free during successive waves of Pleistocene glaciation.

Soil parent materials in the region are derived mainly from the weathering of local rock formations and include residuum and colluvium derived from sandstone, shale, limestone, and metamorphic and igneous rocks. Other parent materials include deposits of wind-blown loess on the Ozark Plateau and in southern Illinois, southern Indiana, Kentucky, and Tennessee. Alluvial deposits are present along rivers and streams throughout the region. Forest soils (i.e., Alfisols and the more highly weathered Ultisols) dominate the region (USDA Natural Resources Conservation Service 2006).

Potential natural vegetation in the Eastern Mountains and Piedmont Region consists of several types of broadleaf and needleleaf forest associations, including Appalachian oak forest, mixed mesophytic forest, oak-hickory forest, and oak-hickory-pine forest. Areas of northern hardwood forest and spruce-fir forest are also present in the northern portion of the region in New York and Pennsylvania, and on high-elevation Appalachian ridges. Common trees in one or more of these forest types include American beech (*Fagus grandifolia*), basswood (*Tilia* spp.), buckeye (*Aesculus* spp.), tuliptree (*Liriodendron tulipifera*), maple (*Acer* spp.), oak (*Quercus* spp.), hickory (*Carya* spp.), birch (*Betula* spp.), pine (*Pinus* spp.), hemlock (*Tsuga* spp.), spruce (*Picea* spp.), and fir (*Abies* spp.) (Küchler 1985; Bailey 1995).

For the purposes of this supplement, the Eastern Mountains and Piedmont Region is divided into three subregions (Figure 1). Important characteristics of each subregion are described briefly below; additional details can be found in USDA Natural Resources Conservation Service (2006).

Central and Eastern Mountains (LRR N)

The Central and Eastern Mountains subregion corresponds to LRR N of the USDA Natural Resources Conservation Service (2006) (Figure 1). It is a large, topographically varied, and floristically diverse subregion. The area is largely forested, with lesser amounts of grassland, cropland, and urban development. Forest composition varies considerably with latitude, altitude, and other factors (Society of American Foresters 1980). Common tree species across much of the subregion include white oak (*Quercus alba*), black oak (*Q. velutina*), northern red oak (*Q. rubra*), southern red oak (*Q. falcata*), chestnut oak (*Q. prinus*), bitternut hickory (*Carya cordiformis*), mockernut hickory (*C. tomentosa*), pignut hickory (*C. glabra*), shagbark hickory (*C. ovata*), tuliptree, blackgum (*Nyssa sylvatica*), sugar maple (*Acer saccharum*), red maple (*A. rubrum*), American elm (*Ulmus americana*), American basswood (*Tilia americana*), eastern redcedar (*Juniperus virginiana*), and many others. In the Appalachian Mountains, northern hardwood forests contain sugar maple, American beech, yellow birch (*Betula alleghaniensis*), red maple, white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), eastern hemlock (*Tsuga canadensis*), and other species. Higher ridges and coves in the Appalachians support eastern white pine (*Pinus strobus*), eastern hemlock, red spruce (*Picea rubens*), chestnut oak, northern red oak, and other species (Society of American Foresters 1980).

The Ouachita Mountains and Ozark Plateau support various oak and oak-pine forest types (Society of American Foresters 1980). Common tree species in oak forest types include post oak (*Q. stellata*), blackjack oak (*Q. marilandica*), white oak, black oak, scarlet oak (*Q. coccinea*), pignut and mockernut hickories, eastern redcedar, and several other species. Oak-pine forests in the area are co-dominated by oaks and shortleaf pine (*Pinus echinata*). Similar oak-pine forests in the southern Appalachian Mountains in Alabama, Georgia, Kentucky, and Tennessee commonly support Virginia pine (*P. virginiana*), southern red oak, scarlet oak, white oak, and other species.

Southern Piedmont (MLRA 136 of LRR P)

The Southern Piedmont subregion in Alabama, Georgia, South Carolina, North Carolina, and Virginia (Figure 1) is an area of hilly terrain dissected by many streams that flow south and east to the Coastal Plain. It is underlain by highly weathered and eroded Precambrian and Paleozoic metamorphic and igneous rocks. A number of down-faulted basins contain younger Triassic and Jurassic sandstones, shales, and other sedimentary rocks. The northern end of the subregion receives 37 to 45 in. (940 to 1,145 mm) of rainfall annually, increasing to 45 to 60 in. (1,145 to 1,525 mm) at the southern end. The average annual temperature is 53 to 64 °F (12 to 18 °C) (USDA Natural Resources Conservation Service 2006).

The Southern Piedmont subregion consists primarily of forests dominated by oaks, hickories, and pines (Society of American Foresters 1980). Depending upon location and elevation, common pines include shortleaf pine, Virginia pine, and loblolly pine (*P. taeda*), in association with a variety of oak species, including chestnut oak, scarlet oak, southern red oak, black oak, white oak, post oak, and blackjack oak.

Northern Mountains and Piedmont (MLRAs 147 and 148 of LRR S)

This subregion includes the northern Appalachian ridges and valleys (MLRA 147) and the northern Piedmont (MLRA 148). The ridge-and-valley portion is underlain by Paleozoic sandstones, conglomerates, limestones, and shales, whereas the Piedmont portion is underlain by generally older metamorphic and igneous rocks. The central portion of the Piedmont also contains sandstones, conglomerates, and shales that were laid down in the ancestral Atlantic Ocean during the Triassic period. Average annual rainfall over most of the subregion ranges from 31 to 52 in. (785 to 1,320 mm), and average annual temperature ranges from 44 to 57 °F (7 to 14 °C) (USDA Natural Resources Conservation Service 2006).

Only about 55 percent of the ridge-and-valley portion of the subregion and 25 percent of the Piedmont portion are forested today. Agricultural and urban development make up the remainder of the subregion. Common tree species in forested areas include white oak, black oak, northern red oak, bear oak (*Q. ilicifolia*), chestnut oak, American elm, hickories, tulip-tree, Virginia pine, pitch pine (*P. rigida*), eastern redcedar, and other species (Society of American Foresters 1980; USDA Natural Resources Conservation Service 2006).

Types and distribution of wetlands

Wetlands occupy a relatively small percentage of the landscape in the Eastern Mountains and Piedmont Region (Dahl 1991; Bales and Newcomb 1996; Darst and Light 1996; Haag and Taylor 1996) but are common and widely distributed. Some notably large concentrations of wetlands are present (e.g., in western Kentucky, south-central Tennessee, eastern Oklahoma, and the Canaan Valley of West Virginia) (Dahl 1991) but, on average, wetlands may comprise only about 1.5 to 2.0 percent of the region (Tiner 1990, 1996; Dahl 1991; Tiner and Burke 1995). However, many wetlands in the region are small and may not appear on large-scale data-bases, such as National Wetlands Inventory maps or county soil surveys (Roberts et al. 2003).

Many different types of wetlands are found in the region and are known by different names in different locations. Some examples include the common and well-known swamps and marshes but also less common types, such as rocky shoals, glades, and seeps. Because of the varying terminology used locally, wetlands may be best described by their hydrogeomorphic (HGM) classification (Brinson 1993), which places wetlands into categories based on landscape position, primary source of hydrology, and hydrodynamics. Types present within the Eastern Mountains and Piedmont Region include representatives from five HGM classes: riverine, depression, slope, mineral soil flat, and lacustrine fringe.

Riverine wetlands occur throughout the region and are located within the floodplains of rivers and streams, particularly those in second- or higher-order positions. In most states in the region, the majority of the wetland acreage is comprised of this type, collectively known as "bottomland hardwoods." In most bottomland systems, the wetlands are maintained by overflow from the adjacent channel. However, because floodplains are in topographically low positions and are natural locations for receiving groundwater discharge (Winter and Woo 1990), there often is significant groundwater input. The influence of groundwater is more pronounced in minor bottoms, and the wetlands within these small floodplains might better be classified as slope wetlands.

Most unaltered riverine wetlands support forest communities dominated by various water-tolerant species, such as water oak (*Quercus nigra*), willow oak (*Q. phellos*), pin oak (*Q. palustris*), Shumard oak (*Q. shumardii*), swamp white oak (*Q. bicolor*), overcup oak (*Q. lyrata*), green ash (*Fraxinus pennsylvanica*), red maple, silver maple (*Acer saccharinum*), sweetgum (*Liquidambar styraciflua*), boxelder (*Acer negundo*), black willow (*Salix nigra*), American hornbeam (*Carpinus caroliniana*), and hazel alder (*Alnus serrulata*). The oak component is less significant in northern portions of the region and in bottomlands where timber harvests have occurred. Black walnut (*Juglans nigra*), American sycamore (*Platanus occidentalis*), eastern cottonwood (*Populus deltoides*), black locust (*Robinia pseudoacacia*), American elm, common hackberry (*Celtis occidentalis*), and black cherry are associated with temporarily flooded lotic wetlands (Tiner and Burke 1995). Bottomland wetlands associated with larger river systems commonly have distinct zones as described by Wharton et al. (1982) and may contain sloughs and oxbow lakes dominated by very water-tolerant species. Baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*), which are common in Coastal Plain systems, also occur in portions of the Eastern Mountains and Piedmont Region, but are absent or uncommon in the majority of the region. They are replaced in these areas by overcup oak, red maple, or by shrub species, especially common buttonbush (*Cephalanthus occidentalis*) in the wettest sites. Smaller riverine systems typically have less-well-defined zones than the larger ones do and often are less complex floristically.

The density of ground-level vegetation is highly variable within riverine wetlands and generally is inversely related to the length of the hydroperiod. The lower zones may contain arrowheads (*Sagittaria* spp.), lizard's tail (*Saururus cernuus*), and a small number of other obligate wetland species, whereas the higher zones can be very diverse with smallspike false nettle (*Boehmeria cylindrica*), Canadian woodnettle (*Laportea canadensis*), white panicle aster (*Symphyotrichum lanceolatum = Aster simplex*), greenbriers (*Smilax* spp.), poison ivy (*Toxicodendron radicans*), various sedges (*Carex* spp.), flatsedges (*Cyperus* spp.), and grasses (e.g., white grass [*Leersia virginica*], wildrye [*Elymus* spp.]) as common dominants. Flowering forbs in these floodplain wetlands include springbeauty (*Claytonia virginica*), troutlily (*Erythronium umbilicatum*), mayapple (*Podophyllum peltatum*), Canada mayflower (*Maianthemum canadense*), white avens (*Geum canadense*), wingstem (*Verbesina alternifolia = Actinomeris alternifolia*), cardinalflower (*Lobelia cardinalis*), and great blue lobelia (*Lobelia siphilitica*) (Tiner and Burke 1995). Asiatic tearthumb (*Polygonum perfoliatum*) and garlic mustard (*Alliaria petiolata*) are invasive species that may be present.

Depression wetlands occur throughout the Eastern Mountains and Piedmont Region and are likely the most abundant type numerically. In portions of the region with karst terrain, wetlands form where limestone rock is subjected to surface drainage or groundwater flow that results in dissolution, weakening, and eventual collapse. Once the "sinkhole" has filled with sediment from the surrounding area, the downward movement of water is restricted, thus promoting the formation of a wetland (Wolfe 1996). In other portions of the region, depressions commonly form in areas in which fracture zones occur in the underlying bedrock (Heath 1984).

The depth of the depression and its primary source of hydrology affect the type of wetland that develops. Shallow depressions that are maintained by surface runoff tend to be seasonally inundated and often dry up by mid- to late spring. These wetlands are commonly referred to as “vernal pools.” In their unaltered condition, most are forested and are dominated by many of the same species found in riverine wetlands in the area (e.g., oaks, red maple, and green ash), plus yellow birch and eastern hemlock. Swamp tupelo (*Nyssa biflora* = *N. sylvatica* var. *biflora*) also occurs regularly in shallow depressions in portions of the region. Common shrubs include Virginia sweetspire (*Itea virginica*), highbush blueberry (*Vaccinium corymbosum*), southern arrowwood (*Viburnum dentatum*), northern spicebush (*Lindera benzoin*), alders, American black elderberry (*Sambucus nigra* ssp. *canadensis*), silky dogwood (*Cornus amomum*), and common winterberry (*Ilex verticillata*). Some depression wetlands support a moderate ground cover of sedges, grasses (e.g., *Chasmanthium laxum*, *Glyceria* spp., and *Cinna arundinacea*), rushes (*Juncus* spp.), smallspike false nettle, lizard’s tail, skunk cabbage (*Symplocarpus foetidus*), cardinal flower, jewelweed (*Impatiens capensis*), tearthumbs (*Polygonum arifolium* and *P. sagittatum*), ferns, greenbriers, and other species; but most are sparsely vegetated due to the prolonged ponding and shading. In some wetlands, sphagnum moss (*Sphagnum* spp.) may be abundant.

Depression wetlands that are deeper, and especially those that receive substantial groundwater discharge from the surrounding uplands, tend to have much longer hydroperiods and the central portions may contain open water for most or all of the year. These wetlands commonly have a zone of herbaceous vegetation, such as broadleaf cattail (*Typha latifolia*), smart-weeds (*Persicaria* spp. = *Polygonum* spp.), bulrushes (*Schoenoplectus* spp. = *Scirpus* spp.), shortbristle horned beaksedge (*Rhynchospora corniculata*), lizard’s tail, rice cutgrass (*Leersia oryzoides*), common rush (*Juncus effusus*), halberdleaf rosemallow (*Hibiscus laevis*), bur-reeds (*Sparganium* spp.), arrowheads, and green arrow arum (*Peltandra virginica*). Buttonbush and swamp rose (*Rosa palustris*) are common shrubs in the deeper areas. At the edge of the depression, a forest community similar to that found in the shallower depressions predominates.

Shrubs dominate other depression wetlands to form dense shrub thickets. Prominent species include white meadowsweet (*Spiraea alba*), alders (*Alnus* spp.), willows (*Salix* spp.), arrowwoods (*Viburnum* spp.), and highbush blueberry. Bluejoint (*Calamagrostis canadensis*) grass is often intermixed with alders forming a mosaic of wet meadow and shrub swamp.

Slope wetlands are common throughout the region. They occur where the discharge and lateral movement of groundwater creates saturated soil conditions on sloping terrain. These wetlands are highly variable and range in size from small seeps at the bases of hill slopes to large wetlands in broad, relatively level valleys. Slope wetlands often occur along shallow drainageways above the headwaters of streams, and may extend for considerable distances through otherwise upland landscapes. In mountains and plateau areas, slope wetlands may form where seepage is held near the surface by shallow bedrock. Soils in such areas are commonly very thin and are composed mainly of mineral material, although some are wet for such long periods that a mucky layer may develop. In the Ozark Plateau and Ouachita Mountains of Arkansas, wetlands that form over sandstone bedrock are known as glades (Arkansas Multi-Agency Wetland Planning Team 2003). In both the Piedmont and mountainous portions of the region, many slope wetlands are referred to locally as bogs (Hayes 1996; Little and Waldron 1996; Meador 1996) although, in fact, they better fit the definition of fens (i.e., they are maintained by groundwater).

The hydroperiod has a pronounced effect on the type of slope wetland that develops. Areas where groundwater discharges throughout the year often are called "perennial seeps" and tend to have soils high in organic-matter content; some even develop muck layers. These wetlands tend to be dominated by plants that are adapted to very long-term saturation. The tree stratum, if present, tends to be dominated by red maple, green ash, sweetgum, and water-tolerant associates. Common shrubs include highbush blueberry, Virginia sweetspire, possumhaw (*Viburnum nudum*), and pink azalea (*Rhododendron periclymenoides* = *R. nudiflorum*). Herbaceous plants include sedges (e.g., *Carex lurida* and *C. vulpinoidea*), Allegheny monkeyflower (*Mimulus ringens*), cardinalflower, jewelweed, skunk cabbage, and ferns, such as royal fern (*Osmunda regalis*) and sensitive fern (*Onoclea sensibilis*). Other slope wetlands have substantially shorter hydroperiods with groundwater inputs ceasing during the dry portions of the year. These wetlands are sometimes called "wet-weather seeps." They contain some of the same species mentioned above but also support species associated with adjacent mesic environments.

The larger slope wetlands that occur in headwater areas or along drainageways in upland landscapes often support swamp forests in their unaltered condition. These wetlands are composed of many of the same species as in riverine and depression wetlands and in small seepage-slope wetlands. Because of their larger size, however, they tend to be much more diverse and structurally complex than the small slope wetlands. These wetlands are similar in landscape position and hydrology to the “bayhead” communities found in the Atlantic and Gulf Coastal Plain Region.

The vegetation in slope wetlands is also influenced by water chemistry (Hayes 1996; Little and Waldron 1996; Arkansas Multi-Agency Wetland Planning Team 2003). Sedges and ferns are typical of neutral to basic soils (Meador 1996) while sphagnum mosses, cranberries (*Vaccinium* spp.), and red spruce (*Picea rubens*) tend to be associated with acid conditions (Little and Waldron 1996).

Mineral soil flat wetlands occur throughout the region in locations where the land surface is nearly level and precipitation is retained near the surface by bedrock or a relatively impermeable soil layer. In some flat wetlands, numerous micro-depressions pond water following rainfall events. Precipitation is the predominant source of hydrology and flat wetlands receive only minor inputs from other sources. Because of the similar terminology, they sometimes are confused with other wetland types, such as the “pin oak flats” that occur within the floodplains of larger river systems. In Virginia, a flat wetland may be called a “slash.” Flat wetlands can be found in areas where there is little topographic relief (e.g., northern Alabama and southern Tennessee) and in extremely dissected landscapes (e.g., the Allegheny Mountains) (Little and Waldron 1996). Most flat wetlands occur on abandoned stream terraces, but they also may occur in alluvial valleys that have been altered with levees that prevent floodwaters from reaching the site (Arkansas Multi-Agency Wetland Planning Team 2003). In areas with little topographic relief, such as parts of central Tennessee and Kentucky, flat wetlands commonly are found on watershed divides where the underlying bedrock is relatively level.

Most undisturbed flat wetlands within the region support forest communities composed of willow oak, red maple, sweetgum, and species commonly found in other types of wetlands. Call (2003) compared the vegetation in flat wetlands and depressions in Tennessee and determined that red maple and blackgum in the midstory and royal fern and cinnamon fern (*Osmunda cinnamomea*) in the ground layer were good indicators for the flats. Because they are level landforms and do not retain surface water, many flat wetlands have shorter hydroperiods than depression or slope wetlands and support overstories dominated by mesic species, such as white oak, white ash, and bitternut hickory (Arkansas Multi-Agency Wetland Planning Team 2003). Some areas with shallow soils and unsuppressed fire regimes historically may have supported communities dominated by prairie grasses, such as big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), and associates. Such wetlands now are rare; May Prairie in south-central Tennessee is an example of one that has been maintained.

Lacustrine fringe wetlands occur throughout the Eastern Mountains and Piedmont Region along the edges of beaver ponds, oxbows, lakes, and other deepwater habitats. Natural lakes are uncommon in much of the region, especially the southern portions; however, reservoir construction has been widespread and impoundments are found throughout the region. North Carolina, for example, has no natural lakes outside of the Coastal Plain, but over 100 reservoirs exist in the Piedmont and Blue Ridge Provinces (Bales and Newcomb 1996). Many reservoirs are very large, with hundreds of miles of shoreline, and contain numerous fringe wetlands, especially in shallow embayments.

Fringe wetlands may support forest, shrub, or herbaceous plant communities. Trees and shrubs in these communities are commonly tolerant of prolonged inundation, such as baldcypress, water tupelo, overcup oak, red maple, buttonbush, black willow, and sandbar willow (*Salix interior*). Floating-leaved species, such as American lotus (*Nelumbo lutea*), American white waterlily (*Nymphaea odorata*), and yellow pond-lily (*Nuphar lutea*), sometimes occur in deeper areas. Depending on the shoreline configuration, emergent and moist-soil species, such as broadleaf cattail, bur-reeds, arrowheads, green arrow arum, smartweeds, swamp loosestrife (*Decodon verticillatus*), rice cutgrass, spikerushes (*Eleocharis* spp.), bulrushes, sedges, and flatsedges, may be present. Fringe wetland communities may vary substantially over time given water-level variations in lakes and reservoirs due to rainfall patterns, changing management goals, demands for hydropower production, and other factors.

Throughout the region, wetlands of all types have been impacted by clearing, grading, drainage, stream-channel alteration, and other disturbances, and many wetland sites are in agricultural use for crop and hay production or pasture. Herbaceous species that may dominate in wetlands managed for agriculture include common rush, flatsedges, spikerushes, woolgrass (*Scirpus cyperinus*), purplestem beggarticks (*Bidens connata*), spotted trumpetweed (*Eupatoriadelphus maculatus* = *Eupatorium maculatum*), rough boneset (*Eupatorium pilosum*), creeping bentgrass (*Agrostis stolonifera*), various goldenrods (*Solidago* spp.), and many other species. If left unmanaged, many of these “wet meadows” would revert to woody plant communities (Keddy 2000).

2 Hydrophytic Vegetation Indicators

Introduction

The Corps Manual defines hydrophytic vegetation as the community of macrophytes that occurs in areas where inundation or soil saturation is either permanent or of sufficient frequency and duration to influence plant occurrence. The manual uses a plant-community approach to evaluate vegetation. Hydrophytic vegetation decisions are based on the assemblage of plant species growing on a site, rather than the presence or absence of particular indicator species. Hydrophytic vegetation is present when the plant community is dominated by species that require or can tolerate prolonged inundation or soil saturation during the growing season. Hydrophytic vegetation in the Eastern Mountains and Piedmont Region is identified by using the indicators described in this chapter.

Many factors besides site wetness affect the composition of the plant community in an area, including regional climate, local weather patterns, topography, soils, natural and human-caused disturbances, and current and historical plant distributional patterns at various spatial scales. The region as a whole is dominated by eastern deciduous forests with fingers and inclusions of grassland habitats along some edges, and various high-elevation plant communities along the spine of the Appalachian Mountains. The composition and spatial arrangement of the vegetation reflect the long-term developmental history of the eastern flora and prior connections to other floras that are now disjunct in Europe, Japan, and eastern China (Barbour and Billings 1988). The current vegetation composition also reflects North America's glacial past and the most recent retreat of continental glaciers that took place about 10,000 years ago. The resulting plant migrations have left northern and boreal species sprinkled in high-elevation refugia and cold pockets along the mountain chain while more southern species, elements of the southeastern Coastal Plain and Mississippi Valley floras, have advanced into many areas (Strausbaugh and Core 1978). The regional flora contains more than 5,000 species (Kartesz 2010), of which approximately 3,000 occur in wetlands to some degree (U.S. Army Corps of Engineers [USACE] 2010).

The great deciduous forest that once covered most of this region has been significantly altered since European settlement through clearing and conversion to pasture and row crops, silviculture, mining, and urban development. Human disturbance and land-use changes have affected some parts of the region more than others. However, one consequence of these changes throughout the region has been the increased number and occurrence of non-native “weedy” species in the flora. Estimates of the percentage of non-native species range from 22 percent (Jones 2005) to 37 percent (Kartesz 2010) in various parts of the region.

The characteristics of wetland plant communities in the region are also affected by seasonal changes in the availability of water, short- and long-term droughts, and natural and human-caused disturbances (e.g., floods, fires, grazing). Wetlands subject to seasonal hydrology include wet meadows, springs, seeps, and seasonal ponds (also known as vernal pools). These wetlands often exhibit seasonal shifts in vegetation composition, potentially changing the status of the community from hydrophytic during the wet season to non-hydrophytic during the dry season. Multi-year droughts and changes in lake levels can also change the composition of plant communities over longer periods (Barkley 1986). Woody shrubs and trees in wetlands are often resistant to droughts, while herbaceous vegetation may show dramatic turnover in species composition from drought years to years of abundant rainfall. See Chapter 5 for discussions of these and other problematic vegetation situations in the region.

Hydrophytic vegetation decisions are based on the wetland indicator status (Reed [1988] or current approved list) of species that make up the plant community. Species in the facultative categories (FACW, FAC, and FACU) are recognized as occurring in both wetlands and uplands to varying degrees. Although most wetlands are dominated mainly by species rated OBL, FACW, and FAC, some wetland communities may be dominated primarily by FACU species and cannot be identified by dominant species alone. In those cases, other indicators of hydrophytic vegetation must also be considered, particularly where indicators of hydric soils and wetland hydrology are present. This situation is not necessarily due to inaccurate wetland indicator ratings; rather, it is due to the broad tolerances of certain plant species that allow them to be widely distributed across the moisture gradient.

Hydrophytic vegetation indicators and procedures presented in this chapter are designed to identify the majority of wetland plant communities in the region. However, some wetland communities may lack any of these indicators. These situations are considered in Chapter 5 (Difficult Wetland Situations in the Eastern Mountains and Piedmont Region).

Guidance on vegetation sampling and analysis

General guidance on sampling of vegetation for wetland-delineation purposes is given in the Corps Manual. Those procedures are intended to be flexible and may need to be modified for application in a given region or on a particular site. Vegetation sampling done as part of a routine wetland delineation is designed to characterize the site in question rapidly. A balance must be established between the need to accomplish the work quickly and the need to characterize the site's heterogeneity accurately and at an appropriate scale. The following guidance on vegetation sampling is intended to supplement the Corps Manual for applications in the Eastern Mountains and Piedmont Region.

The first step is to identify the major landscape or vegetation units so that they can be evaluated separately. This may be done in advance using a current aerial photograph or topographic map, or by walking the site. In general, routine wetland determinations are based on visual estimates of percent cover of plant species that can be made either (1) within the vegetation unit as a whole, or (2) within one or more sampling plots established in representative locations within each unit. Percent cover estimates are more accurate and repeatable if taken within a defined plot. This also facilitates field verification of another delineator's work. The sizes and shapes of plots, if used, may be modified as appropriate to adapt to site conditions and should be recorded on the field data form. When sampling near a plant-community boundary, and particularly near the wetland boundary, it may be necessary to adjust plot size or shape to avoid overlapping the boundary and extending into an adjacent community having different vegetation, soils, or hydrologic conditions.

Proper plant identification is critical to the quality of the hydrophytic vegetation determination. If needed, wetland delineators should obtain professional assistance to ensure accurate species identification.

If it is not possible to locate at least one plot in a way that adequately represents the vegetation unit being sampled, then percent cover estimates for each species can be made during a meandering survey of the broader community. If additional quantification of cover estimates is needed, then the optional procedure for point-intercept sampling along transects (see Appendix B) or other sampling procedures may be used to characterize the vegetation unit. To use either of these sampling methods, soil and hydrologic conditions must be uniform across the sampled area.

Definitions of strata

Vegetation strata within the sampled area or plot are sampled separately when evaluating indicators of hydrophytic vegetation. In this region, the four vegetation strata described in the Corps Manual are recommended (see below). A data form that includes four vegetation strata is provided in Appendix C. Unless otherwise noted, a stratum for sampling purposes is defined as having 5 percent or more total plant cover. If a stratum has less than 5 percent cover during the growing season, then those species and their cover values should be recorded on the data form but should not be used in the calculations for the dominance test, unless it is the only stratum present.

1. *Tree stratum* – Consists of woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.
2. *Sapling/shrub stratum* – Consists of woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.
3. *Herb stratum* – Consists of all herbaceous (non-woody) plants, regardless of size, and all other plants less than 3.28 ft tall.
4. *Woody vines* – Consists of all woody vines greater than 3.28 ft in height.

Although the four-stratum sampling design presented above is recommended in the Eastern Mountains and Piedmont Region, investigators who prefer a five-stratum sampling design may use the one recommended in the Atlantic and Gulf Coastal Plain Region (U.S. Army Corps of Engineers [2008] or current version; data form provided in Appendix D), as follows:

1. *Tree stratum* – Consists of woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger DBH.
2. *Sapling stratum* – Consists of woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.
3. *Shrub stratum* – Consists of woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.
4. *Herb stratum* – Consists of all herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody species, except woody vines, less than approximately 3 ft (1 m) in height.
5. *Woody vines* – Consists of all woody vines, regardless of height.

Plot and sample sizes

Hydrophytic vegetation determinations under the Corps Manual are based on samples taken in representative locations within each community. Random sampling of the vegetation is not required except in rare cases where representative sampling might give misleading results. For routine determinations in fairly uniform vegetation, one or more plots in each community are usually sufficient for an accurate determination. Sampling of a multi-layered community is usually accomplished using a graduated series of plots, one for each stratum, or a number of small plots nested within the largest plot (Figure 2). Nested plots to sample the herb stratum can be helpful in forested areas with highly variable understories or in very diverse communities. Plant abundance data are averaged across the multiple small plots.

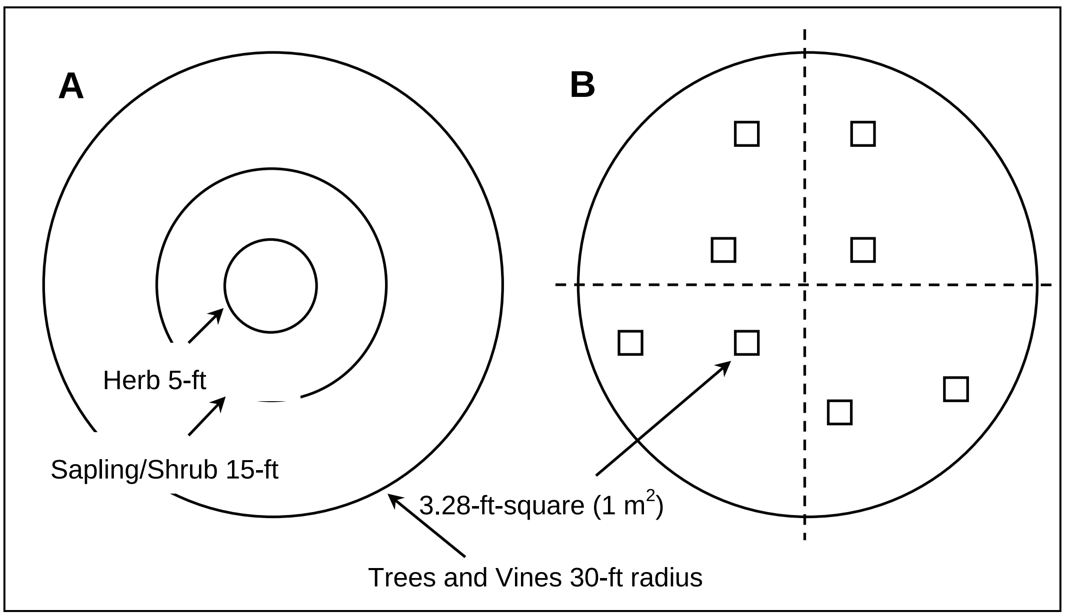

Figure 2. Suggested plot arrangements for vegetation sampling. (A) Single plots in graduated sizes. (B) Example of nested 3.28- by 3.28-ft square (1-m^2) plots for herbs within the 30-ft (9.1-m) radius plot. The number of small subplots needed varies depending upon species diversity.

The appropriate size and shape for a sample plot depend on the type of vegetation (i.e., trees, shrubs, herbaceous plants, etc.) and the size or shape of the plant community or patch being sampled. The plot should be large enough to include adequate numbers of individuals in all strata, but small enough so that plant species or individuals can be separated and measured without duplication or omission, and the sampling can be done in a timely fashion (Cox 1990; Barbour et al. 1999). For hydrophytic vegetation determinations, the abundance of each species is determined by using areal cover estimates. Plot sizes should make visual sampling both accurate and efficient. The sizes and shapes of sampling plots, if used, may be modified as appropriate to adapt to site conditions and should be recorded on the field data form if they deviate from those recommended in the Corps Manual or this supplement. In this region, the following plot sizes are suggested.

1. Tree stratum – 30-ft (9.1 m) radius
2. Sapling/shrub stratum, or separate sapling and shrub strata – 15-ft (4.6-m) radius
3. Herb stratum – 5-ft (1.5-m) radius
4. Woody vines – 30-ft (9.1-m) radius

An acceptable alternative design is to sample all vegetation strata within a 30-ft radius. In any case, the sampling plot should not be allowed to extend beyond the edges of the plant community being sampled or to overlap an adjacent community having different vegetation, soil, or hydrologic conditions. This may happen if vegetation patches are small or occur as narrow bands or zones along a topographic or moisture gradient. In such cases, plot sizes and shapes should be adjusted to fit completely within the vegetation patch of interest. For example, in linear riparian communities where the width of a standard plot may exceed the width of the plant community, an elongated rectangular plot or belt transect that parallels the stream is recommended. If possible, the area sampled should be equivalent to the 30-ft-radius plot (2,827 ft^2 [263 m^2]) for the tree stratum or the 15-ft-radius plot (707 ft^2 [65.7 m^2]) for the sapling/shrub stratum. An alternative approach involves sampling a series of smaller subplots and averaging the data across subplots.

A 30-ft-radius tree plot works well in most forests but can be increased to 40 ft (12.2 m) or more in a nonlinear forest stand if tree diversity is high or diameters are large. Highly diverse or patchy communities of herbs or other low vegetation may be sampled with nested 3.28- by 3.28-ft (1-m^2) quadrats randomly located within a 30-ft radius (Figure 2B). Furthermore, point-intercept sampling performed along a transect is an alternative to plot-based methods that can improve the accuracy and repeatability of vegetation sampling in diverse or heterogeneous communities (see Appendix B). To use this method, soil and hydrologic conditions must be uniform across the area where transects are located.

Vegetation sampling guidance presented here should be adequate for hydrophytic vegetation determinations in most situations. However, many variations in vegetation structure, diversity, and spatial arrangement exist on the landscape that are not addressed in this supplement. A list of references is given in Table 2 for more complex sampling situations. If alternative sampling techniques are used, they should be derived from the scientific literature and described in field notes or in the delineation report. The basic data must include abundance values for each species present. Typical abundance measures include basal area for tree species, percent areal cover, stem density, or frequency based on point-intercept sampling. The data must be in a format that can be used in the dominance test or prevalence index for hydrophytic vegetation (see the section on Hydrophytic Vegetation Indicators).

Table 2. Selected references to additional vegetation sampling approaches that could be used in wetland delineation.

Reference	Comment
Brohman, R. J., and L. D. Bryant, eds. 2005. *Existing Vegetation Classification and Mapping Technical Guide, Version 1.0.* General Technical Report WO-67. Washington, DC: U.S. Department of Agriculture Forest Service.	Contains a brief summary of vegetation sampling methods.
Kent, M., and P. Coker. 1992. *Vegetation Description and Analysis: A Practical Approach.* New York, NY: Wiley.	Contains simple and clear methods for setting up a study and collecting and analyzing the data. Initial chapters are helpful for data collection and sampling approaches in wetland delineation.
Mueller-Dombois, D., and H. Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*. New York, NY: Wiley.	A standard text in vegetation ecology, sampling, and analysis. This reference provides many sampling and analytical methods that are helpful in complex delineations.
Tiner, R.W. 1999. *Wetland indicators: A guide to wetland delineation, classification, and mapping.* Boca Raton, FL: CRC Press.	Includes reviews of various sampling techniques and provides a list of vegetation references.
USDI Bureau of Land Management. 1996. *Sampling vegetation attributes.* BLM/RS/ST-96/002+1730. Denver, CO.	Describes many aspects of vegetation sampling, including sampling protocols, data collection, and analysis.

In this supplement, absolute percent cover is the preferred abundance measure for all species. For percent cover estimates, it is not necessary for all plants to be rooted in the plot as long as they are growing under the same soil and hydrologic conditions. It may be necessary to exclude plants that overhang the plot if they are rooted in areas having different soil and hydrologic conditions, particularly when sampling near the wetland boundary.

Basal area is an alternative abundance measure for species in the tree stratum. Basal area of each species in a stand can be estimated quickly and efficiently with a basal-area prism or angle gauge. In this region, a prism with a basal-area factor (BAF) of 10 works well. Basal-area estimates can be used to select dominant species from the tree stratum for use in the dominance test for hydrophytic vegetation (see Hydrophytic Vegetation Indicators). However, basal-area estimates cannot be used to calculate a prevalence index, which is based on absolute percent cover of species in each stratum. Therefore, if basal-area estimates are used initially to evaluate the tree stratum but the dominance test is inconclusive, then the use of the prevalence index will require that the tree stratum be resampled to estimate absolute percent cover of each species.

Seasonal considerations and cautions

To the extent possible, the hydrophytic vegetation decision should be based on the plant community that is normally present during the wet portion of the growing season in a normal rainfall year. However, wetland determinations must often be performed at other times of year, or in years with unusual or atypical weather conditions. Portions of the Eastern Mountains and Piedmont Region have cold winters with considerable snow accumulation. Vegetation sampling for a wetland determination can be challenging when some plants are covered by snow or die back due to freezing temperatures or other factors. At these times, experience and professional judgment may be required to adapt the vegetation sampling scheme or use other sources of information to determine the plant community that is normally present.

When an on-site evaluation of the vegetation is impractical due to snow and ice or other factors, one option is to use existing off-site data sources, such as National Wetlands Inventory (NWI) maps, soil surveys, and aerial photographs, to make a preliminary hydrophytic vegetation determination. These sources may be supplemented with limited on-site data, including those plant species that can be observed and identified. Later, when conditions are favorable, an on-site investigation should be made to verify the preliminary determination and complete the wetland delineation.

Other factors can alter the plant community on a site and affect a hydrophytic vegetation determination, including seasonal changes in species composition, intensive grazing, flooding, wildfires, other natural disturbances, and human land-use practices. These factors are considered in Chapter 5.

Hydrophytic vegetation indicators

The following indicators should be applied in the sequence presented. The stepwise procedure is designed to reduce field effort by requiring that only one or two indicators, variations of the dominance test, be evaluated in the majority of wetland determinations. However, hydrophytic vegetation is present if any of the indicators is satisfied. All of these indicators are applicable throughout the entire Eastern Mountains and Piedmont Region.

Indicators of hydrophytic vegetation involve looking up the wetland indicator status of plant species on the wetland plant list (Reed [1988] or current list). For the purposes of this supplement, only the five basic levels of wetland indicator status (i.e., OBL, FACW, FAC, FACU, and UPL) are used in hydrophytic vegetation indicators. Plus (+) and minus (–) modifiers are not used (e.g., FAC–, FAC, and FAC+ plants are all considered to be FAC). For species listed as NI (reviewed but given no regional indicator) or NO (no known occurrence in the region at the time the list was compiled), apply the indicator status assigned to the species in the nearest adjacent region. If the species is listed as NI or NO but no adjacent regional indicator is assigned, do not use the species to calculate hydrophytic vegetation indicators. In general, species that are not listed on the wetland plant list are assumed to be upland (UPL) species. However, recent changes in plant nomenclature have resulted in a number of species that are not listed by Reed (1988) but are not necessarily UPL plants. Procedures described in Chapter 5, section on Problematic Hydrophytic Vegetation, can be used if it is believed that individual FACU, NI, NO, or unlisted plant species are functioning as hydrophytes on a particular site. For Clean Water Act purposes, wetland delineators should use the latest plant lists approved by Headquarters, U.S. Army Corps of Engineers (Figure 3) (http://geo.usace.army.mil/wetland_plants/index.html).

Evaluation of vegetation can begin with a rapid field test for hydrophytic vegetation to determine if there is a need to collect more detailed vegetation data. The rapid test for hydrophytic vegetation (Indicator 1) is met if all dominant species across all strata are OBL or FACW, or a combination of the two, based on a visual assessment. If the site is not dominated solely by OBL and FACW species, proceed to the standard dominance test (Indicator 2), which is the basic hydrophytic vegetation indicator. Either

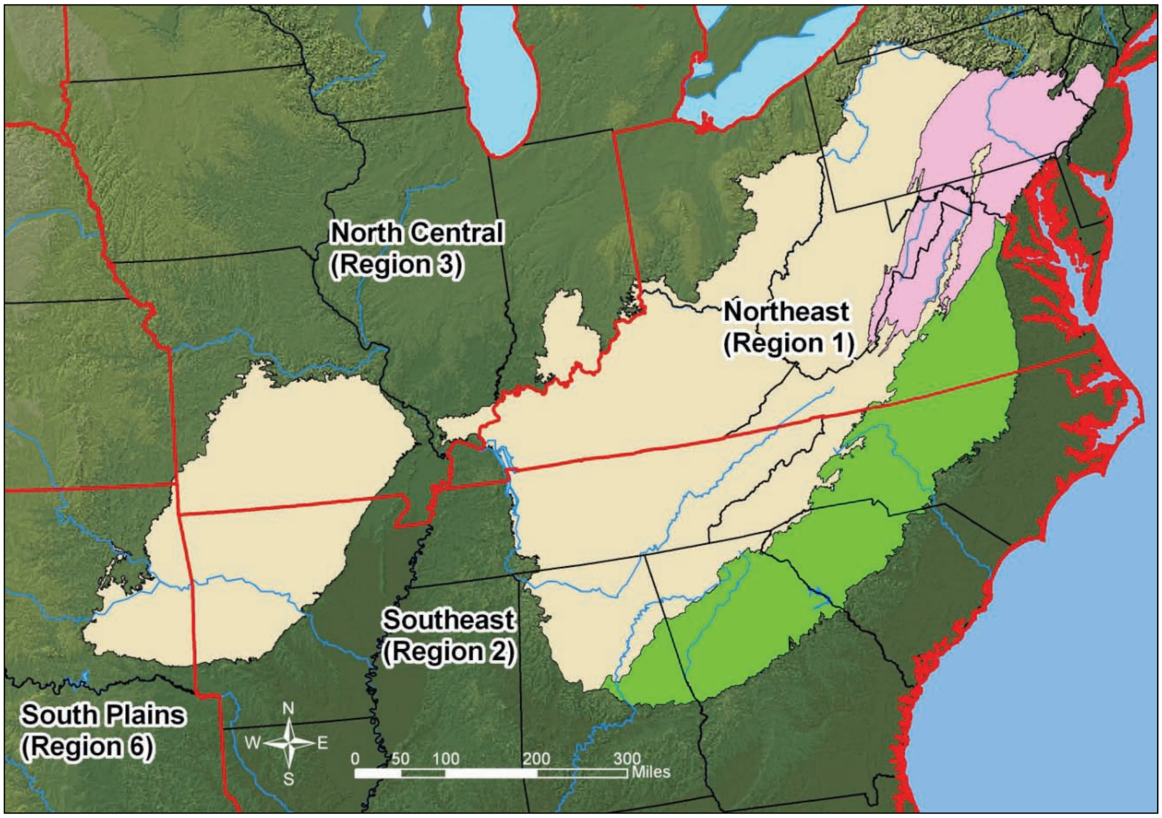

Figure 3. Plant list regional boundaries (red lines) currently used by the U.S. Fish and Wildlife Service, National Wetlands Inventory, in the Eastern Mountains and Piedmont Region.

Indicator 1 or 2 should be applied in every wetland determination. Most wetlands in the Eastern Mountains and Piedmont Region have plant communities that will meet one or both of these indicators. These are the only indicators that need to be considered in most situations. However, some wetland plant communities may fail a test based only on dominant species. Therefore, in those cases where indicators of hydric soil and wetland hydrology are present, the vegetation should be reevaluated with the prevalence index (Indicator 3), which takes non-dominant plant species into consideration, or by observing plant morphological adaptations for life in wetlands (Indicator 4). Finally, certain disturbed or problematic wetland situations may lack any of these indicators and are described in Chapter 5.

Procedure

The procedure for using hydrophytic vegetation indicators is as follows:

1. Apply Indicator 1 (Rapid Test for Hydrophytic Vegetation).

a. If the plant community passes the rapid test for hydrophytic vegetation, then the vegetation is hydrophytic and no further vegetation analysis is required.
b. If the rapid test for hydrophytic vegetation is not met, then proceed to step 2.

2. Apply Indicator 2 (Dominance Test).

a. If the plant community passes the dominance test, then the vegetation is hydrophytic and no further vegetation analysis is required.
b. If the plant community fails the dominance test, and indicators of hydric soil and/or wetland hydrology are absent, then hydrophytic vegetation is absent unless the site meets requirements for a problematic wetland situation (see Chapter 5).
c. If the plant community fails the dominance test, but indicators of hydric soil and wetland hydrology are both present, proceed to step 3.

3. Apply Indicator 3 (Prevalence Index). This and the following step assume that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present.

a. If the plant community satisfies the prevalence index, then the vegetation is hydrophytic. No further vegetation analysis is required.
b. If the plant community fails the prevalence index, proceed to step 4.

4. Apply Indicator 4 (Morphological Adaptations).

a. If the indicator is satisfied, the vegetation is hydrophytic.
b. If none of the indicators is satisfied, then hydrophytic vegetation is absent unless indicators of hydric soil and wetland hydrology are present and the site meets the requirements for a problematic wetland situation (Chapter 5).

Indicator 1: Rapid test for hydrophytic vegetation

Description: All dominant species across all strata are rated OBL or FACW, or a combination of these two categories, based on a visual assessment.

User Notes: This test is intended as a quick confirmation in obvious cases that a site has hydrophytic vegetation, without the need for more intensive sampling. Dominant species are selected visually from each stratum of the community using the "50/20 rule" (see Indicator 2 – Dominance Test below) as a general guide but without the need to gather quantitative data. Only the dominant species in each stratum must be recorded on the data form.

Indicator 2: Dominance test

Description: More than 50 percent of the dominant plant species across all strata are rated OBL, FACW, or FAC.

User Notes: Use the 50/20 rule described below to select dominant species from each stratum of the community. Combine dominant species across strata and apply the dominance test to the combined list. Once a species is selected as a dominant, its cover value is not used in the dominance test; each dominant species is treated equally. Thus, a plant community with seven dominant species across all strata would need at least four dominant species that are OBL, FACW, or FAC to be considered hydrophytic by this indicator. Species that are dominant in two or more strata should be counted two or more times in the dominance test.

Procedure for Selecting Dominant Species by the 50/20 Rule:
Dominant plant species are the most abundant species in the community; they contribute more to the character of the community than do the other non-dominant species present. The 50/20 rule is a repeatable and objective procedure for selecting dominant plant species and is recommended when data are available for all species in the community. The rule can also be used to guide visual sampling of plant communities in rapid wetland determinations.

Dominant species are chosen independently from each stratum of the community. In general, dominants are the most abundant species that individually or collectively account for more than 50 percent of the total absolute coverage of vegetation in the stratum, plus any other species that, by itself, accounts for at least 20 percent of the total. For the purposes of this regional supplement, absolute percent cover is the recommended abundance measure for plants in all vegetation strata. See Table 3 for an example application of the 50/20 rule in evaluating a plant community. Steps in selecting dominant species by the 50/20 rule are as follows:

Table 3. Example of the selection of dominant species by the 50/20 rule and determination of hydrophytic vegetation by the dominance test.

Stratum	Species Name	Wetland Indicator Status (Region 1)	Absolute Percent Cover	Dominant?
Herb	*Smilacina stellata*	FACW	15	Yes
	Toxicodendron radicans[1]	FAC	10	Yes
	Podophyllum peltatum[1]	FACU	10	Yes
	Symplocarpus foetidus	OBL	2	No
	Osmunda cinnamomea	FACW	2	No
	Parthenocissus quinquefolia	FACU	1	No
		Total Cover	40.0	
		50/20 Thresholds: 50% of total cover = 20.0% 20% of total cover = 8.0%		
Sapling/Shrub	*Carpinus caroliniana*	FAC	35	Yes
	Fagus grandifolia	FACU	10	No
	Betula lenta	FACU	5	No
	Berberis vulgaris	FACU	5	No
		Total Cover	55.0	
		50/20 Thresholds: 50% of total cover = 27.5% 20% of total cover = 11.0%		
Tree	*Quercus palustris*	FACW	40	Yes
	Salix nigra	FACW	20	Yes
	Fraxinus pennsylvanica	FACW	5	No
	Ostrya virginiana	FACU	5	No
		Total Cover	70.0	
		50/20 Thresholds: 50% of total cover = 35.0% 20% of total cover = 14.0%		
Woody Vine	*Toxicodendron radicans*	FAC	2	No[2]
Hydrophytic Vegetation Determination	Total number of dominant species across all strata = 6. Percent of dominant species that are OBL, FACW, or FAC = 83%. Therefore, this community is hydrophytic by Indicator 2 (Dominance Test).			

[1] If two or more species are equally abundant (i.e., tied in rank), they are all selected at once in the 50/20 rule.

[2] A stratum with less than 5 percent total cover is not considered in the dominance test, unless it is the only stratum present.

1. Estimate the absolute percent cover of each species in the first stratum. Since the same data may be used later to calculate the prevalence index, the data should be recorded as absolute cover and not converted to relative cover.
2. Rank all species in the stratum from most to least abundant.

3. Calculate the total absolute coverage of all species in the stratum (i.e., sum their individual absolute percent cover values). Absolute cover estimates do not necessarily sum to 100 percent.
4. Calculate the 50-percent threshold for the stratum by multiplying the total cover of that stratum by 50 percent.
5. Calculate the 20-percent threshold for the stratum by multiplying the total cover of that stratum by 20 percent.
6. Select plant species from the ranked list, in decreasing order of absolute coverage, until the cumulative coverage of selected species *exceeds* the threshold representing 50 percent of the total coverage for the stratum. If two or more species are equal in coverage (i.e., they are tied in rank), they should all be selected. The selected plant species are all considered to be dominants. All dominants must be identified to species.
7. In addition, select any other species that, by itself, is at least 20 percent of the total percent cover in the stratum. Any such species is also considered to be a dominant and must be accurately identified.
8. Repeat steps 1-7 for any other stratum present. Combine the lists of dominant species across all strata. Note that a species may be dominant in more than one stratum (e.g., a woody species may be dominant in both the tree and sapling/shrub strata).

Indicator 3: Prevalence index

Description: The prevalence index is 3.0 or less.

User Notes: The prevalence index ranges from 1 to 5. A prevalence index of 3.0 or less indicates that hydrophytic vegetation is present. If practical, all species in the plot should be identified and recorded on the data form. At a minimum, at least 80 percent of the total vegetation cover on the plot (summed across all strata) must be of species that have been correctly identified and have assigned wetland indicator statuses (Reed [1988] or current list) or are not listed and assumed to be upland (UPL) species.

Procedure for Calculating a Plot-Based Prevalence Index: The prevalence index is a weighted-average wetland indicator status of all plant species in the sampling plot. All plants are given a numeric value based on indicator status (OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5) and their abundance (absolute percent cover) is used to calculate the prevalence index. It is a more comprehensive analysis of the hydrophytic status of the community than one based on just a few dominant species. It is particularly useful in (1) communities with only one or two dominants, (2) highly diverse communities where many species may be present at roughly equal coverage, and (3) cases where strata differ greatly in total plant cover (e.g., total herb cover is 80 percent but sapling/shrub cover is only 10 percent).

The following procedure is used to calculate a plot-based prevalence index. The method was described by Wentworth et al. (1988) and modified by Wakeley and Lichvar (1997). It uses the same field data (i.e., absolute percent cover estimates for each plant species) that were used to select dominant species by the 50/20 rule, with the added constraint that at least 80 percent of the total vegetation cover on the plot must be of species that have been correctly identified and have an assigned indicator status (including UPL). For any species that occurs in more than one stratum, cover estimates are summed across strata. Steps for determining the prevalence index are as follows:

1. Identify and estimate the absolute percent cover of each species in each stratum of the community. Sum the cover estimates for any species that is present in more than one stratum.
2. Organize all species (across all strata) into groups according to their wetland indicator status (i.e., OBL, FACW, FAC, FACU, or UPL) and sum their cover values within groups. Do not include species that were not identified.
3. Calculate the prevalence index using the following formula:

$$PI = \frac{A_{OBL} + 2A_{FACW} + 3A_{FAC} + 4A_{FACU} + 5A_{UPL}}{A_{OBL} + A_{FACW} + A_{FAC} + A_{FACU} + A_{UPL}}$$

where:

PI = prevalence index;
A_{OBL} = summed percent cover values of obligate (OBL) plant species;
A_{FACW} = summed percent cover values of facultative wetland (FACW) plant species;
A_{FAC} = summed percent cover values of facultative (FAC) plant species;
A_{FACU} = summed percent cover values of facultative upland (FACU) plant species; and
A_{UPL} = summed percent cover values of upland (UPL) plant species.

See Table 4 for an example calculation of the prevalence index using the same data set as in Table 3. The following web link provides free public-domain software for simultaneous calculation of the 50/20 rule, dominance test, and prevalence index: http://www.crrel.usace.army.mil/rsgisc/wetshed/wetdatashed.htm.

Table 4. Example of the Prevalence Index using the same data as in Table 3.

Indicator Status Group	Species name	Absolute Percent Cover by Species	Total Cover by Group	Multiply by:[1]	Product
OBL species	*Symplocarpus foetidus*	2	2	1	2
FACW species	*Smilacina stellata* *Osmunda cinnamomea* *Quercus palustris* *Salix nigra* *Fraxinus pennsylvanica*	15 2 40 20 5	82	2	164
FAC species	*Toxicodendron radicans*[2] *Carpinus caroliniana*	12 35	47	3	141
FACU species	*Podophyllum peltatum* *Parthenocissus quinquefolia* *Fagus grandifolia* *Betula lenta* *Berberis vulgaris* *Ostrya virginiana*	10 1 10 5 5 5	36	4	144
UPL species	None	0	0	5	0
Sum			167 (A)		451 (B)
Hydrophytic Vegetation Determination		Prevalence Index = B/A = 451/167 = 2.70 Therefore, this community is hydrophytic by Indicator 3 (Prevalence Index).			

[1] Where OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5.

[2] A stratum with less than 5 percent cover is not considered in the dominance test but is included in the prevalence index. *Toxicodendron radicans* was recorded in two strata (see Table 3) so the cover estimates for this species were summed across strata.

Indicator 4: Morphological adaptations

Description: The plant community passes either the dominance test (Indicator 2) or the prevalence index (Indicator 3) after reconsideration of the indicator status of certain plant species that exhibit morphological adaptations for life in wetlands.

User Notes: Some hydrophytes in the Eastern Mountains and Piedmont Region develop easily recognized physical characteristics, or morphological adaptations, when they occur in wetlands. Some of these adaptations may help them to survive prolonged inundation or saturation in the root zone; others may simply be a consequence of living under such wet conditions. Common morphological adaptations in the region include — but are not limited to — adventitious roots, hypertrophied lenticels, buttressed trunks, multi-stemmed trunks, and shallow root systems developed on or near the soil surface (Figure 4). Morphological adaptations may develop on FACU species when they occur in wetlands, indicating that those individuals are functioning as hydrophytes in that setting. Users should be cautious that shallow roots were not caused by erosion or near-surface bedrock, and that multi-trunk plants were not the result of sprouting after logging or browsing. In the Appalachian region, the fungus that causes chestnut blight (*Cryphonectria parasitica*) can also produce swollen trunks and cankers in some oak species.

Figure 4. Shallow roots of eastern hemlock are a response to high water tables in this forested wetland.

To apply this indicator, these morphological features must be observed on more than 50 percent of the individuals of a FACU species living in an area where indicators of hydric soil and wetland hydrology are present. Follow this procedure:

1. Confirm that the morphological feature is present mainly in the potential wetland area and is not also common on the same species in the surrounding non-wetlands.
2. For each FACU species that exhibits morphological adaptations, estimate the percentage of individuals that have the features. Record this percentage on the data form.
3. If more than 50 percent of the individuals of a FACU species have morphological adaptations for life in wetlands, that species is considered to be a hydrophyte and its indicator status on that plot should be reassigned as FAC. All other species retain their published indicator statuses. Record any supporting information on the data sheet, including a description of the morphological adaptation(s) present and any other observations of the growth habit of the species in adjacent wetland and non-wetland locations (photo documentation is recommended).
4. Recalculate the dominance test (Indicator 2) and/or the prevalence index (Indicator 3) using a FAC indicator status for this species. The vegetation is hydrophytic if either test is satisfied.

3 Hydric Soil Indicators

Introduction

The National Technical Committee for Hydric Soils (NTCHS) defines a hydric soil as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service 1994). Most hydric soils exhibit characteristic morphologies that result from repeated periods of saturation or inundation for more than a few days. Saturation or inundation, when combined with microbial activity in the soil, causes the depletion of oxygen. This anaerobiosis promotes certain biogeochemical processes, such as the accumulation of organic matter and the reduction, translocation, or accumulation of iron and other reducible elements. These processes result in distinctive characteristics that persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils in the field (USDA Natural Resources Conservation Service 2010).

This chapter presents indicators that are designed to help identify hydric soils in the Eastern Mountains and Piedmont Region. Indicators are not intended to replace or relieve the requirements contained in the definition of a hydric soil. Therefore, a soil that meets the definition of a hydric soil is hydric whether or not it exhibits indicators. Guidance for identifying hydric soils that lack indicators can be found later in this chapter (see the sections on documenting the site and its soils) and in Chapter 5 (Difficult Wetland Situations in the Eastern Mountains and Piedmont Region).

This list of indicators is dynamic; changes and additions to the list are anticipated with new research and field testing. The indicators presented in this supplement are a subset of the NTCHS *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service [2010] or current version) that are commonly found in the region. Any change to the NTCHS *Field Indicators of Hydric Soils in the United States* represents a change to this subset of indicators for the Eastern Mountains and Piedmont Region. The current version of the indicators can be found on the NRCS hydric soils web site (http://soils.usda.gov/use/hydric). To use the indicators properly, a basic knowledge of soil/landscape relationships is necessary.

Most of the hydric soil indicators presented in this Supplement are applicable throughout the region; however, some are specific to certain subregions. As used in this supplement, subregions are equivalent to the Land Resource Regions (LRR) or Major Land Resource Areas (MLRA) recognized by the USDA Natural Resources Conservation Service (2006) (see Chapter 1, Figure 1). It is important to understand that boundaries between subregions are actually broad transition zones. Although an indicator may be noted as most relevant in a specific subregion, it may also be applicable in the transition to an adjacent subregion.

Concepts

Hydric soil indicators are formed predominantly by the accumulation or loss of iron, manganese, sulfur, or carbon compounds in a saturated and anaerobic environment. These processes and the features that develop are described in the following paragraphs.

Iron and manganese reduction, translocation, and accumulation

In an anaerobic environment, soil microbes reduce iron from the ferric (Fe^{3+}) to the ferrous (Fe^{2+}) form, and manganese from the manganic (Mn^{4+}) to the manganous (Mn^{2+}) form. Of the two, evidence of iron reduction is more commonly observed in soils. Areas in the soil where iron is reduced may develop characteristic bluish-gray or greenish-gray colors known as *gley*. Ferric iron is insoluble but ferrous iron easily enters the soil solution and may be moved or translocated to other areas of the soil. Areas that have lost iron typically develop characteristic gray or reddish-gray colors and are known as *redox depletions*. If a soil reverts to an aerobic state, iron that is in solution will oxidize and become concentrated in patches and along root channels and other pores. These areas of oxidized iron are called *redox concentrations*. Since water movement in these saturated or inundated soils can be multi-directional, redox depletions and concentrations can occur anywhere in the soil and have irregular shapes and sizes. Soils that are saturated and contain ferrous iron at the time of sampling may change color upon exposure to the air, as ferrous iron is rapidly converted to ferric iron in the presence of oxygen. Such soils are said to have a *reduced matrix* (Vepraskas 1992).

While indicators related to iron or manganese depletion or concentration are the most common in hydric soils, they cannot form in soils whose parent materials are low in Fe or Mn. Soils formed in such materials may have low-chroma colors that are not related to saturation and reduction.

For such soils, features formed through accumulation of organic carbon may be present.

Sulfate reduction

Sulfur is one of the last elements to be reduced by microbes in an anaerobic environment. The microbes convert SO_4^{2-} to H_2S, or hydrogen sulfide gas. This results in a very pronounced "rotten egg" odor in some soils that are inundated or saturated for very long periods. In non-saturated or non-inundated soils, sulfate is not reduced and there is no rotten egg odor. The presence of hydrogen sulfide is a strong indicator of a hydric soil, but this indicator is found only in the wettest sites in soils that contain sulfur-bearing compounds.

Organic matter accumulation

Soil microbes use carbon compounds found in organic matter as an energy source. However, the rate at which organic carbon is utilized by soil microbes is considerably lower in a saturated and anaerobic environment than under aerobic conditions. Therefore, in saturated soils, partially decomposed organic matter may accumulate. The result in wetlands is often the development of thick organic surfaces, such as peat or muck, or dark organic-rich mineral surface layers.

Non-saturated or non-inundated organic soils. In northern regions and at high elevations in southern regions, cool temperatures and acid conditions slow the decomposition of organic matter. Under these conditions, even some well-drained soils, under predominantly aerobic conditions, can develop thick organic surface layers called folistic epipedons. These layers are not necessarily related to wetness. Folistic layers are organic accumulations that are saturated less than 30 days cumulatively in normal years (USDA Natural Resources Conservation Service 1999). Most folistic layers consist of poorly decomposed organic material (i.e., fibric or hemic material; see the following section), although some consist of highly decomposed (i.e., sapric) material. Folistic surface layers are of limited extent in the region. They overlie rock, mineral layers, or saturated organic layers, and are most commonly found on north- and east-facing slopes, in dense shade, and on nearly level, convex landforms in coniferous or mixed deciduous/coniferous forests. It may be necessary to involve a soil scientist with local knowledge to help distinguish folistic surface layers from saturated organic layers.

Determining the texture of soil materials high in organic carbon. Material high in organic carbon could fall into three categories: organic, mucky mineral, or mineral. In lieu of laboratory data, the following estimation method can be used for soil material that is wet or nearly saturated with water. This method may be inconclusive with loamy or clayey textured mineral soils. Gently rub the wet soil material between forefinger and thumb. If upon the first or second rub the material feels gritty, it is mineral soil material. If after the second rub the material feels greasy, it is either mucky mineral or organic soil material. Gently rub the material two or three more times. If after these additional rubs it feels gritty or plastic, it is mucky mineral soil material; if it still feels greasy, it is organic soil material. If the material is organic soil material a further division should be made, as follows.

Organic soil materials are classified as sapric, hemic, or fibric based on the percentage of visible fibers observable with a hand lens in an undisturbed state and after rubbing between thumb and fingers 10 times (Table 5). If there is a conflict between unrubbed and rubbed fiber content, rubbed content is used. *Live roots are not considered*. In saturated organic materials, the terms sapric, hemic, and fibric correspond to the textures muck, mucky peat, and peat, respectively (Table 5). The terms muck, mucky peat, and peat should only be used for organic accumulations associated with wetness.

Table 5. Proportion of sample consisting of fibers visible with a hand lens.

Unrubbed	Rubbed	Horizon Descriptor	Soil Texture (Saturated Organic Soils)
<33%	<17%	Sapric	Muck
33-67%	17-40%	Hemic	Mucky peat
>67%	>40%	Fibric	Peat

Adapted from USDA Natural Resources Conservation Service (1999).

Another field method for determining the degree of decomposition for organic materials is a system modified from a method originally developed by L. von Post and described in detail in ASTM standard D 5715-00 (http://www.astm.org/). This method is based on a visual examination of the color of the water that is expelled and the soil material remaining in the hand after a saturated sample is squeezed (Table 6). If a conflict occurs between results for sapric, hemic, or fibric material using percent visible fiber (Table 5) and degree of humification (Table 6), then percent visible fiber should be used.

Table 6. Determination of degree of decomposition of organic materials.

Degree of Humification	Nature of Material Extruded on Squeezing	Nature of Plant Structure in Residue	Horizon Descriptor
H1	Clear, colorless water; no organic solids squeezed out	Unaltered, fibrous, undecomposed	Fibric (Peat)
H2	Yellowish water; no organic solids squeezed out	Almost unaltered, fibrous	
H3	Brown, turbid water; no organic solids squeezed out	Easily identifiable	
H4	Dark brown, turbid water; no organic solids squeezed out	Visibly altered but identifiable	Hemic (Mucky peat)
H5	Turbid water and some organic solids squeezed out	Recognizable but vague, difficult to identify	
H6	Turbid water; 1/3 of sample squeezed out	Indistinct, pasty	
H7	Very turbid water; 1/2 of sample squeezed out	Faintly recognizable; few remains identifiable, mostly amorphous	Sapric (Muck)
H8	Thick and pasty; 2/3 of sample squeezed out	Very indistinct	
H9	No free water; nearly all of sample squeezed out	No identifiable remains	
H10	No free water; all of sample squeezed out	Completely amorphous	

Cautions

A soil that is artificially drained or protected (for instance, by dikes or levees) is still hydric if the soil in its undisturbed state would meet the definition of a hydric soil. To be identified as hydric, these soils should generally have one or more of the indicators. However, not all areas that have hydric soils will qualify as wetlands, if they no longer have wetland hydrology or support hydrophytic vegetation.

Morphological features that do not reflect contemporary or recent conditions of saturation and anaerobiosis are called relict features. Contemporary and relict hydric soil features can be difficult to distinguish. For example, nodules and concretions that are actively forming often have gradual or diffuse boundaries, whereas relict or degrading nodules and concretions tend to have sharp boundaries (Vepraskas 1992). Guidance for some of the most common problem hydric soils can be found in Chapter 5. When soil morphology seems inconsistent with the landscape, vegetation, or observable hydrology, it may be necessary to obtain the assistance of an experienced soil or wetland scientist to determine whether the soil is hydric.

Procedures for sampling soils

Observe and document the site

Before making any decision about the presence or absence of hydric soils, the overall site and how it interacts with the soil should be considered. The questions below, while not required to identify a hydric soil, can help to explain why one is or is not present. Always look at the landscape features of the immediate site and compare them to surrounding areas. Try to contrast the features of wet and dry sites that are close to one another. When observing slope features, look first at the area immediately around the sampling point. For example, a nearly level bench or depression at the sampling point may be more important to site wetness than the overall landform on which it occurs. By understanding how water moves across the site, the reasons for the presence or absence of hydric soil indicators should be clear.

If one or more of the hydric soil indicators given later in this chapter is present, then the soil is hydric. If no hydric soil indicator is present, the additional site information below may be useful in documenting whether the soil is indeed non-hydric or if it might represent a “problem” hydric soil that meets the hydric soil definition despite the absence of indicators.

- *Hydrology*–Is standing water observed on the site or is water observed in the soil pit? What is the depth of the water table in the area? Is there indirect evidence of ponding or flooding? Is there a seep or spring?
- *Slope*–Is the site level or nearly level so that surface water does not run off readily, or is it steeper where surface water would run off from the soil?
- *Slope shape*–Is the surface concave (e.g., depressions), where water would tend to collect and possibly pond on the soil surface? On hillsides, are there convergent slopes (Figure 5), where surface or groundwater may be directed toward a central stream or swale? Or is the surface or slope shape convex, causing water to run off or disperse?
- *Landform*–Is the soil on a low terrace or floodplain that may be subject to seasonal high water tables or flooding? Is it at the toe of a slope (Figure 6) where runoff may tend to collect or groundwater emerge at or near the surface? Has the microtopography been altered by cultivation?
- *Soil materials*– Is there a restrictive layer in the soil that could slow or prevent the infiltration of water, perhaps resulting in a perched water table or hillslope seep? Restrictive layers could include consolidated bedrock, fragipans, mechanically compacted layers, layers of silt or substantial clay content, or strongly contrasting soil textures (e.g., silt over sand).

- *Vegetation*–Does the vegetation at the site indicate wetter conditions than at other nearby sites, or is it similar to what is found at nearby upland sites?

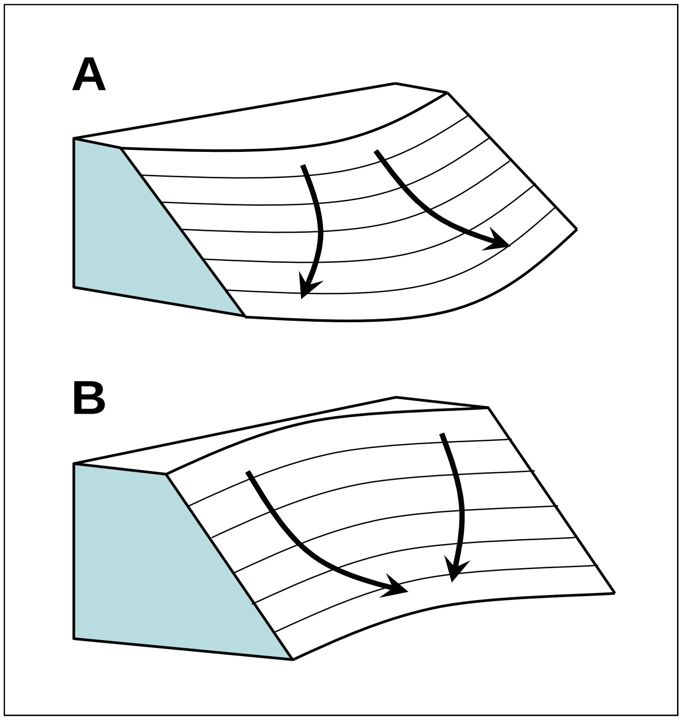

Figure 5. Divergent slopes (A) disperse surface water, whereas convergent slopes (B) concentrate water. Surface flow paths are indicated by the arrows.

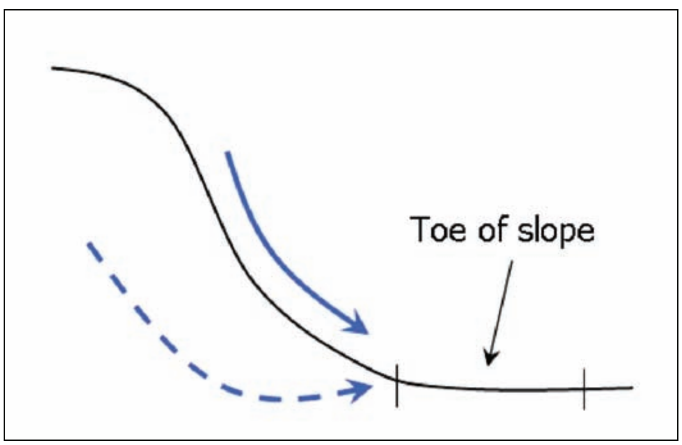

Figure 6. At the toe of a hill slope, the gradient is only slightly inclined or nearly level. Blue arrows represent flow paths of surface water (solid arrow) and groundwater (dashed arrow).

Observe and document the soil

To observe and document a hydric soil, first remove any loose leaves, needles, or bark from the soil surface. Do not remove the organic surface layers of the soil, which usually consist of plant remains in varying stages of decomposition. Dig a hole and describe the soil profile. In general, the hole should be dug to the depth needed to document an indicator or to confirm the absence of indicators. For most soils, the recommended excavation depth is approximately 20 in. (50 cm) from the soil surface, although a shallower soil pit may suffice for some indicators (e.g., A2 – Histic Epipedon). Digging may be difficult in some areas due to rocks and hardpans. Use the completed profile description to determine which hydric soil indicators have been met (USDA Natural Resources Conservation Service 2010).

For soils with deep, dark surface layers, deeper examination may be required when field indicators are not easily seen within 20 in. (50 cm) of the surface. The accumulation of organic matter in these soils may mask redoximorphic features in the surface layers. Examination to 40 in. (1 m) or more may be needed to determine whether they meet the requirements of indicator A12 (Thick Dark Surface). A soil auger or probe may be useful for sampling soil materials below 20 in.

Whenever possible, excavate the soil deep enough to determine if there are layers or materials present that might restrict soil drainage. This will help to understand why the soil may or may not be hydric. After a sufficient number of exploratory excavations have been made to understand the soil-hydrologic relationships at the site, subsequent excavations can be limited to the depth needed to identify hydric soil indicators. Consider taking photographs of both the soil and the overall site, including a clearly marked measurement scale in soil pictures.

Depths used in the indicators are measured from the muck surface, or from the mineral soil surface if a muck surface is absent. For indicators A1 (Histosol), A2 (Histic Epipedon), and A3 (Black Histic), depths are measured from the top of the organic material (peat, mucky peat, or muck), or from the top of any mineral material that may overlie the organic layer.

All colors noted in this supplement refer to moist Munsell® colors (Gretag/Macbeth 2000). Do not determine colors while wearing sunglasses or tinted lenses. Colors must be determined under natural light and not under artificial light.

Soil colors should not be rounded to qualify as meeting an indicator. For example, a soil matrix with a chroma between 2 and 3 should be recorded as having a chroma of 2+. This soil material does not have a chroma of 2 and would not meet any indicator that requires a chroma of 2 or less.

Always examine soil matrix colors in the field immediately after sampling. Ferrous iron, if present, can oxidize rapidly and create colors of higher chroma or redder hue. In soils that are saturated at the time of sampling, redox concentrations may be absent or difficult to see, particularly in dark-colored soils. It may be necessary to let the soil dry to a moist state (5 to 30 minutes or more) for the iron or manganese to oxidize and redox features to become visible.

Particular attention should be paid to changes in microtopography over short distances. Small changes in elevation may result in repetitive sequences of hydric/non-hydric soils, making the delineation of individual areas of hydric and non-hydric soils difficult. Often the dominant condition (hydric or non-hydric) is the only reliable interpretation (also see the section on Wetland/Non-Wetland Mosaics in Chapter 5). The shape of the local landform can greatly affect the movement of water through the landscape. Significant changes in parent material or lithologic discontinuities in the soil can affect the hydrologic properties of the soil.

Use of existing soil data

Soil surveys

Soil surveys are available for most areas of the Eastern Mountains and Piedmont Region and can provide useful information regarding soil properties and soil moisture conditions for an area. A list of available soil surveys is located at http://soils.usda.gov/survey/online_surveys/, and soil survey maps and data are available online from the Web Soil Survey at http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. Soil survey maps divide the landscape into areas called map units. Map units usually contain more than one soil type or component. Map units often contain several minor components or inclusions of soils with properties that may be similar to or quite different from the major component. Those soils that are hydric are noted in the *Hydric Soils List* published separately from the soil survey report. Soil survey information can be valuable for planning purposes, but it is not site-specific and does not preclude the need for an on-site investigation.

Hydric soils lists

Hydric Soils Lists are developed for each detailed soil survey. Using criteria approved by the NTCHS, these lists rate each soil component as either hydric or non-hydric based on soil property data. If the soil is rated as hydric, information is provided regarding which hydric criteria are met and on what landform the soil typically occurs. Hydric Soils Lists are useful as general background information for an on-site delineation. The Hydric Soils List is a tool indicating that hydric soil will likely be found within a given area. However, map polygons identified as having hydric soils may also contain areas of non-hydric soils, and vice versa.

Hydric Soils Lists developed for individual detailed soil surveys are known as Local Hydric Soils Lists. They are available from state or county NRCS offices and over the internet from the Soil Data Mart (http://soildatamart.nrcs.usda.gov/SDM%20Web%20Application/default.aspx). Local Hydric Soils Lists have been compiled into a National Hydric Soils List available at http://soils.usda.gov/use/hydric/. However, use of Local Hydric Soils Lists is preferred since they are more current and reflect local variations in soil properties.

Hydric soil indicators

Many of the hydric soil indicators were developed specifically for wetland-delineation purposes. During the development of these indicators, soils in the interior of wetlands were not always examined; therefore, there are wetlands that lack any of the approved hydric soil indicators in the wettest interior portions. Wetland delineators and other users of the hydric soil indicators should concentrate their sampling efforts near the wetland edge and, if these soils are hydric, assume that soils in the wetter, interior portions of the wetland are also hydric even if they lack an indicator.

Hydric soil indicators are presented in three groups. Indicators for "All Soils" are used in any soil regardless of texture. Indicators for "Sandy Soils" are used in soil layers with USDA textures of loamy fine sand or coarser. Indicators for "Loamy and Clayey Soils" are used with soil layers of loamy very fine sand and finer. Organic, sandy, and loamy/clayey layers may be present in the same soil profile. For example, a soil that contains a loamy surface layer over sand is hydric if it meets all of the requirements of matrix color, amount and contrast of redox concentrations, depth, and thickness for a specific A (All Soils), F (Loamy and Clayey Soils), or S (Sandy Soils) indicator. Additional indicators for problematic hydric soils are presented on pages 76-79. These indicators are used in conjunction with the procedure given in Chapter 5.

It is permissible to combine certain hydric soil indicators if all requirements of the individual indicators are met except thickness (see Hydric Soil Technical Note 4, http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html). The most restrictive requirements for thickness of layers in any indicators used must be met. Not all indicators are possible candidates for combination. For example, indicator F2 (Loamy Gleyed Matrix) has no thickness requirement, so a site would either meet the requirements of this indicator or it would not. Table 7 lists the indicators that are the most likely candidates for combining in the region.

Table 7. Minimum thickness requirements for commonly combined indicators in the Eastern Mountains and Piedmont Region.

Indicator	Minimum Thickness Requirement
S5 – Sandy Redox	4 in. (10 cm) thick starting within 6 in. (15 cm) of the soil surface
F3 – Depleted Matrix	6 in. (15 cm) thick starting within 10 in. (25 cm) of the soil surface
F6 – Redox Dark Surface	4 in. (10 cm) thick entirely within the upper 12 in. (30 cm)
F7 – Depleted Dark Surface	4 in. (10 cm) thick entirely within the upper 12 in. (30 cm)

Table 8 presents an example of a soil in which a combination of layers meets the requirements for indicators F6 (Redox Dark Surface) and F3 (Depleted Matrix). The second layer meets the morphological characteristics of F6 and the third layer meets the morphological characteristics of F3, but neither meets the thickness requirement for its respective indicator. However, the combined thickness of the second and third layers meets the more restrictive conditions of thickness for F3 (i.e., 6 in. [15 cm] starting within 10 in. [25 cm] of the soil surface). Therefore, the soil is considered to be hydric based on the combination of indicators.

Another common situation in which it is appropriate to combine the characteristics of hydric soil indicators is when stratified textures of sandy (i.e., loamy fine sand and coarser) and loamy/clayey (i.e., loamy very fine sand and finer) material occur in the upper 12 in. (30 cm) of the soil. For example, the soil shown in Table 9 is hydric based on a combination of indicators F6 (Redox Dark Surface) and S5 (Sandy Redox). This soil meets the morphological characteristics of F6 in the first layer and S5 in the second layer, but neither layer by itself meets the thickness requirement for its respective indicator. However, the combined thickness of the two layers (6 in. [15 cm]) meets the more restrictive thickness requirement of either indicator (4 in. [10 cm]).

Table 8. Example of a soil that is hydric based on a combination of indicators F6 and F3.

Depth (inches)	Matrix Color	Redox Concentrations			Texture
		Color	Abundance	Contrast	
0 – 3	10YR 2/1	--	--	--	Loamy/clayey
3 – 6	10YR 3/1	7.5YR 5/6	3 percent	Prominent	Loamy/clayey
6 – 10	10YR 5/2	7.5YR 5/6	5 percent	Prominent	Loamy/clayey
10 – 14	2.5Y 4/2	--	--	--	Loamy/clayey

Table 9. Example of a soil that is hydric based on a combination of indicators F6 and S5.

Depth (inches)	Matrix Color	Redox Concentrations			Texture
		Color	Abundance	Contrast	
0 – 3	10YR 3/1	10YR 5/6	3 percent	Prominent	Loamy/clayey
3 – 6	10YR 4/1	10YR 5/6	3 percent	Prominent	Sandy
6 – 16	10YR 4/1	--	--	--	Loamy/clayey

All Soils

"All soils" refers to soils with any USDA soil texture. Use the following indicators regardless of soil texture.

Unless otherwise noted, all mineral layers above any of the layers meeting an A indicator, except for indicator A16, must have a dominant chroma of 2 or less, or the layer(s) with a dominant chroma of more than 2 must be less than 6 in. (15 cm) thick to meet any hydric soil indicator. Nodules and concretions are not considered to be redox concentrations unless otherwise noted.

Indicator A1: Histosol

Technical Description: Classifies as a Histosol (except Folists)

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: In most Histosols, 16 in. (40 cm) or more of the upper 32 in. (80 cm) is organic soil material (Figure 7). Histosols also include soils that have organic soil material of any thickness over rock or fragmental soil material that has interstices filled with organic soil material (Figure 8). Use caution in areas that may have folistic surface layers; folistic layers do not meet the requirements of this indicator. Organic soil material has an organic carbon content (by weight) of 12 to 18 percent or more, depending on the clay content of the soil. The material includes muck (sapric soil material), mucky peat (hemic soil material), or peat (fibric soil material). See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2010) for definitions of muck, mucky peat, peat, and organic soil material. See the Concepts section of this chapter for field methods to identify organic soil materials, and Appendix A for the definition of fragmental soil material.

Histosols are of limited extent in this region but are most common at elevations above 3,000 ft (914 m). They typically occur in bogs, fens, and slope wetlands that are ponded or saturated to the surface nearly all of the growing season in most years. This indicator almost never occurs at the wetland-upland boundary except where there is shallow bedrock (Figure 8).

Figure 7. Example of a Histosol, in which muck (sapric soil material) is greater than 3 ft (0.9 m) thick.

Figure 8. This Histosol consists of only a few inches of organic soil material over bedrock.

Indicator A2: Histic Epipedon

Technical Description: A histic epipedon underlain by mineral soil material with a chroma of 2 or less.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: Most histic epipedons are surface horizons 8 in. (20 cm) or more thick of organic soil material (Figure 9). Aquic conditions or artificial drainage are required (see *Soil Taxonomy*, USDA Natural Resources Conservation Service 1999); however, aquic conditions can be assumed if indicators of hydrophytic vegetation and wetland hydrology are present. See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2010) for definitions. See the Concepts section of this chapter for field methods to identify organic soil materials. See indicator A1 for organic carbon requirements. Slightly lower organic carbon contents are allowed in plowed soils.

Histic epipedons are of limited extent in this region but are most common at elevations above 3,000 ft (914 m). They typically occur in bogs, fens, and slope wetlands that are ponded or saturated to the surface nearly all of the growing season in most years. This indicator almost never occurs at the wetland-upland boundary.

Figure 9. In this soil, the organic surface layer is about 9 in. (23 cm) thick.

Indicator A3: Black Histic

Technical Description: A layer of peat, mucky peat, or muck 8 in. (20 cm) or more thick that starts within 6 in. (15 cm) of the soil surface; has a hue of 10YR or yellower, value of 3 or less, and chroma of 1 or less; and is underlain by mineral soil material with a chroma of 2 or less.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: This indicator does not require proof of aquic conditions or artificial drainage. See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2010) for definitions of peat, mucky peat, and muck. See the Concepts section of this chapter for field methods to identify organic soil materials. See indicator A1 for organic carbon requirements.

This indicator is of limited extent in this region but is most common at elevations above 3,000 ft (914 m). It typically occurs in bogs, fens, and slope wetlands that are ponded or saturated to the surface nearly all of the growing season in most years. This indicator almost never occurs at the wetland-upland boundary.

Indicator A4: Hydrogen Sulfide

Technical Description: A hydrogen sulfide (rotten egg) odor within 12 in. (30 cm) of the soil surface.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: Any time the soil smells of hydrogen sulfide (rotten egg odor), sulfur is currently being reduced and the soil is definitely in an anaerobic state. In some soils, the odor is pronounced; in others it is very fleeting as the gas dissipates rapidly. If in doubt, quickly open several small holes in the area of concern to determine if a hydrogen sulfide odor is really present. This indicator is most commonly found on floodplains on the Piedmont (MLRAs 136 and 148) that are inundated or saturated most of the growing season in most years.

Indicator A5: Stratified Layers

Technical Description: Several stratified layers starting within 6 in. (15 cm) of the soil surface. At least one of the layers has a value of 3 or less with a chroma of 1 or less or it is muck, mucky peat, peat, or mucky modified mineral texture. The remaining layers have chromas of 2 or less (Figure 10). Any sandy material that constitutes the layer with a value of

Figure 10. Stratified layers in loamy material.

3 or less and a chroma of 1 or less, when viewed with a 10- or 15-power hand lens, must have at least 70 percent of the visible soil particles masked with organic material (Figure 11). When viewed without a hand lens, the particles appear to be nearly 100 percent masked.

Figure 11. Stratified layers in sandy material.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: Use of this indicator may require assistance from a soil scientist with local experience. An undisturbed sample must be observed.

Individual strata are dominantly less than 1 in. (2.5 m) thick. Stratified layers are not common, but occur in any type of soil material, generally in floodplains and other areas where wet soils are subject to rapid and repeated burial with thin deposits of sediment.

Indicator A10: 2 cm Muck

Technical Description: A layer of muck 0.75 in. (2 cm) or more thick with a value of 3 or less and chroma of 1 or less, starting within 6 in. (15 cm) of the soil surface.

Applicable Subregions: Applicable to the Central and Eastern Mountains Subregion (LRR N).

User Notes: This indicator is commonly found in the interiors of potholes and other depressions that are ponded for several months each year. Normally the muck layer is at the soil surface; however, it may occur at any depth within 6 in. (15 cm) of the surface (Figure 12). Muck is sapric soil material with at least 12 to 18 percent organic carbon. Organic soil material is called muck (sapric soil material) if virtually all of the material has undergone sufficient decomposition to limit recognition of the plant parts. Hemic (mucky peat) and fibric (peat) soil materials do not qualify. Generally, muck is black and has a greasy feel; sand grains should not be evident (see the Concepts section of this chapter for field methods to identify organic soil materials). This indicator can also be used in problem soils outside of LRR N (see the section on Hydric Soil Indicators for Problem Soils in this chapter).

Figure 12. A layer of muck (dark material indicated by the knife point) occurs in the upper 6 in. (15 cm) of this soil.

Indicator A11: Depleted Below Dark Surface

Technical Description: A layer with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less, starting within 12 in. (30 cm) of the soil surface, and having a minimum thickness of either:

- 6 in. (15 cm), or
- 2 in. (5 cm) if the 2 in. (5 cm) consists of fragmental soil material.

Loamy/clayey layer(s) above the depleted or gleyed matrix must have a value of 3 or less and chroma of 2 or less. Any sandy material above the depleted or gleyed matrix must have a value of 3 or less and chroma of 1 or less and, when viewed with a 10- or 15-power hand lens, must have at least 70 percent of the visible soil particles masked with organic material. When viewed without a hand lens, the particles appear to be nearly 100 percent masked.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: This indicator often occurs in wet soils with dark-colored surface layers (Figure 13). For soils that have dark surface layers greater than 12 in. (30 cm) thick, use indicator A12. Two percent or more distinct or prominent redox concentrations, including iron/manganese soft masses, pore linings, or both, are required in soils that have matrix values/chromas of 4/1, 4/2, and 5/2 (Figure A1). If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. See the Glossary (Appendix A) for definitions of depleted matrix, gleyed matrix, distinct and prominent features, and fragmental soil material.

Figure 13. In this soil, a depleted matrix starts immediately below the black surface layer at approximately 11 in. (28 cm).

In some places, the gleyed matrix may change color upon exposure to air (reduced matrix). This phenomenon is included in the concept of a gleyed matrix (USDA Natural Resources Conservation Service 2002).

This indicator is commonly found at the boundaries of wetlands on floodplains, terraces, and foot slopes.

Indicator A12: Thick Dark Surface

Technical Description: A layer at least 6 in. (15 cm) thick with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less starting below 12 in. (30 cm) of the surface. The layer(s) above the depleted or gleyed matrix must have a value of 2.5 or less and chroma of 1 or less to a depth of at least 12 in. (30 cm) and a value of 3 or less and chroma of 1 or less in any remaining layers above the depleted or gleyed matrix. Any sandy material above the depleted or gleyed matrix, when viewed with a 10- or 15-power hand lens, must have at least 70 percent of the visible soil particles masked with organic material. When viewed without a hand lens, the particles appear to be nearly 100 percent masked.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: The soil has a depleted matrix or gleyed matrix below a black or very dark gray surface layer 12 in. (30 cm) or more thick (Figure 14). This indicator is most often associated with over-thickened soils in concave landscape positions. Two percent or more distinct or prominent redox concentrations (Table A1), including iron/manganese soft masses, pore linings, or both, are required in soils that have matrix values/chromas of 4/1, 4/2, and 5/2 (Figure A1). If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. See the Glossary (Appendix A) for the definitions of depleted and gleyed matrix.

In some places, the gleyed matrix may change color upon exposure to air (reduced matrix). This phenomenon is included in the concept of a gleyed matrix (USDA Natural Resources Conservation Service 2002).

This indicator is not common in this region and is almost never found at the wetland/non-wetland boundary. It is much less common than indicators A11 (Depleted Below Dark Surface), F3 (Depleted Matrix), and F6 (Redox Dark Surface).

Sandy soils

"Sandy soils" refers to soil materials with a USDA soil texture of loamy fine sand and coarser. Use the following indicators in soil layers consisting of sandy soil materials.

Unless otherwise noted, all mineral layers above any of the layers meeting an S indicator, except for indicator S6, must have a dominant chroma of 2 or less, or the layer(s) with a dominant chroma of more than 2 must be less than 6 in. (15 cm) thick to meet any hydric soil indicator. Nodules and concretions are not considered to be redox concentrations unless otherwise noted.

Figure 14. Deep observations may be necessary to identify the depleted or gleyed matrix below a thick, dark surface layer. In this example, the depleted matrix starts at 20 in. (50 cm).

Indicator S1: Sandy Mucky Mineral

Technical Description: A layer of mucky modified sandy soil material 2 in. (5 cm) or more thick, starting within 6 in. (15 cm) of the soil surface (Figure 15).

Applicable Subregions: Applicable to the Central and Eastern Mountains Subregion (LRR N) and the Northern Mountains and Piedmont Subregion (MLRAs 147 and 148 of LRR S) (Figures 1 and 33).

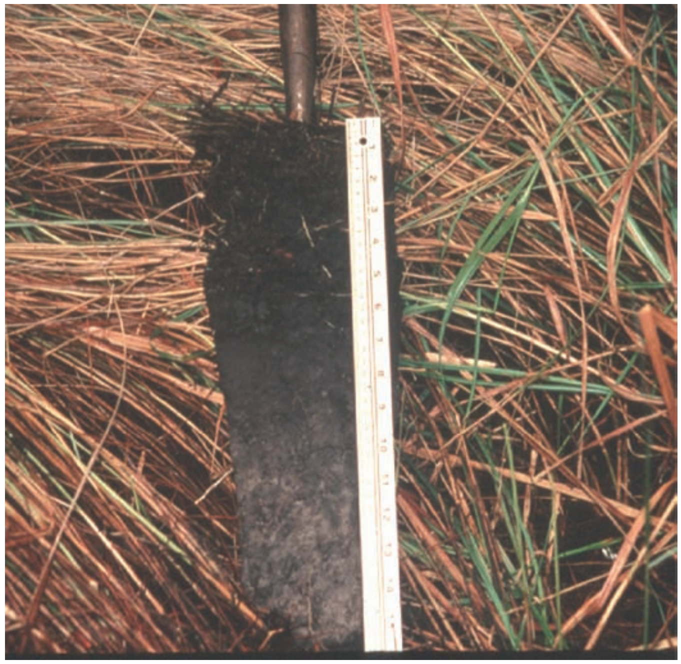

Figure 15. The mucky modified sandy layer is approximately 3 in. (7.5 cm) thick. Scale in inches on the right side of ruler.

User Notes: This indicator is very rare in this region and is most likely found in floodplains. *Mucky* is a USDA texture modifier for mineral soils. The organic carbon content is at least 5 percent and ranges to as high as 14 percent for sandy soils. The percentage requirement is dependent upon the clay content of the soil; the higher the clay content, the higher the organic carbon requirement. See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2010) for the definition of mucky modified mineral texture. A field procedure for identifying mucky mineral soil material is presented in the Concepts section of this chapter.

Indicator S4: Sandy Gleyed Matrix

Technical Description: A gleyed matrix that occupies 60 percent or more of a layer starting within 6 in. (15 cm) of the soil surface (Figure 16).

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: The gleyed matrix only has to be present within 6 in. (15 cm) of the surface. Soils with gleyed matrices are saturated for significant periods; therefore, *no minimum thickness of gleyed layer is required*. See the Glossary (Appendix A) for the definition of a gleyed matrix.

Figure 16. In this example, the gleyed matrix begins at the soil surface.

This indicator is very rare in the region and generally is not found at the boundaries between wetlands and non-wetlands.

Indicator S5: Sandy Redox

Technical Description: A layer starting within 6 in. (15 cm) of the soil surface that is at least 4 in. (10 cm) thick and has a matrix with 60 percent or more chroma of 2 or less with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings (Figure 17).

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: This indicator is the most common of the sandy soil indicators in this region. Distinct and prominent are defined in the Glossary (Appendix A). Redox concentrations include iron and manganese masses (reddish mottles) and pore linings (Vepraskas 1992). Included within the concept of redox concentrations are iron/manganese bodies as soft masses with diffuse boundaries. Common (2 to less than 20 percent) to many (20 percent or more) redox concentrations (USDA Natural Resources Conservation Service 2002) are required. If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible.

Figure 17. Redox concentrations (orange areas) in sandy soil material.

Indicator S6: Stripped Matrix

Technical Description: A layer starting within 6 in. (15 cm) of the soil surface in which iron/manganese oxides and/or organic matter have been stripped from the matrix and the primary base color of the soil material has been exposed. The stripped areas and translocated oxides and/or organic matter form a faintly contrasting pattern of two or more colors with diffuse boundaries. The stripped zones are 10 percent or more of the volume and are rounded.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: This indicator includes the indicator previously named streaking (Environmental Laboratory 1987). The stripped areas are typically 0.5 to 1 in. (1 to 3 cm) in size but may be larger or smaller. Commonly, the stripped areas have a value of 5 or more and chroma of 1 and/or 2 and unstripped areas have a chroma of 3 and/or 4. However, there are no specific color requirements for this indicator. The mobilization and translocation of the oxides and/or organic matter are the important processes involved in this indicator and should result in splotchy coated and uncoated soil areas. This may be a difficult pattern to recognize and is often more evident in a horizontal slice (Figure 18).

Figure 18. A diffuse, splotchy pattern of stripped and unstripped areas is revealed in this horizontal slice through a sandy soil.

This is a very common indicator of hydric soils and is often used to identify the hydric/non-hydric boundary in sandy soils. This indicator is found in all wetland types and all wet landscape positions.

Indicator S7: Dark Surface

Technical Description: A layer 4 in. (10 cm) thick starting within 6 in. (15 cm) of the soil surface with a matrix value of 3 or less and chroma of 1 or less. When viewed with a 10- or 15-power hand lens, at least 70 percent of the visible soil particles must be masked with organic material. When viewed without a hand lens, the particles appear to be nearly 100 percent masked. The matrix color of the layer immediately below the dark layer must have the same colors as those described above or any color that has a chroma of 2 or less.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: If the dark layer is greater than 4 in. (10 cm) thick, then the indicator is met, because any dark soil material in excess of 4 in. (10 cm) meets the requirement that "the layer immediately below the dark layer must have the same colors as those described above… ." If the dark layer is exactly 4 in. (10 cm) thick, then the material immediately below must have a matrix chroma of 2 or less.

The organic carbon content for this indicator is slightly less than that required for "mucky." An undisturbed sample must be observed (Figure 19). Many moderately wet soils have a ratio of about 50 percent of soil particles covered or coated with organic matter to about 50 percent uncoated or uncovered soil particles, giving the soil a salt-and-pepper appearance. Where the percent coverage by organic matter is less than 70 percent, a Dark Surface indicator is not present.

Figure 19. This sandy soil has a dark surface approximately 6 in. (15 cm) thick. Scale in inches on the right side of ruler.

Indicator S8: Polyvalue Below Surface

Technical Description: A layer with a value of 3 or less and chroma of 1 or less starting within 6 in. (15 cm) of the soil surface. When viewed with a 10- or 15-power hand lens, at least 70 percent of the visible soil particles in this layer must be masked with organic material. When viewed without a hand lens, the particles appear to be nearly 100 percent masked. Immediately below this layer, 5 percent or more of the soil volume has a value of 3 or less and chroma of 1 or less and the remainder of the soil volume has a value of 4 or more and chroma of 1 or less to a depth of 12 in. (30 cm) or to the spodic horizon, whichever is less.

Applicable Subregions: Applicable to the Northern Mountains and Piedmont Subregion (MLRAs 147 and 148 of LRR S) (Figures 1 and 33).

User Notes: This indicator applies to soils with a very dark gray or black surface or near-surface layer that is underlain by a layer in which organic matter has been differentially distributed within the soil by water movement (Figure 20). The mobilization and translocation of organic matter result in splotchy coated and uncoated soil areas.

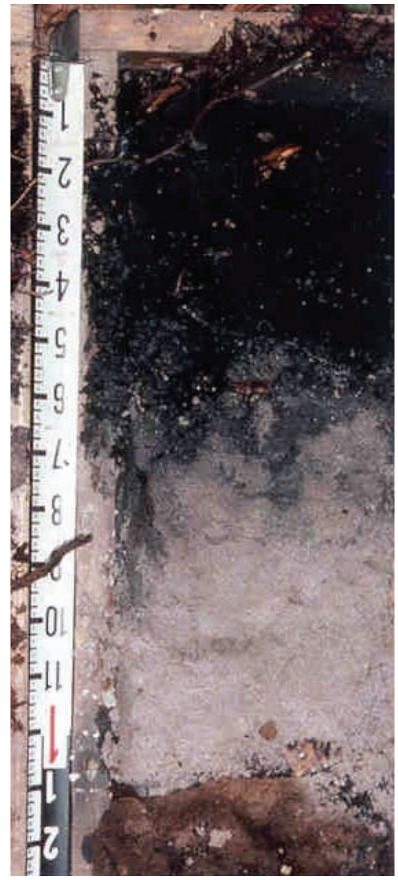

Figure 20. In this soil, the splotchy pattern below the dark surface is due to mobilization and translocation of organic matter. Scale is in inches.

Indicator S9: Thin Dark Surface

Technical Description: A layer 2 in. (5 cm) or more thick starting within the upper 6 in. (15 cm) of the soil, with a value of 3 or less and chroma of 1 or less. When viewed with a 10- or 15-power hand lens, at least 70 percent of the visible soil particles in this layer must be masked with organic material. When viewed without a hand lens, the particles appear to be nearly 100 percent masked. This layer is underlain by a layer(s) with a value of 4 or less and chroma of 1 or less to a depth of 12 in. (30 cm) or to the spodic horizon, whichever is less.

Applicable Subregions: Applicable to the Northern Mountains and Piedmont Subregion (MLRAs 147 and 148 of LRR S) (Figures 1 and 33).

User Notes: This indicator applies to soils with a very dark gray or black near-surface layer that is at least 2 in. (5 cm) thick and is underlain by a layer in which organic matter has been carried downward by flowing water (Figure 21). The mobilization and translocation of organic matter result in an even distribution of organic matter in the eluvial (E) horizon. The chroma of 1 or less is critical because it limits application of this indicator to only those soils that are depleted of iron. This indicator commonly occurs in hydric Spodosols; however, a spodic horizon is not required (see *Soil Taxonomy* [USDA Natural Resources Conservation Service 1999] for the definitions of Spodosol and spodic horizon).

Loamy and Clayey Soils

"Loamy and clayey soils" refers to soil materials with USDA textures of loamy very fine sand and finer. Use the following indicators in soil layers consisting of loamy or clayey soil materials.

Unless otherwise noted, all mineral layers above any of the layers meeting an F indicator, except for indicators F8, F12, and F19, must have a dominant chroma of 2 or less, or the layer(s) with a dominant chroma of more than 2 must be less than 6 in. (15 cm) thick to meet any hydric soil indicator. Nodules and concretions are not considered to be redox concentrations unless otherwise noted.

Figure 21. Example of the Thin Dark Surface indicator. A spodic horizon is present starting at 8 in. (20 cm). Scale is in inches.

Indicator F2: Loamy Gleyed Matrix

Technical Description: A gleyed matrix that occupies 60 percent or more of a layer starting within 12 in. (30 cm) of the soil surface (Figure 22).

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: Gley colors are not synonymous with gray colors. Gley colors are those colors that are on the gley pages (Gretag/Macbeth 2000). The gleyed matrix only has to be present within 12 in. (30 cm) of the surface. Soils with gleyed matrices are saturated for significant periods; therefore, *no minimum thickness of gleyed layer is required*. See the Glossary (Appendix A) for the definition of a gleyed matrix.

This indicator is found in soils that are inundated or saturated nearly all of the growing season in most years (e.g., in oxbows with permanent water) and is not usually found at the boundaries between wetlands and non-wetlands.

Figure 22. This soil has a gleyed matrix in the lowest layer, starting about 7 in. (18 cm) from the soil surface. The layer above the gleyed matrix has a depleted matrix.

Indicator F3: Depleted Matrix

Technical Description: A layer that has a depleted matrix with 60 percent or more chroma of 2 or less and that has a minimum thickness of either:

- 2 in. (5 cm) if the 2 in. (5 cm) is entirely within the upper 6 in. (15 cm) of the soil, or
- 6 in. (15 cm) starting within 10 in. (25 cm) of the soil surface.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: This is the most commonly observed hydric soil indicator at wetland boundaries across the region. Redox concentrations including iron/manganese soft masses or pore linings, or both, are required in soils with matrix values/chromas of 4/1, 4/2, and 5/2 (Figures 23 and 24).

Figure 23. Example of indicator F3 (Depleted Matrix), in which redox concentrations extend nearly to the surface.

Figure 24. This soil has a depleted matrix with redox concentrations in a low-chroma matrix.

If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. Redox concentrations are not required in soils with matrix values of 5 or more and chroma of 1, or values of 6 or more and chromas of 2 or 1. The low-chroma matrix must be caused by wetness and not be a relict or parent material feature. See the Glossary (Appendix A) for the definition of a depleted matrix.

Indicator F6: Redox Dark Surface

Technical Description: A layer that is at least 4 in. (10 cm) thick, is entirely within the upper 12 in. (30 cm) of the mineral soil, and has a:

- Matrix value of 3 or less and chroma of 1 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings, or
- Matrix value of 3 or less and chroma of 2 or less and 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: This is a very common indicator used to delineate wetland boundaries in soils with dark-colored surface layers. The layer meeting the requirements of the indicator may extend below 12 in. (30 cm) as long as at least 4 in. (10 cm) occurs within 12 in. (30 cm) of the surface. Redox concentrations are often small and difficult to see in mineral soils that have dark (value of 3 or less) surface layers due to high organic-matter content (Figure 25). The organic matter masks some or all of the concentrations that may be present; it also masks the diffuse boundaries of the concentrations and makes them appear to be more sharp. Careful examination is required to see what are often brownish redox concentrations in the darkened materials. If the soil is saturated at the time of sampling, it may be necessary to let it dry at least to a moist condition for redox features to become visible. In some cases, further drying of the samples makes the concentrations (if present) easier to see. A hand lens may be helpful in seeing and describing small redox concentrations. Care should be taken to examine the interiors of soil peds for redox concentrations. Dry colors, if used, also must have matrix chromas of 1 or 2, and the redox concentrations must be distinct or prominent (see the Glossary [Appendix A] for definitions).

Figure 25. Redox features can be small and difficult to see within a dark soil layer.

In soils that are wet because of subsurface saturation, the layer immediately below the dark epipedon will likely have a depleted or gleyed matrix (see the Glossary for definitions). Soils that are wet because of ponding or have a shallow, perched layer of saturation may not always have a depleted/gleyed matrix below the dark surface. This morphology has been observed in soils that have been compacted by tillage and other means. It is recommended that delineators evaluate the hydrologic source and examine and describe the layer below the dark-colored epipedon when applying this indicator.

Indicator F7: Depleted Dark Surface

Technical Description: Redox depletions with a value of 5 or more and chroma of 2 or less in a layer that is at least 4 in. (10 cm) thick, is entirely within the upper 12 in. (30 cm) of the mineral soil (Figure 26), and has a:

- Matrix value of 3 or less and chroma of 1 or less and 10 percent or more redox depletions, or
- Matrix value of 3 or less and chroma of 2 or less and 20 percent or more redox depletions.

Figure 26. Redox depletions (lighter colored areas) are scattered within the darker matrix. Scale is in centimeters.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: This indicator is rare across the region. The layer meeting the requirements of the indicator may extend below 12 in. (30 cm) as long as at least 4 in. (10 cm) occurs within 12 in. (30 cm) of the surface.

Care should be taken not to mistake the mixing of eluvial (highly leached) layers that have high value and low chroma (E horizon) or illuvial layers that have accumulated carbonates (calcic horizon) into the surface layer as depletions (see *Soil Taxonomy* [USDA Natural Resources Conservation Service 1999] for definitions). Mixing of layers can be caused by burrowing animals or cultivation. Pieces of deeper layers that become incorporated into the surface layer are not redox depletions. Knowledge of local conditions is required in areas where light-colored eluvial layers and/or layers high in carbonates may be present. In soils that are wet because of subsurface saturation, the layer immediately below the dark surface is likely to have a depleted or gleyed matrix. Redox depletions will usually have associated microsites with redox concentrations that occur as pore linings or masses within the depletion(s) or surrounding the depletion(s).

Indicator F8: Redox Depressions

Technical Description: In closed depressions subject to ponding, 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings in a layer that is 2 in. (5 cm) or more thick and is entirely within the upper 6 in. (15 cm) of the soil (Figure 27).

Figure 27. In this example, the layer of redox concentrations begins at the soil surface and is slightly more than 2 in. (5-cm) thick.

Applicable Subregions: Applicable throughout the Eastern Mountains and Piedmont Region.

User Notes: This indicator occurs on depressional landforms, such as closed depressions on flats and backwater depressions on floodplains. *Note that there is no color requirement for the soil matrix.* The layer containing redox concentrations may extend below 6 in. (15 cm) as long as at least 2 in. (5 cm) occurs within 6 in. (15 cm) of the surface. If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. See the Glossary (Appendix A) for definitions of distinct and prominent.

This is a common but often overlooked indicator found at the wetland/ non-wetland boundary on depressional sites.

Indicator F12: Iron-Manganese Masses

Technical Description: On floodplains, a layer 4 in. (10 cm) or more thick with 40 percent or more chroma of 2 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft iron-manganese masses with diffuse boundaries. The layer occurs entirely within 12 in. (30 cm) of the soil surface. Iron-manganese masses have value and chroma of 3 or less. Most commonly, they are black. The thickness requirement is waived if the layer is the mineral surface layer.

Applicable Subregions: Applicable to the Central and Eastern Mountains Subregion (LRR N) and the Southern Piedmont Subregion (MLRA 136 of LRR P) (Figure 1).

User Notes: The layer meeting the requirements of the indicator may extend below 12 in. (30 cm) as long as at least 4 in. (10 cm) occurs within 12 in. (30 cm) of the surface. Iron-manganese masses generally are small (2 to 5 mm in size) and have a value and chroma of 3 or less. They can be dominated by manganese and, therefore, have a color approaching black (Figure 28). If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. The low matrix chroma must be the result of wetness and not be a weathering or parent material feature. Iron-manganese masses should not be confused with the larger and redder iron nodules associated with plinthite or with concretions that have sharp boundaries.

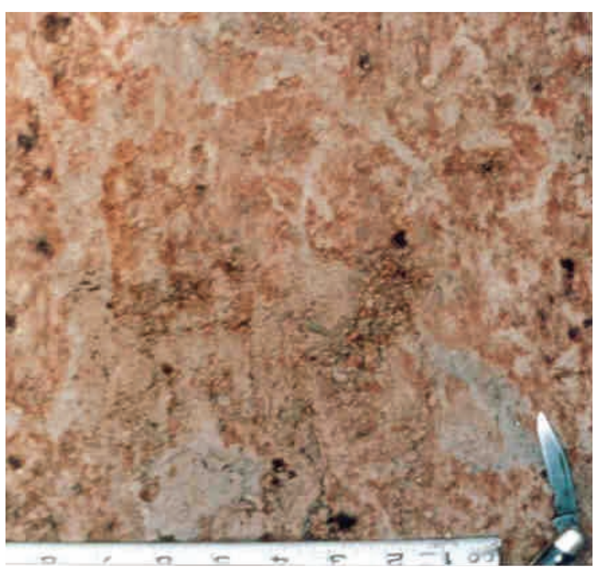

Figure 28. Iron-manganese masses (black spots) in a 40 percent depleted matrix. Scale is in inches.

Indicator F13: Umbric Surface

Technical Description: In depressions and other concave landforms, a layer 10 in. (25 cm) or more thick starting within 6 in. (15 cm) of the soil surface in which the upper 6 in. (15 cm) has a value of 3 or less and chroma of 1 or less and in which the lower 4 in. (10 cm) has the same colors as those described above or any other color that has a chroma of 2 or less (Figure 29).

Applicable Subregions: Applicable to the Southern Piedmont Subregion (MLRA 136 of LRR P) (Figure 1) and MLRA 122 in the Central and Eastern Mountains Subregion (LRR N) (Figure 30).

User Notes: This indicator is rarely found in this region and is most often seen in the interiors of depressions. The thickness requirements may be slightly less than those for an umbric epipedon. Umbric surfaces in the higher landscape positions, such as side slopes, are excluded.

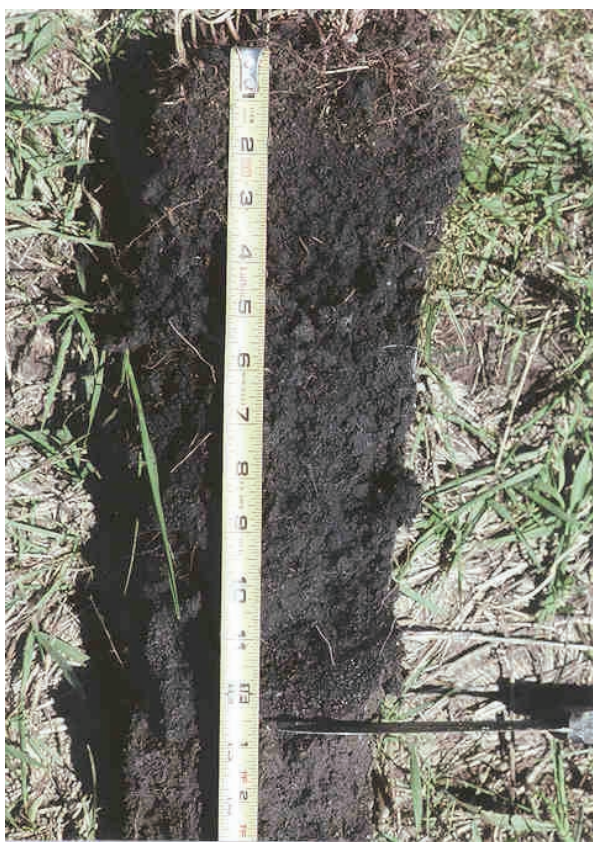

Figure 29. This umbric surface is approximately 12 in. (30 cm) thick. Scale is in inches.

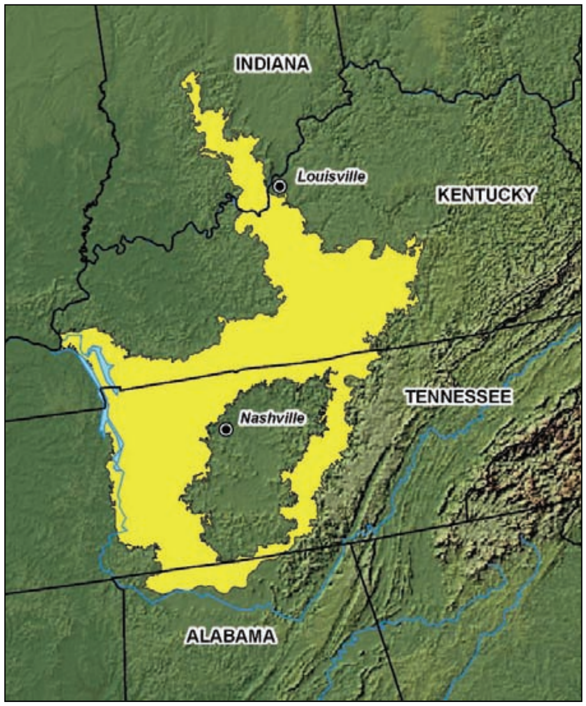

Figure 30. Location of MLRA 122 in LRR N.

Indicator F19: Piedmont Floodplain Soils

Technical Description: On active floodplains, a mineral layer at least 6 in. (15 cm) thick starting within 10 in. (25 cm) of the soil surface with a matrix (60 percent or more of the volume) chroma of less than 4 and 20 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings.

Applicable Subregions: Applicable to the Northern Piedmont (MLRA 148 of LRR S) (Figure 31).

User Notes: This indicator is restricted to floodplains that are actively receiving sediments and groundwater discharge with high iron content (Figure 32). The soil chroma must be less than 4. If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. This indicator can also be used in problem soils outside of MLRA 148 (see the section on Hydric Soil Indicators for Problem Soils in this chapter).

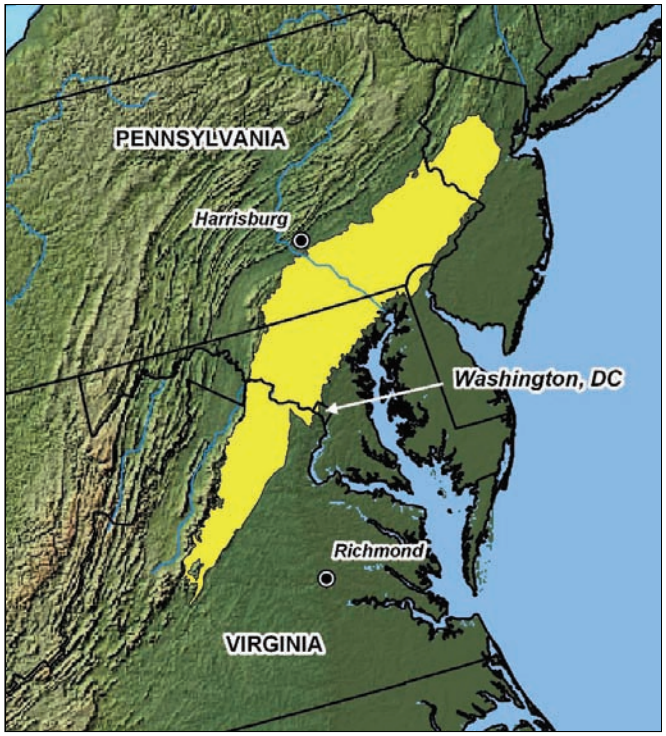

Figure 31. Location of MLRA 148 in LRR S.

Figure 32. The Piedmont Floodplain Soils indicator is restricted to floodplains that are actively receiving sediments and groundwater discharge with high iron content. Photo by M. Rabenhorst. Scale is in 4-in. (10-cm) increments.

Indicator F21: Red Parent Material.

Technical Description: A layer at least 10 cm (4 inches) thick, starting within 25 cm (10 inches) of the soil surface with a hue of 7.5YR or redder. The matrix has a value and chroma greater than 2 and less than or equal to 4. The layer must contain 10 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings and/or depletions. Redox depletions should differ in color by having:

- Value one or more higher and chroma one or more lower than the matrix, or
- Value of 4 or more and chroma of 2 or less.

Applicable Subregions: For use in MLRA 147 and 148 of LRR S and MLRA 127 of LRR N; for testing in all soils derived from red parent materials (Figures 33 and 34).

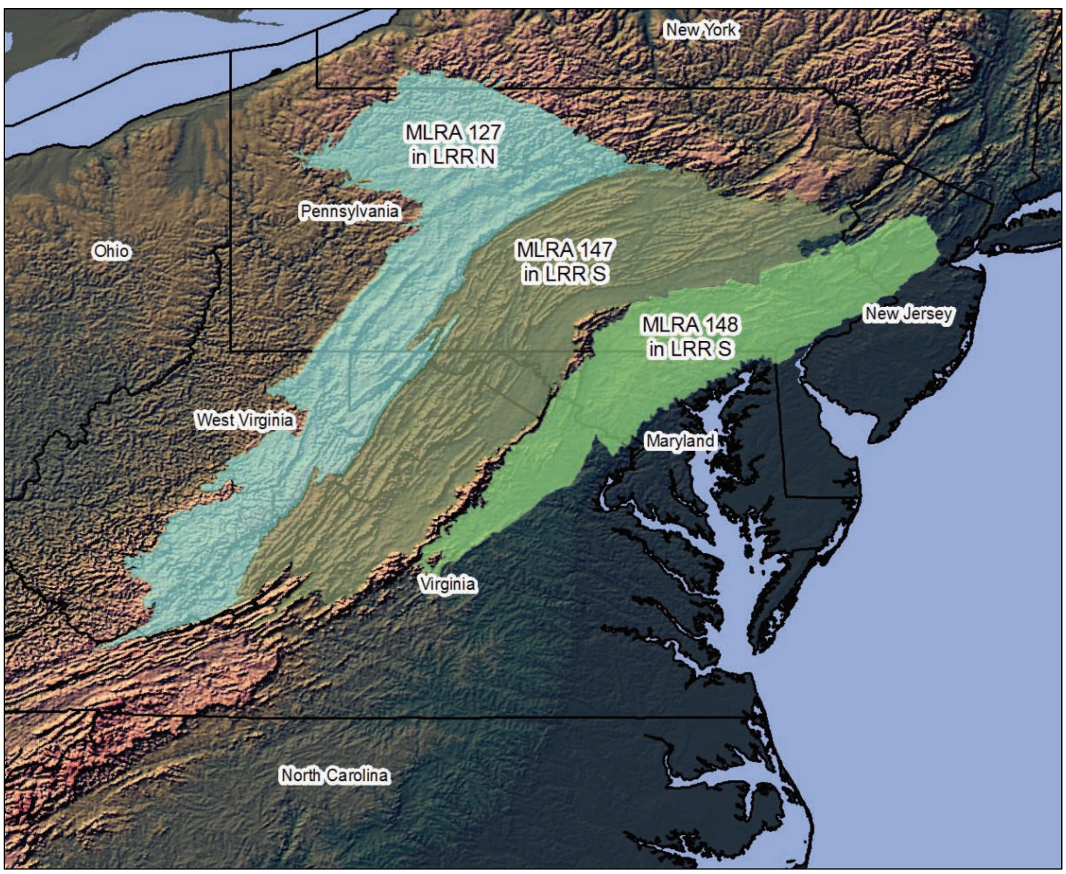

Figure 33. Location of MLRA 127 in LRRN, MLRA 147 in LRR S, and MLRA 148 in LRR S.

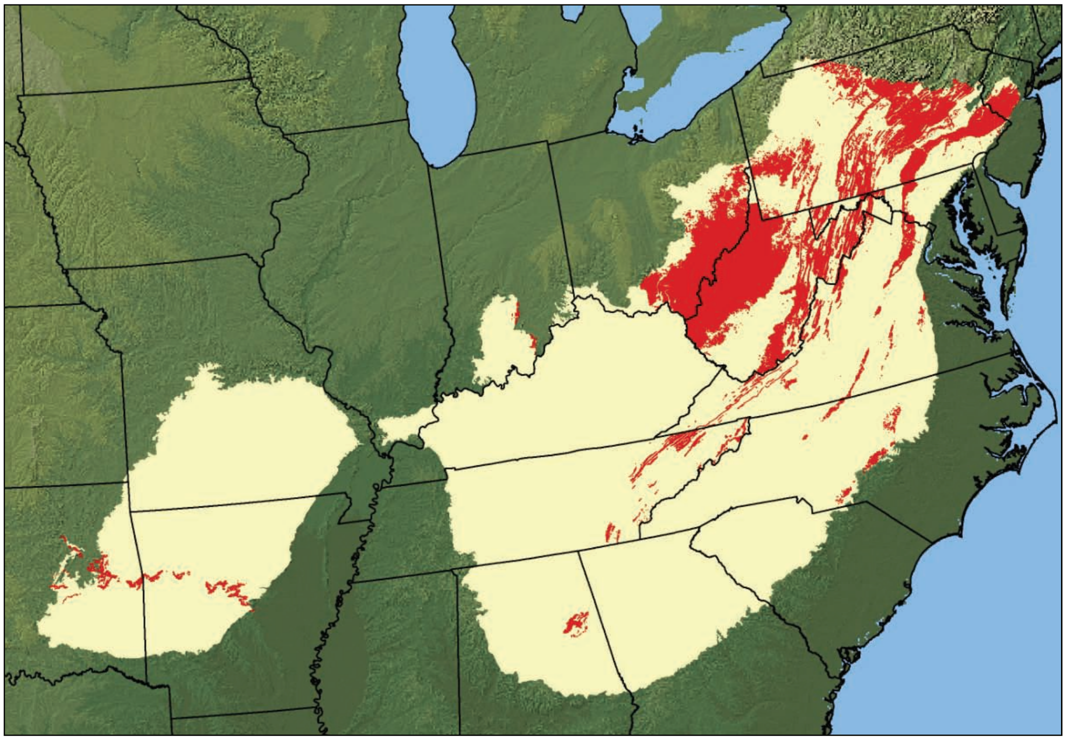

Figure 34. Approximate locations of soils derived from red parent materials (red areas) in the Eastern Mountains and Piedmont Region. The map was developed using NRCS soil survey (SSURGO) data and depicts map units that contain at least one soil component derived from red parent materials.

User Notes: This indicator was developed for use in areas of red parent material, such as residuum in the Piedmont Province Triassic lowlands section or the Paleozoic "red beds" of the Appalachian Mountains, and in alluvium or colluvium derived from these materials. In order to confirm that it is appropriate to apply this indicator to particular soils, soils formed from similar parent materials in the area should have been evaluated to determine their Color Change Propensity Index (CCPI) and be shown to have CCPI values below 30 (Rabenhorst and Parikh 2000.) It cannot be assumed that sediment overlying redcolored bedrock is derived solely from that bedrock.

This indicator is typically found at the boundary between hydric and non-hydric soils. Users who encounter a depleted matrix in the upper part should consider F3-Depleted Matrix. F3 is often found in sites than are anaerobic for a longer period. Users who encounter a dark soil surface (value 3 or less and chroma 2 or less) should consider F6-Redox Dark Surface or F7-Depleted Dark Surface. If the site is in a closed depression subject to ponding users should consider F8-Redox Depressions. See glossary for definition of Red Parent Material.

Hydric soil indicators for problem soils

The following indicators are not currently recognized for general application by the NTCHS, or they are not recognized in the specified geographic area. However, these indicators may be used in problem wetland situations in the Eastern Mountains and Piedmont Region where there is evidence of wetland hydrology and hydrophytic vegetation, and the soil is believed to meet the definition of a hydric soil despite the lack of other indicators of a hydric soil. To use these indicators, follow the procedure described in the section on Problematic Hydric Soils in Chapter 5. If any of the following indicators is observed, it is recommended that the NTCHS be notified by following the protocol described in the "Comment on the Indicators" section of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2010).

Indicator A10: 2 cm Muck

Technical Description: A layer of muck 0.75 in. (2 cm) or more thick with a value of 3 or less and chroma of 1 or less, starting within 6 in. (15 cm) of the soil surface.

Applicable Subregions: For use with problem soils in the Northern Appalachian Ridges and Valleys (MLRA 147 of LRR S) (Figure 33).

User Notes: Normally the muck layer is at the soil surface; however, it may occur at any depth within 6 in. (15 cm) of the surface. Muck is sapric soil material with at least 12 to 18 percent organic carbon. Organic soil material is called muck (sapric soil material) if virtually all of the material has undergone sufficient decomposition to limit recognition of the plant parts. Hemic (mucky peat) and fibric (peat) soil materials do not qualify. Generally, muck is black and has a greasy feel; sand grains should not be evident (see the Concepts section of this chapter for field methods to identify organic soil materials).

Indicator A16: Coast Prairie Redox

Technical Description: A layer starting within 6 in. (15 cm) of the soil surface that is at least 4 in. (10 cm) thick and has a matrix chroma of 3 or less with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings.

Applicable Subregions: For use with problem soils in the Northern Mountains and Piedmont Subregion (MLRAs 147 and 148 of LRR S) (Figures 31 and 33).

User Notes: These hydric soils occur mainly on depressional and inter-mound landforms. Redox concentrations occur mainly as iron-dominated pore linings. Common to many redox concentrations are required. If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. Chroma 3 matrices are allowed because they may be the color of stripped sand grains, or because few to common sand-sized reddish particles may be present and may prevent obtaining a chroma of 2 or less.

Indicator F19: Piedmont Floodplain Soils

Technical Description: On active floodplains, a mineral layer at least 6 in. (15 cm) thick starting within 10 in. (25 cm) of the soil surface with a matrix (60 percent or more of the volume) chroma of less than 4 and 20 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings.

Applicable Subregions: For use with problem soils on floodplains in the Southern Piedmont Subregion (MLRA 136 of LRR P) (Figure 1) and the Northern Appalachian Ridges and Valleys (MLRA 147 of LRR S) (Figure 33).

User Notes: This indicator is restricted to floodplains that are actively receiving sediments and groundwater discharge with high iron content (Figure 32). The soil chroma must be less than 4. If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible.

Indicator TF12: Very Shallow Dark Surface

Technical Description: In depressions and other concave landforms, one of the following:

- If bedrock occurs between 6 in. (15 cm) and 10 in. (25 cm), a layer at least 6 in. (15 cm) thick starting within 4 in. (10 cm) of the soil surface with a value of 3 or less and chroma of 1 or less, and the remaining soil to bedrock must have the same colors as above or any other color that has a chroma of 2 or less, or

- If bedrock occurs within 6 in. (15 cm), more than half of the soil thickness must have a value of 3 or less and chroma of 1 or less, and the remaining soil to bedrock must have the same colors as above or any other color that has a chroma of 2 or less.

Applicable Subregions: For use with problem soils throughout the Eastern Mountains and Piedmont Region.

4 Wetland Hydrology Indicators

Introduction

Wetland hydrology indicators are used in combination with indicators of hydric soil and hydrophytic vegetation to determine whether an area is a wetland under the Corps Manual. Indicators of hydrophytic vegetation and hydric soil generally reflect a site's medium- to long-term wetness history. They provide readily observable evidence that episodes of inundation or soil saturation lasting more than a few days during the growing season have occurred repeatedly over a period of years and that the timing, duration, and frequency of wet conditions have been sufficient to produce a characteristic wetland plant community and hydric soil morphology. If hydrology has not been altered, vegetation and soils provide strong evidence that wetland hydrology is present (National Research Council 1995). Wetland hydrology indicators provide evidence that the site has a *continuing* wetland hydrologic regime and that hydric soils and hydrophytic vegetation are not relicts of a past hydrologic regime. Wetland hydrology indicators confirm that an episode of inundation or soil saturation occurred recently, but may provide little additional information about the timing, duration, or frequency of such events (National Research Council 1995).

Hydrology indicators are often the most transitory of wetland indicators. Some hydrology indicators are naturally temporary or seasonal, and many are affected by recent or long-term meteorological conditions. For example, indicators involving direct observation of surface water or saturated soils often are present only during the normal wet portion of the growing season and may be absent during the dry season or during drier-than-normal years. Hydrology indicators also may be subject to disturbance or destruction by natural processes or human activities. Most wetlands in the Eastern Mountains and Piedmont Region will exhibit one or more of the hydrology indicators presented in this chapter. However, some wetlands may lack any of these indicators due to temporarily dry conditions, disturbance, or other factors. Therefore, the lack of an indicator is not evidence for the absence of wetland hydrology. See Chapter 5 (Difficult Wetland Situations in the Eastern Mountains and Piedmont Region) for help in identifying wetlands that may lack wetland hydrology indicators at certain times.

The Eastern Mountains and Piedmont Region has a temperate climate with relatively abundant rainfall during normal years. The area is also affected by occasional tropical storms that can produce heavy downpours. Some wetland hydrology indicators may be present on non-wetland sites immediately after a heavy rain or during periods of unusually high precipitation, river stages, snowmelt, reservoir releases, or runoff. Therefore, it is important to consider weather and climatic conditions prior to the site visit to minimize both false-positive and false-negative wetland hydrology decisions. An understanding of normal seasonal and annual variations in rainfall, temperature, and other climatic conditions is important in interpreting hydrology indicators in the region. Some useful sources of climatic data are described in Chapter 5.

Areas that have hydrophytic vegetation and hydric soils generally have wetland hydrology unless the hydrologic regime has changed due to natural events or human activities (National Research Council 1995). Therefore, when wetland hydrology indicators are absent from an area that has indicators of hydric soil and hydrophytic vegetation, further information may be needed to determine whether or not wetland hydrology is present. If possible, one or more site visits should be scheduled to coincide with the normal wet portion of the growing season, the period of the year when the presence or absence of wetland hydrology indicators is most likely to reflect the true wetland/non-wetland status of the site. In addition, aerial photography or other remote-sensing data, stream gauge data, runoff estimates, scope-and-effect equations for ditches and subsurface drainage systems, or groundwater modeling are tools that may help to determine whether wetland hydrology is present when indicators are equivocal or lacking (e.g., USDA Natural Resources Conservation Service 1997). Off-site procedures developed under the National Food Security Act Manual (USDA Natural Resources Conservation Service 1994), which use wetland mapping conventions developed by NRCS state offices, can help identify areas that have wetland hydrology on agricultural lands. The technique is based on wetness signatures visible on standard high-altitude aerial photographs or on annual crop-compliance slides taken by the USDA Farm Service Agency. Finally, on highly disturbed or problematic sites, direct hydrologic monitoring may be undertaken to determine whether wetland hydrology is present. The U.S. Army Corps of Engineers (2005) provides a technical standard for monitoring hydrology on such sites. This standard requires 14 or more consecutive days of flooding or ponding, or a water table 12 in. (30 cm) or less below the soil surface, during the growing season at a minimum frequency of 5 years in 10 (50 percent or higher probability) (National Research Council 1995) unless an alternative standard has been established for a particular region or wetland type. See Chapter 5 for further information on these techniques.

Growing season

Beginning and ending dates of the growing season may be needed to evaluate certain wetland indicators, such as visual observations of flooding, ponding, or shallow water tables on potential wetland sites. In addition, growing season dates are needed in the event that recorded hydrologic data, such as stream gauge or water-table monitoring data, must be analyzed to determine whether wetland hydrology is present on highly disturbed or problematic sites.

Depletion of oxygen and the chemical reduction of nitrogen, iron, and other elements in saturated soils during the growing season is the result of biological activity occurring in plant roots and soil microbial populations (National Research Council 1995). Two indicators of biological activity that are readily observable in the field are (1) above-ground growth and development of vascular plants, and (2) soil temperature as an indicator of soil microbial activity (Megonigal et al. 1996; USDA Natural Resources Conservation Service 1999). If information about growing season is needed and on-site data gathering is practical, the following approaches should be used in this region to determine growing season dates in a given year. The growing season has begun and is ongoing if either of these conditions is met. Therefore, the beginning of the growing season in a given year is indicated by whichever condition occurs earlier, and the end of the growing season is indicated by whichever condition persists later.

1. The growing season has begun on a site in a given year when two or more different non-evergreen vascular plant species growing in the wetland or surrounding areas exhibit one or more of the following indicators of biological activity:

    a. Emergence of herbaceous plants from the ground
    b. Appearance of new growth from vegetative crowns (e.g., in graminoids, bulbs, and corms)
    c. Coleoptile/cotyledon emergence from seed

d. Bud burst on woody plants (i.e., some green foliage is visible between spreading bud scales)
e. Emergence or elongation of leaves of woody plants
f. Emergence or opening of flowers

The end of the growing season is indicated when woody deciduous species lose their leaves and/or the last herbaceous plants cease flowering and their leaves become dry or brown, generally in the fall due to cold temperatures or reduced moisture availability. Early plant senescence due to the initiation of the summer dry season in some areas does not necessarily indicate the end of the growing season and alternative procedures (e.g., soil temperature) should be used.

This determination should not include evergreen species. Observations should be made in the wetland or in surrounding areas subject to the same climatic conditions (e.g., similar elevation and aspect); however, soil moisture conditions may differ. Supporting data should be reported on the data form, in field notes, or in the delineation report, and should include the species observed (if identifiable), their abundance and location relative to the potential wetland, and type of biological activity observed. A one-time observation of biological activity during a single site visit is sufficient, but is not required unless growing season information is necessary to evaluate particular wetland hydrology indicators. However, if long-term hydrologic monitoring is planned, then plant growth, maintenance, and senescence should be monitored for continuity over the same period.

2. The growing season has begun in spring, and is still in progress, when soil temperature measured at the 12 in. (30 cm) depth is 41 °F (5 °C) or higher. A one-time temperature measurement during a single site visit is sufficient, but is not required unless growing season information is necessary to evaluate particular wetland hydrology indicators. However, if long-term hydrologic monitoring is planned, then soil temperature should also be monitored to ensure that it remains continuously at or above 41 °F during the monitoring period. Soil temperature can be measured directly in the field by immediately inserting a soil thermometer into the wall of a freshly dug soil pit.

If the timing of the growing season based on vegetation growth and development and/or soil temperature is unknown and on-site data collection is not practical, such as when analyzing previously recorded stream-gauge or monitoring-well data, then growing season dates may be approximated by the median dates (i.e., 5 years in 10, or 50 percent probability) of 28 °F (−2.2 °C) air temperatures in spring and fall, based on long-term records gathered at National Weather Service meteorological stations (U.S. Army Corps of Engineers 2005). These dates are reported in WETS tables available from the NRCS National Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html) for the nearest appropriate weather station.

Wetland hydrology indicators

In this chapter, wetland hydrology indicators are presented in four groups. Indicators in Group A are based on the direct observation of surface water or groundwater during a site visit. Group B consists of evidence that the site is subject to flooding or ponding, although it may not be inundated currently. These indicators include water marks, drift deposits, sediment deposits, and similar features. Group C consists of other evidence that the soil is saturated currently or was saturated recently. Some of these indicators, such as oxidized rhizospheres surrounding living roots and the presence of reduced iron or sulfur in the soil profile, indicate that the soil has been saturated for an extended period. Group D consists of landscape, vegetation, and soil features that indicate contemporary rather than historical wet conditions. Wetland hydrology indicators are intended as one-time observations of site conditions that are sufficient evidence of wetland hydrology in areas where hydric soils and hydrophytic vegetation are present. Unless otherwise noted, all indicators are applicable throughout the Eastern Mountains and Piedmont Region.

Within each group, indicators are divided into two categories – *primary* and *secondary* – based on their estimated reliability in this region. Primary indicators provide stand-alone evidence of a current or recent hydrologic event; some of these also indicate that inundation or saturation was long-lasting. Secondary indicators provide evidence of recent inundation or saturation when supported by one or more other primary or secondary wetland hydrology indicators, but should not be used alone.

One primary indicator from any group is sufficient to conclude that wetland hydrology is present; the area is a wetland if indicators of hydric soil and hydrophytic vegetation are also present. In the absence of a primary indicator, two or more secondary indicators from any group are required to conclude that wetland hydrology is present. Indicators of wetland hydrology include, but are not necessarily limited to, those listed in Table 10 and described on the following pages. Investigators should record on the data form all indicators seen at each field site. Other evidence of wetland hydrology may also be used with appropriate documentation.

Table 10. Wetland hydrology indicators for the Eastern Mountains and Piedmont Region.

Indicator	Category	
	Primary	Secondary
Group A – Observation of Surface Water or Saturated Soils		
A1 – Surface water	X	
A2 – High water table	X	
A3 – Saturation	X	
Group B – Evidence of Recent Inundation		
B1 – Water marks	X	
B2 – Sediment deposits	X	
B3 – Drift deposits	X	
B4 – Algal mat or crust	X	
B5 – Iron deposits	X	
B7 – Inundation visible on aerial imagery	X	
B9 – Water-stained leaves	X	
B13 – Aquatic fauna	X	
B14 – True aquatic plants	X	
B6 – Surface soil cracks		X
B8 – Sparsely vegetated concave surface		X
B10 – Drainage patterns		X
B16 – Moss trim lines		X
Group C – Evidence of Current or Recent Soil Saturation		
C1 – Hydrogen sulfide odor	X	
C3 – Oxidized rhizospheres along living roots	X	
C4 – Presence of reduced iron	X	
C6 – Recent iron reduction in tilled soils	X	
C7 – Thin muck surface	X	
C2 – Dry-season water table		X
C8 – Crayfish burrows		X
C9 – Saturation visible on aerial imagery		X
Group D – Evidence from Other Site Conditions or Data		
D1 – Stunted or stressed plants		X
D2 – Geomorphic position		X
D3 – Shallow aquitard		X
D4 – Microtopographic relief		X
D5 – FAC-neutral test		X

Group A – Observation of Surface Water or Saturated Soils

Indicator A1: Surface water

Category: Primary

General Description: This indicator consists of the direct, visual observation of surface water (flooding or ponding) during a site visit (Figure 35).

Figure 35. Wetland with surface water present.

Cautions and User Notes: Care must be used in applying this indicator because surface water may be present in non-wetland areas immediately after a rainfall event or during periods of unusually high precipitation, runoff, or river stages. Furthermore, some non-wetlands flood frequently for brief periods. Surface water observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. If this is questionable and other hydrology indicators are absent, a follow-up visit during the growing season may be needed. Note that surface water may be absent from a wetland during the normal dry season or during extended periods of drought. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., wetlands are inundated or saturated at least 5 out of 10 years, or 50 percent or higher probability). Groundwater-dominated wetland systems may never or rarely contain surface water; however, groundwater discharge may result in ponded or flowing water that meet this indicator. Use caution in areas with functioning ditches and/or subsurface drains that may remove surface water quickly.

Indicator A2: High water table

Category: Primary

General Description: This indicator consists of the direct, visual observation of the water table 12 in. (30 cm) or less below the surface in a soil pit, auger hole, or shallow monitoring well (Figure 36). This indicator includes water tables derived from perched water, throughflow, and discharging groundwater (e.g., in seeps) that may be moving laterally near the soil surface.

Figure 36. High water table observed in a soil pit.

Cautions and User Notes: Sufficient time must be allowed for water to infiltrate into a newly dug hole and to stabilize at the water-table level. The required time will vary depending upon soil texture and other properties. In some cases, the water table can be determined by examining the wall of the soil pit and identifying the upper level at which water is seeping into the pit. A water table within 12 in. of the surface observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. If this is questionable and other hydrology indicators are absent, a follow-up visit during the growing season may be needed. Care must be used in interpreting this indicator because water-table levels normally vary seasonally and are a function of both recent and long-term precipitation. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., wetlands are inundated or saturated at least 5 out of 10 years, or 50 percent or higher probability). For an accurate determination of the water-table level, the soil pit, auger hole, or well should not penetrate any restrictive soil layer capable of perching water near the surface. Use caution in areas with functioning ditches and/or subsurface drains that may improve soil drainage and reduce the duration of episodes of high water tables.

Indicator A3: Saturation

Category: Primary

General Description: Visual observation of saturated soil conditions 12 in. (30 cm) or less from the soil surface as indicated by water glistening on the surfaces and broken interior faces of soil samples removed from the pit or auger hole (Figure 37). This indicator must be associated with an existing water table located immediately below the saturated zone; however, this requirement is waived under episaturated conditions if there is a restrictive soil layer or bedrock within 12 in. (30 cm) of the surface.

Cautions and User Notes: Glistening is evidence that the soil sample was taken either below the water table or within the saturated capillary fringe above the water table. Recent rainfall events and the proximity of the water table at the time of sampling must be considered in applying and interpreting this indicator. Water observed in soil cracks or on the faces of soil aggregates (peds) does not meet this indicator unless ped interiors are also saturated. Depth to the water table must be recorded on the data form or in field notes. Sufficient time must be allowed for water to infiltrate into a newly dug hole and to stabilize at the water-table level. A water table is not required below the saturated zone under episaturated conditions if the restrictive layer or bedrock is present within 12 in. (30 cm) of the surface.

Figure 37. Water glistens on the surface of a saturated soil sample.

Note the restrictive layer in the soils section of the data form. The restrictive layer may be at the surface. Use caution in areas with functioning ditches and/or subsurface drains.

Group B – Evidence of Recent Inundation

Indicator B1: Water marks

Category: Primary

General Description: Water marks are discolorations or stains on the bark of woody vegetation, rocks, bridge supports, buildings, fences, or other fixed objects as a result of inundation (Figure 38).

Cautions and User Notes: When several water marks are present on an object, the highest reflects the maximum extent of inundation. Water marks indicate a water-level elevation and can be extrapolated from nearby objects across lower elevation areas. Water marks on different trees or other objects should form a level plane that can be viewed from one object to another. Use caution with water marks that may have been caused by extreme, infrequent, or very brief flooding events, or by flooding that occurred outside the growing season. Along streams subject to severe downcutting in recent years, water marks may reflect historic rather than contemporary flooding levels.

Figure 38. Water marks (dark stains) on trees in a seasonally flooded wetland. The top of one water mark is indicated by the arrow.

Indicator B2: Sediment deposits

Category: Primary

General Description: Sediment deposits are thin layers or coatings of fine-grained mineral material (e.g., silt or clay) or organic matter (e.g., pollen), sometimes mixed with other detritus, remaining on tree bark (Figure 39), plant stems or leaves, rocks, and other objects after surface water recedes.

Cautions and User Notes: Sediment deposits most often occur in riverine backwater and ponded situations where water has stood for sufficient time to allow suspended sediment to settle. Sediment deposits may remain for a considerable period before being removed by precipitation or subsequent inundation. Sediment deposits on vegetation or other objects indicate the minimum inundation level. This level can be extrapolated across lower elevation areas. Use caution with sediment left after infrequent high flows or very brief flooding events. This indicator does not include thick accumulations of sand or gravel in fluvial channels that may reflect historic flow conditions or recent extreme events.

Figure 39. Silt deposit left after a recent high-water event forms a tan coating on these tree trunks (upper edge indicated by the arrow).

Indicator B3: Drift deposits

Category: Primary

General Description: Drift deposits consist of rafted debris that has been deposited on the ground surface or entangled in vegetation or other fixed objects. Debris consists of remnants of vegetation (e.g., branches, stems, and leaves), man-made litter, or other waterborne materials. Drift material may be deposited at or near the high water line in ponded or flooded areas, piled against the upstream side of trees, rocks, and other fixed objects (Figure 40), or widely distributed within the dewatered area.

Cautions and User Notes: Deposits of drift material are often found adjacent to streams or other sources of flowing water in wetlands. They also occur along lake shores and in other ponded areas. The elevation of a drift line can be extrapolated across lower elevation areas. Use caution with drift lines that may have been caused by extreme, infrequent, or very brief flooding events; and in areas with functioning drainage systems capable of removing excess water quickly.

Figure 40. Drift deposit in a floodplain wetland.

Indicator B4: Algal mat or crust

Category: Primary

General Description: This indicator consists of a mat or dried crust of algae, perhaps mixed with other detritus, left on or near the soil surface after dewatering.

Cautions and User Notes: Algal deposits include those produced by green algae (Chlorophyta) and blue-green algae (cyanobacteria). They may be attached to low vegetation or other fixed objects, or may cover the soil surface (Figure 41). Dried crusts of blue-green algae may crack and curl at plate margins (Figure 42). Algal deposits are usually seen in seasonally ponded areas, lake fringes, and low-gradient stream margins. They reflect prolonged wet conditions sufficient for algal growth and development.

Figure 41. Dried algal crust in a forested wetland.

Figure 42. Close-up of crust of blue-green algae on the soil surface.

Indicator B5: Iron deposits

Category: Primary

General Description: This indicator consists of a thin orange or yellow crust or gel of oxidized iron on the soil surface or on objects near the surface.

Cautions and User Notes: Iron deposits form in areas where reduced iron discharges with groundwater and oxidizes upon exposure to air. The oxidized iron forms a film or sheen on standing water (Figure 43) and an orange or yellow deposit (Figure 44) on the ground surface after dewatering. Iron sheen on water can be distinguished from an oily film by touching with a stick or finger; iron films are crystalline and will crack into angular pieces. In mined areas and in discharges from landfills, iron deposits may be very abundant.

Figure 43. Iron sheen on the water surface may be deposited as an orange or yellow crust after dewatering.

Figure 44. Iron deposit (orange streaks) in a small channel.

Indicator B7: Inundation visible on aerial imagery

Category: Primary

General Description: One or more recent aerial photographs or satellite images show the site to be inundated (Figure 45).

Cautions and User Notes: Care must be used in applying this indicator because surface water may be present on a non-wetland site immediately after a heavy rain or during periods of unusually high precipitation, runoff, or river stages. See Chapter 5 for procedures to evaluate the normality of precipitation prior to the photo date. Surface water observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. Surface water may be absent from a wetland during the normal dry season or during extended periods of drought. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., wetlands are inundated or saturated at least 5 out of 10 years, or 50 percent or higher probability). If available, it is recommended that multiple years of photography be evaluated, emphasizing photos taken during the normal wet portion of the growing season. If 5 or more years of aerial photos are available, the procedure described by the USDA Natural Resources Conservation Service (1997, section 650.1903) is recommended (see Chapter 5, section on Wetlands that Periodically Lack Indicators of Wetland Hydrology, for additional information).

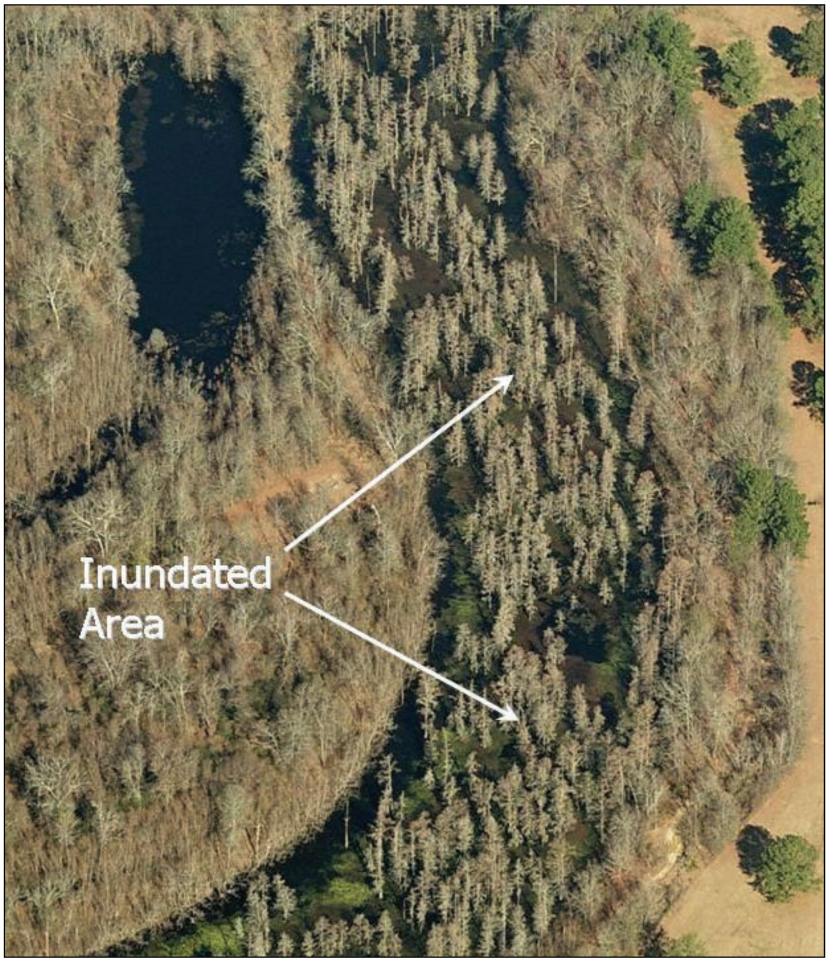

Figure 45. Aerial view of a forested wetland with surface water present.

Indicator B9: Water-stained leaves

Category: Primary

General Description: Water-stained leaves are fallen or recumbent dead leaves that have turned grayish or blackish in color due to inundation for long periods.

Cautions and User Notes: Water-stained leaves are most often found in depressional wetlands and along streams in shrub-dominated or forested habitats; however, they also occur in herbaceous communities. Staining often occurs in leaves that are in contact with the soil surface while inundated for long periods. Water-stained leaves maintain their grayish or blackish colors when dry (Figure 46). They should contrast strongly with fallen leaves in nearby non-wetland landscape positions.

Figure 46. Water-stained leaves in a depressional wetland (unstained leaf for comparison).

Indicator B13: Aquatic fauna

Category: Primary

General Description: Presence of live individuals, diapausing insect eggs or crustacean cysts, or dead remains of aquatic fauna, such as, but not limited to, sponges, bivalves, aquatic snails, aquatic insects, ostracods, shrimp, other crustaceans, tadpoles, or fish, either on the soil surface or clinging to plants or other emergent objects.

Cautions and User Notes: Examples of dead remains include mussel and clam shells, chitinous exoskeletons (e.g., dragonfly nymphs), insect head capsules, aquatic snail shells (Figure 47), and skins or skeletons of aquatic amphibians or fish (Figure 48). Aquatic fauna or their remains should be reasonably abundant; one or two individuals are not sufficient. Use caution in areas where faunal remains may have been transported by high winds, unusually high water, or other animals into non-wetland areas. Shells and exoskeletons are resistant to tillage but may be moved by equipment beyond the boundaries of the wetland. They may also persist in the soil for years after dewatering.

Figure 47. Shells of aquatic snails in a seasonally ponded wetland.

Figure 48. Dead green frogs (*Rana clamitans melanota*) in a drying seasonal pool.

Indicator B14: True aquatic plants

Category: Primary

General Description: This indicator consists of the presence of live individuals or dead remains of true aquatic plants.

Cautions and User Notes: True aquatic plants are species that are normally submerged, have floating leaves or stems, require water for support, or desiccate in the absence of standing water. Examples in the region include watershield (*Brasenia schreberi*), water-milfoil (*Myriophyllum* spp.), yellow pond-lily (*Nuphar lutea*), waterlily (*Nymphaea* spp.), American lotus (*Nelumbo lutea*), pondweeds (*Potamogeton* spp.), aquatic bladderworts (*Utricularia* spp.), and duckweeds (*Lemna* spp.) (Figure 49).

Figure 49. Dried remains of waterlilies in a semipermanently ponded wetland.

Indicator B6: Surface soil cracks

Category: Secondary

General Description: Surface soil cracks consist of shallow cracks that form when fine-grained mineral or organic sediments dry and shrink, often creating a network of cracks or small polygons (Figure 50).

Figure 50. Surface soil cracks in a seasonally ponded depression.

Cautions and User Notes: Surface soil cracks are often seen in recent deposits of fine sediments and in concave landscape positions where ponded water prevents the development of surface soil structure, such as in depressions, lake fringes, and floodplains. Use caution, however, as they may also occur in temporary ponds and puddles in non-wetlands and in areas that have been effectively drained. This indicator does not include deep cracks due to shrink-swell action in clay soils (e.g., Vertisols).

Indicator B8: Sparsely vegetated concave surface

Category: Secondary

General Description: On concave land surfaces (e.g., depressions and swales), the ground surface is either unvegetated or sparsely vegetated (less than 5 percent ground cover) due to long-duration ponding or flooding during the growing season (Figure 51).

Cautions and User Notes: Sparsely vegetated concave surfaces should contrast with vegetated slopes and convex surfaces in the same area. A woody overstory of trees or shrubs may or may not be present. Examples in the region include, but are not limited to, concave positions on floodplains and seasonally ponded depressions (e.g., vernal pools).

Figure 51. A sparsely vegetated, seasonally ponded depression.

Indicator B10: Drainage patterns

Category: Secondary

General Description: This indicator consists of flow patterns visible on the soil surface or eroded into the soil, low vegetation bent over in the direction of flow, absence of leaf litter or small woody debris due to flowing water, and similar evidence that water flowed across the ground surface.

Cautions and User Notes: Drainage patterns are usually seen in areas where water flows broadly over the surface or in a braided pattern and is not confined to a channel, such as in areas adjacent to streams, in seeps, slope wetlands, vegetated swales, and hardwood flats (Figures 52 and 53). Use caution in areas subject to high winds or affected by recent extreme or unusual flooding events.

Indicator B16: Moss trim lines

Category: Secondary

General Description: Presence of moss trim lines on trees or other upright objects in seasonally inundated areas.

Cautions and User Notes: Moss trim lines (Figure 54) are formed when water-intolerant mosses growing on tree trunks and other upright objects are killed by prolonged inundation, forming an abrupt lower edge

Figure 52. Drainage patterns seen during a flooding event. The patterns are also evident when the wetland is dry.

Figure 53. Vegetation bent over in the direction of water flow across a stream terrace.

Figure 54. Moss trim lines in a seasonally inundated wetland.

to the moss community at the high-water level (Carr et al. 2006). Trim lines on different trees in the inundated area should indicate the same water-level elevation. The elevation of a trim line can be extrapolated across lower elevation areas in the vicinity. This indicator does not include lichen trim lines which, due to slow regrowth, may reflect unusually high or infrequent flooding events. Certain species of aquatic mosses and liverworts are tolerant of long-duration inundation and occur on trees and other objects below the high-water level. Therefore, the lack of a trim line does not indicate that the site does not pond or flood.

Group C – Evidence of Current or Recent Soil Saturation

Indicator C1: Hydrogen sulfide odor

Category: Primary

General Description: A hydrogen sulfide (rotten egg) odor within 12 in. (30 cm) of the soil surface.

Cautions and User Notes: Hydrogen sulfide is a gas produced by soil microbes in response to prolonged saturation in soils where oxygen, nitrogen, manganese, and iron have been largely reduced and there is a source of sulfur. For hydrogen sulfide to be detectable, the soil must be saturated at the time of sampling and must have been saturated long enough to become highly reduced. These soils are often permanently saturated and anaerobic at or near the surface. To apply this indicator, dig the soil pit no deeper than 12 in. to avoid release of hydrogen sulfide from deeper in the profile. Hydrogen sulfide odor serves as both an indicator of hydric soil and wetland hydrology. This single observation proves that the soil meets the definition of a hydric soil (i.e., anaerobic in the upper part), plus has an ongoing wetland hydrologic regime. Often these soils have a high water table (wetland hydrology indicator A2), but the hydrogen sulfide odor provides further proof that the soil has been saturated for a long period of time.

Indicator C3: Oxidized rhizospheres along living roots

Category: Primary

General Description: Presence of a layer containing 2 percent or more iron-oxide coatings or plaques on the surfaces of living roots and/or iron-oxide coatings or linings on soil pores immediately surrounding living roots within 12 in. (30 cm) of the soil surface (Figures 55 and 56).

Cautions and User Notes: Oxidized rhizospheres are the result of oxygen leakage from living roots into the surrounding anoxic soil, causing oxidation of ferrous iron present in the soil solution. They are evidence of saturated and reduced soil conditions during the plant's lifetime. Iron concentrations or plaques may form on the immediate root surface or may coat the soil pore adjacent to the root. In either case, the oxidized iron must be associated with living roots to indicate contemporary wet conditions and to distinguish these features from other pore linings. Care

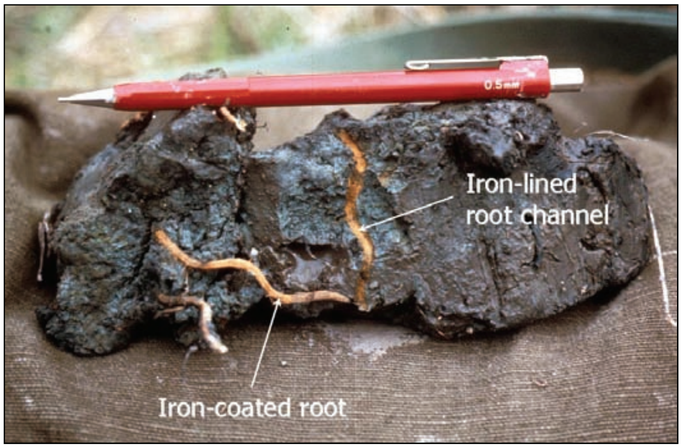

Figure 55. Iron-oxide plaque (orange coating) on a living root. Iron also coats the channel or pore from which the root was removed.

Figure 56. This soil has many oxidized rhizospheres associated with living roots.

must be taken to distinguish iron-oxide coatings from organic matter associated with plant roots. Viewing with a hand lens may help to distinguish mineral from organic material and to identify oxidized rhizospheres along fine roots and root hairs. Iron coatings sometimes show concentric layers in cross section and may transfer iron stains to the fingers when rubbed. Note the location and abundance of oxidized rhizospheres in the soil profile description or remarks section of the data form. There is no minimum thickness requirement for the layer containing oxidized rhizospheres. Oxidized rhizospheres must occupy at least 2 percent of the volume of the layer.

Indicator C4: Presence of reduced iron

Category: Primary

General Description: Presence of a layer containing reduced (ferrous) iron in the upper 12 in. (30 cm) of the soil profile, as indicated by a ferrous iron test or by the presence of a soil that changes color upon exposure to the air.

Cautions and User Notes: The reduction of iron occurs in soils that have been saturated long enough to become anaerobic and chemically reduced. Ferrous iron is converted to oxidized forms when saturation ends and the soil reverts to an aerobic state. Thus, the presence of ferrous iron indicates that the soil is saturated and anaerobic at the time of sampling, and has been saturated for an extended period. The presence of ferrous iron can be verified with alpha, alpha-dipyridyl reagent (Figure 57) or by observing a soil that changes color upon exposure to air (i.e., reduced matrix). A positive reaction to alpha, alpha-dipyridyl reagent should occur within a few seconds over more than 50 percent of the soil layer in question. Apply the reagent to

Figure 57. When alpha, alpha-dipyridyl is applied to a soil containing reduced iron, a positive reaction is indicated by a pink or red coloration to the treated area.

freshly broken samples to avoid any chance of a false positive test due to iron contamination from digging tools. The reagent does not react when wetlands are dry; therefore, a negative test result is not evidence that the soil is not reduced at other times of year. Soil samples should be tested or examined immediately after opening the soil pit because ferrous iron may oxidize and colors change soon after the sample is exposed to the air. Soils that contain little weatherable iron may not react even when saturated and reduced. There are no minimum thickness requirements or initial color requirements for the soil layer in question.

Indicator C6: Recent iron reduction in tilled soils

Category: Primary

General Description: Presence of a layer containing 2 percent or more redox concentrations as pore linings or soft masses in the tilled surface layer of soils cultivated within the last two years. The layer containing redox concentrations must be within the tilled zone or within 12 in. (30 cm) of the soil surface, whichever is shallower.

Cautions and User Notes: Cultivation breaks up or destroys redox features in the plow zone. The presence of continuous and unbroken redox features indicates that the soil was saturated and reduced since the last episode of cultivation (Figure 58). Redox features often form around organic material, such as crop residue, incorporated into the tilled soil. Use caution with older features that may be broken up but not destroyed by tillage. The indicator is most reliable in areas that are cultivated regularly, so that soil aggregates and older redox features are more likely to be broken up. If not obvious, information about the timing of last cultivation may be available from the land owner. A plow zone 6 to 8 in. (15 to 20 cm) in depth is typical but may extend deeper. There is no minimum thickness requirement for the layer containing redox concentrations.

Indicator C7: Thin muck surface

Category: Primary

General Description: This indicator consists of a layer of muck 1 in. (2.5 cm) or less thick at the soil surface.

Figure 58. Redox concentrations in the tilled surface layer of a recently cultivated soil.

Cautions and User Notes: Muck is highly decomposed organic material (see the Concepts section of Chapter 3 for guidance on identifying muck). In this region, muck accumulates only where soils are saturated to the surface for long periods each year. Thick muck layers can persist for years after wetland hydrology is effectively removed; therefore, a muck layer greater than 1 in. thick does not qualify for this indicator. However, thin muck surfaces disappear quickly or become incorporated into mineral horizons when wetland hydrology is withdrawn. Therefore, the presence of a thin muck layer on the soil surface indicates an active wetland hydrologic regime.

Indicator C2: Dry-season water table

Category: Secondary

General Description: Visual observation of the water table between 12 and 24 in. (30 and 60 cm) below the surface during the normal dry season or during a drier-than-normal year.

Cautions and User Notes: Due to normal seasonal fluctuations, water tables in wetlands often drop below 12 in. during the summer dry season. A water table between 12 and 24 in. during the dry season, or during an unusually dry year, indicates a normal wet-season water table within 12 in. of the surface. Sufficient time must be allowed for water to infiltrate into a newly dug hole and to stabilize at the water-table level. The required time will vary depending upon soil texture and other properties. In some cases, the water table can be determined by examining the wall of the soil pit and identifying the upper level at which water is seeping into the pit. For an accurate determination of the water-table level, the soil pit, auger hole, or well should not penetrate any restrictive soil layer capable of perching water near the surface. Water tables in wetlands often drop well below 24 in. during dry periods. Therefore, a dry-season water table below 24 in. does not necessarily indicate a lack of wetland hydrology. Water tables are a function of both recent and long-term precipitation; use caution in interpreting this indicator immediately following an unusually heavy rainfall event. See Chapter 5 (section on Wetlands that Periodically Lack Indicators of Wetland Hydrology) for determining average dry-season dates, periods of below-normal rainfall, and drought periods. In the remarks section of the data form or in a separate report, provide documentation for the conclusion that the site visit occurred during the normal dry season, recent rainfall has been below normal, or the area has been affected by drought.

Indicator C8: Crayfish burrows

Category: Secondary

General Description: Presence of crayfish burrows, as indicated by openings in soft ground up to 2 in. (5 cm) in diameter, often surrounded by chimney-like mounds of excavated mud.

Cautions and User Notes: Crayfish breathe with gills and most species require at least periodic contact with water. Some species dig burrows for refuge and breeding (Figure 59). Crayfish burrows are usually found near streams, ditches, and ponds in areas that are seasonally inundated or have seasonal high water tables at or near the surface. They are also found in wet meadows and pastures where there is no open water. Crayfish may extend their burrows 10 ft (3 m) or more in depth to keep pace with a falling water table; thus, the eventual depth of the burrow does not reflect the level of the seasonal high water table.

Figure 59. Crayfish burrow in a saturated wetland.

Indicator C9: Saturation visible on aerial imagery

Category: Secondary

General Description: One or more recent aerial photographs or satellite images indicate soil saturation. Saturated soil signatures must correspond to field-verified hydric soils, depressions or drainage patterns, differential crop management, or other evidence of a seasonal high water table.

Cautions and User Notes: This indicator is useful when plant cover is sparse or absent and the ground surface is visible from above. Saturated areas generally appear as darker patches within the field (Figure 60). Inundated (indicator B7) and saturated areas may be present in the same

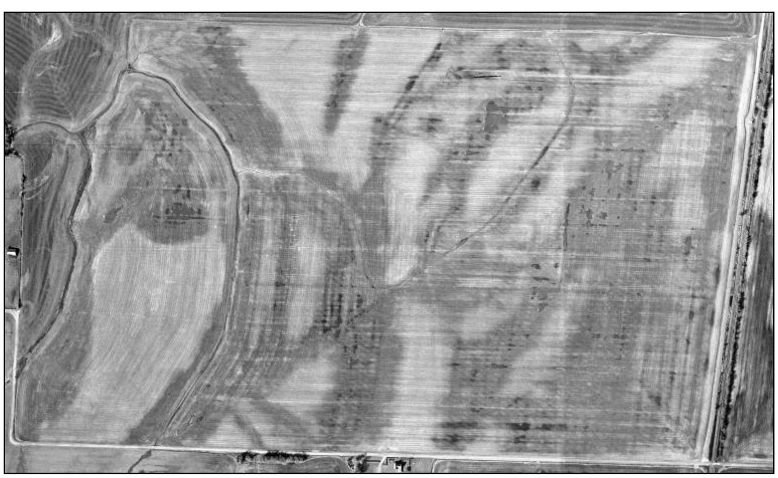

Figure 60. Aerial photograph of an agricultural field with saturated soils indicated by darker colors.

field; if they cannot be distinguished, then use indicator C9 for the entire wet area. Care must be used in applying this indicator because saturation may be present on a non-wetland site immediately after a heavy rain or during periods of abnormally high precipitation, runoff, or river stages. Saturation observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. Saturation may be absent from a wetland during the normal dry season or during extended periods of drought. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., wetlands are inundated or saturated at least 5 out of 10 years, or 50 percent or higher probability). If available, it is recommended that multiple years of photography be evaluated, emphasizing photos taken during the normal wet portion of the growing season. If 5 or more years of aerial photos are available, the procedure described by the USDA Natural Resources Conservation Service (1997, section 650.1903) is recommended. Use caution, as similar signatures may be caused by factors other than saturation.

Group D – Evidence from Other Site Conditions or Data

Indicator D1: Stunted or stressed plants

Category: Secondary

General Description: In agricultural or planted vegetation located in a depression, swale, or other topographically low area, this indicator is present if individuals of the same species growing in the potential wetland are clearly of smaller stature, less vigorous, or stressed compared with individuals growing in nearby drier landscape situations.

Cautions and User Notes: Usually this indicator is associated with depressions or swales in crop or hay fields. Agricultural crops and other introduced or planted species, such as corn (*Zea mays*), soybeans (*Glycine max*), wheat (*Triticum* spp.), and alfalfa (*Medicago* spp.), can become established in wetlands but often exhibit obvious stunting, yellowing, or stress in wet situations (Figure 61). Use caution in areas where stunting of plants on non-wetland sites may be caused by low soil fertility, excessively drained soils, cold temperatures, uneven application of agricultural chemicals, or other factors not related to wetness. For this indicator to be present, a majority of individuals in the potential wetland area must be stunted or stressed. This indicator is restricted to agricultural or planted vegetation.

Figure 61. Stunted and yellowed corn due to wet spots in an agricultural field.

Indicator D2: Geomorphic position

Category: Secondary

General Description: This indicator is present if the area in question is located in a localized depression, drainageway, concave position within a floodplain, at the toe of a slope, on the low-elevation fringe of a pond or other water body, or in an area where groundwater discharges.

Cautions and User Notes: Excess water from precipitation naturally accumulates in certain geomorphic positions in the landscape, particularly in low-lying areas such as depressions, drainages, floodplain depressions and backwaters, toes of slopes (Figure 6), and fringes of ponds, lakes, and other water bodies. In regions with abundant rainfall, these geomorphic positions often, but not always, exhibit wetland hydrology. This indicator is not applicable in areas with functioning drainage systems and does not include concave positions on rapidly permeable soils (e.g., floodplains with sand and gravel substrates) unless the water table is periodically near the surface.

Indicator D3: Shallow aquitard

Category: Secondary

General Description: This indicator occurs in and around the margins of depressions and in flat landscapes, and consists of the presence of an aquitard within the soil profile that is potentially capable of perching water within 12 in. (30 cm) of the surface.

Cautions and User Notes: An aquitard is a relatively impermeable soil layer or bedrock that slows the downward infiltration of water and can produce a perched water table, generally in flat or depressional landforms. In some cases, the aquitard may be at the surface (e.g., in clay soils) and cause water to pond on the surface. Potential aquitards in this region include fragipans, cemented layers, lacustrine deposits, and clay layers. An aquitard can often be identified by the limited root penetration through the layer and/or the presence of redoximorphic features in the layer(s) above the aquitard. Local experience and professional judgment should indicate that the perched water table is likely to occur during the growing season for sufficient duration in most years. Use caution in areas with functioning drainage systems that are capable of removing perched water quickly.

Indicator D4: Microtopographic Relief

Category: Secondary

General Description: This indicator consists of the presence of micro-topographic features that occur in areas of seasonal inundation or shallow water tables, such as hummocks and tussocks (Figure 62).

Figure 62. This hemlock-dominated wetland has trees growing on hummocks and herbaceous plants growing in tussocks.

Cautions and User Notes: These features are the result of vegetative and geomorphic processes in wetlands and produce the characteristic microtopographic diversity of some wetland systems. Microtopographic lows are either inundated or have shallow water tables for long periods each year. Microtopographic highs may or may not have wetland hydrology, but usually are small, narrow, or fragmented, often occupying less than half of the surface area. If indicators of hydrophytic vegetation or hydric soil are absent from microhighs, see the procedure for wetland/non-wetland mosaics in Chapter 5. This indicator does not include uneven topography due to vegetation-covered rocks, logs, or other debris; microtopography due to grazing or trampling by livestock; or man-made microtopographic relief (e.g., bedding for silviculture).

Indicator D5: FAC-neutral test

Category: Secondary

General Description: The plant community passes the FAC-neutral test.

Cautions and User Notes: The FAC-neutral test is performed by compiling a list of dominant plant species across all strata in the community, and dropping from the list any species with a Facultative indicator status (i.e., FAC, FAC–, and FAC+). The FAC-neutral test is met if more than 50 percent of the remaining dominant species are rated FACW and/or OBL (Figure 63). This indicator may also be used in communities that contain no FAC dominants. If there are an equal number of dominants that are OBL and FACW versus FACU and UPL, or if all dominants are FAC, non-dominant species should be considered.

Step 1: Use the 50/20 rule to select dominant species from each stratum of the community.

Step 2: Combine dominant species from all strata into a single list. Determine the wetland indicator status for each dominant species (Reed [1988] or current list). For example:

Dominant Species	Stratum	Indicator Status
Carya ovata	Tree	FACU
Ulmus americana	Tree	FACW
Liquidambar styraciflua	Sapling	FAC
Celtis laevigata	Sapling	FACW
Carpinus caroliniana	Shrub	FAC
Boehmeria cylindrica	Herb	FACW
Leersia lenticularis	Herb	OBL
Toxicodendron radicans	Woody vine	FAC

Step 3: Drop the FAC species and sort the remaining species into two groups: FACW and OBL species, and FACU and UPL species:

FACW and OBL Species	FACU and UPL Species
Ulmus americana	*Carya ovata*
Celtis laevigata	
Boehmeria cylindrica	
Leersia lenticularis	

Step 4: Count the number of species in each group. If the number of dominant species that are FACW and OBL is greater than the number of dominant species that are FACU and UPL, then the site passes the FAC-neutral test. In the example, four species are FACW and/or OBL, and only one species is FACU or UPL. Therefore, the site passes the FAC-neutral test.

Figure 63. Procedure and example of the FAC-neutral test. This example uses the Region 2 (Southeast) plant list.

5 Difficult Wetland Situations in the Eastern Mountains and Piedmont Region

Introduction

Some wetlands can be difficult to identify because wetland indicators may be missing due to natural processes or recent disturbances. This chapter provides guidance for making wetland determinations in difficult-to-identify wetland situations in the Eastern Mountains and Piedmont Region. It includes regional examples of problem area wetlands and atypical situations as defined in the Corps Manual, as well as other situations that can make wetland delineation more challenging. Problem area wetlands are naturally occurring wetland types that lack indicators of hydrophytic vegetation, hydric soil, or wetland hydrology periodically due to normal seasonal or annual variability, or permanently due to the nature of the soils or plant species on the site. Atypical situations are wetlands in which vegetation, soil, and/or hydrology indicators are absent due to recent human activities or natural events. In addition, this chapter addresses certain procedural problems (e.g., wetland/non-wetland mosaics) that can make wetland determinations in the region difficult or confusing. The chapter is organized into the following sections:

- Lands Used for Agriculture and Silviculture
- Problematic Hydrophytic Vegetation
- Problematic Hydric Soils
- Wetlands that Periodically Lack Indicators of Wetland Hydrology
- Wetland/Non-Wetland Mosaics

The list of difficult wetland situations presented in this chapter is not intended to be exhaustive and other problematic situations may exist in the region. See the Corps Manual for general guidance. Furthermore, more than one wetland factor (i.e., vegetation, soil, and/or hydrology) may be disturbed or problematic on a given site. In general, *wetland determinations on difficult or problematic sites must be based on the best information available to the field inspector, interpreted in light of his or her professional experience and knowledge of the ecology of wetlands in the region.*

Lands used for agriculture and silviculture

Agriculture and silviculture are important land uses in the Eastern Mountains and Piedmont Region, and both of these activities present challenges to wetland identification and delineation. Wetlands used for agriculture or silviculture often lack a natural plant community and may be planted in crops, pasture species, or tree species and may be altered by mowing, grazing, herbicide use, or other management practices. Soils may be disturbed by cultivation, land clearing, grading, or bedding, at least in the surface layers, and hydrology may or may not be manipulated. Some areas that are used for agriculture or silviculture still retain wetland hydrology. In other areas, historic wetlands have been effectively drained and no longer meet wetland hydrology standards. Relict wetland indicators may still be present in these areas, making it difficult to distinguish current wetlands from those that have been effectively drained. In addition, agricultural activities can include improved groundwater management, involving the manipulation of water tables to conserve both water and nutrients (e.g., Frankenberger et al. 2006).

Agricultural and silvicultural drainage systems use ditches, subsurface drainage lines or "tiles," and water-control structures to manipulate the water table and improve conditions for crops or other desired species. A freely flowing ditch or drainage line depresses the water table within a certain lateral distance or zone of influence (Figure 64). The effectiveness of drainage in an area depends in part on soil characteristics, the timing and amount of rainfall, and the depth and spacing of ditches or drains. Wetland determinations on current and former agricultural or silvicultural lands must consider whether a drainage system is present, how it is designed to function, and whether it is effective in removing wetland hydrology from the area.

A number of information sources and tools are listed below to help determine whether wetlands are present on lands where vegetation, soils, hydrology, or a combination of these factors have been manipulated. Some of these options are discussed in more detail later in this chapter under the appropriate section headings.

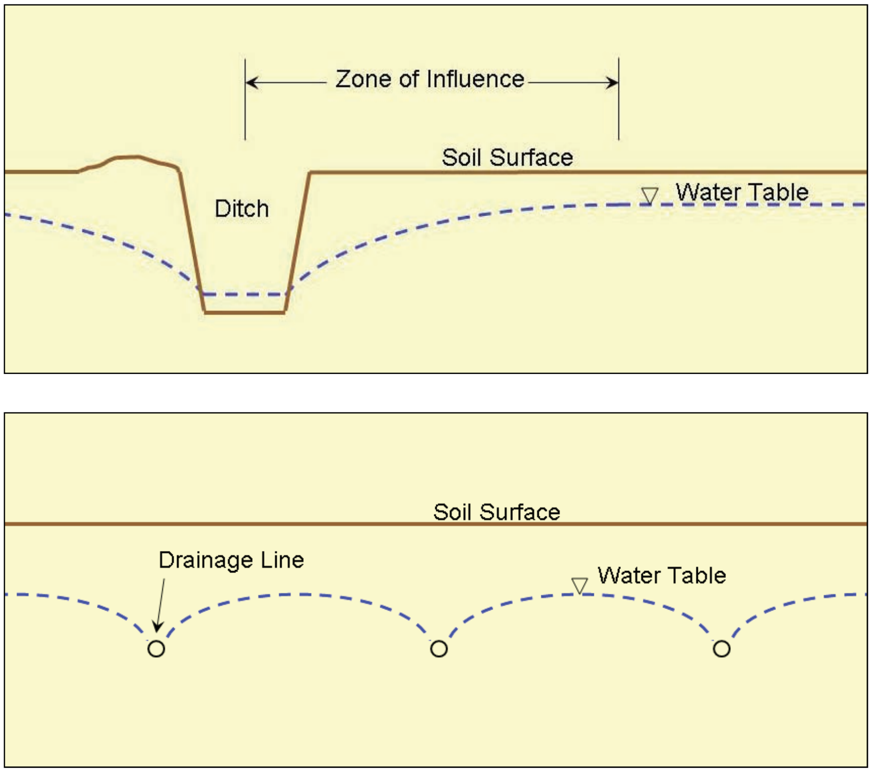

Figure 64. Effects of ditches (upper) and parallel subsurface drainage lines (lower) on the water table.

1. **Vegetation** – The goal is to determine the plant community that would occupy the site under normal circumstances, if the vegetation were not cleared or manipulated.

    a. Examine the site for volunteer vegetation that emerges between cultivations, plantings, mowings, or other treatments, or emerges after the crop is harvested.
    b. Examine the vegetation on an undisturbed reference area with soils and hydrology similar to those on the site.
    c. Check NRCS soil survey reports for information on the typical vegetation on soil map units (hydrology of the site must be unaltered).
    d. If the conversion to agriculture or silviculture was recent and the hydrology of the site was not manipulated, examine pre-disturbance aerial photography, NWI maps, and other sources for information on the previous vegetation.
    e. Cease the clearing, cultivation, or manipulation of the site for one or more growing seasons with normal rainfall and examine the plant community that develops.

2. **Soils** – Tilling of agricultural land mixes the surface layer(s) of the soil and may cause compaction below the tilled zone (i.e., a "plow pan") due to the weight and repeated passage of farm machinery. Similar disturbance to surface soils, such as ruts and trails made by logging equipment, may also occur in areas managed for silviculture. Nevertheless, a standard soil profile description and examination for hydric soil indicators are often sufficient to determine whether hydric soils are present. Other options and information sources include the following:

    a. Examine NRCS soil survey maps and the local hydric soils list for the likely presence of hydric soils on the site.
    b. Examine the soils on an undisturbed reference area with landscape position, parent materials, and hydrology similar to those on the site.
    c. Use alpha, alpha-dipyridyl to check for the presence of reduced iron during the normal wet portion of the growing season, or note whether the soil changes color upon exposure to the air.
    d. Monitor the site in relation to the appropriate wetland hydrology or hydric soils technical standard.

3. **Hydrology** – The goal is to determine whether wetland hydrology is present on a managed site under normal circumstances, as defined in the Corps Manual and subsequent guidance. These sites may or may not have been hydrologically manipulated.

    a. Examine the site for existing indicators of wetland hydrology. If the natural hydrology of the site has been permanently altered, discount any indicators known to have been produced before the alteration (e.g., relict water marks or drift lines).
    b. In agricultural areas (e.g., row crops, hayfields, tree farms, nurseries, orchards, and others) examine five or more years of aerial photographs for wetness signatures listed in Part 513.30 of the National Food Security Act Manual (USDA Natural Resources Conservation Service 1994) or in wetland mapping conventions available from NRCS offices or online in the electronic Field Office Technical Guide (eFOTG) (http://www.nrcs.usda.gov/technical/efotg/). Use the procedure given by the USDA Natural Resources Conservation Service (1997) to determine whether wetland hydrology is present.
    c. Estimate the effects of ditches and subsurface drainage systems using scope-and-effect equations (USDA Natural Resources Conservation Service 1997). Scope-and-effect equations are approximations only and

may not reflect actual field conditions. The results should be verified by comparison with other techniques for evaluating drainage and should not overrule onsite evidence of wetland hydrology.

d. Use state drainage guides to estimate the effectiveness of an existing drainage system (USDA Natural Resources Conservation Service 1997). Drainage guides may be available from NRCS offices. Cautions noted in item *c* above also apply to the use of drainage guides. In addition, Corps of Engineers district offices should be consulted for locally developed techniques to evaluate wetland drainage.
e. Use hydrologic models (e.g., runoff, surface water, and groundwater models) to determine whether wetland hydrology is present (e.g., USDA Natural Resources Conservation Service 1997).
f. Monitor the hydrology of the site in relation to the appropriate wetland hydrology technical standard (U.S. Army Corps of Engineers 2005).

Problematic hydrophytic vegetation

Description of the problem

Many factors affect the structure and composition of plant communities in the region, including climatic variability, spread of exotic species, agricultural and silvicultural use, and other human land-use practices. As a result, some wetlands may exhibit indicators of hydric soil and wetland hydrology but may lack any of the hydrophytic vegetation indicators presented in Chapter 2, at least at certain times. To identify and delineate these wetlands may require special sampling procedures or additional analysis of factors affecting the site. To the extent possible, the hydrophytic vegetation decision should be based on the plant community that is normally present during the wet portion of the growing season in a normal rainfall year. The following procedure addresses several examples of problematic vegetation situations in the Eastern Mountains and Piedmont Region.

Procedure

Problematic hydrophytic vegetation can be identified using a combination of observations made in the field and/or supplemental information from the scientific literature and other sources. These procedures should be applied only where indicators of hydric soil and wetland hydrology are present, unless one or both of these factors is also disturbed or problematic, but no indicators of hydrophytic vegetation are evident. The following procedures are recommended:

1. Verify that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present. If indicators of either hydric soil or wetland hydrology are absent, the area is likely non-wetland unless soil and/or hydrology are also disturbed or problematic. If indicators of hydric soil and wetland hydrology are present (or are absent due to disturbance or other problem situations), proceed to step 2.

2. Verify that the area is in a landscape position that is likely to collect or concentrate water, such as those listed below. If the landscape setting is appropriate, proceed to step 3.

   a. Concave surface (e.g., depression or swale)
   b. Active floodplain or low terrace
   c. Level or nearly level area (e.g., 0- to 3-percent slope)
   d. Toe slope (Figure 6) or an area of convergent slopes (Figure 5)
   e. Fringe of another wetland or water body
   f. Area with a restrictive soil layer or aquitard within 24 in. (60 cm) of the surface
   g. Area where groundwater discharges (e.g., a seep)
   h. Other (explain in field notes why this area is likely to be inundated or saturated for long periods)

3. Use one or more of the approaches described in step 4 (Specific Problematic Vegetation Situations below) or step 5 (General Approaches to Problematic Hydrophytic Vegetation on page 125) to determine whether the vegetation is hydrophytic. In the remarks section of the data form or in the delineation report, explain the rationale for concluding that the plant community is hydrophytic even though indicators of hydrophytic vegetation described in Chapter 2 were not observed.

4. Specific Problematic Vegetation Situations

   a. *Temporal shifts in vegetation*. As described in Chapter 2, the species composition of some wetland plant communities in the region can change in response to seasonal weather patterns and long-term climatic fluctuations. Wetland types that are influenced by these shifts include vernal pools, impoundment drawdown zones, seeps, and springs. Lack of hydrophytic vegetation during the dry season, when FACU and UPL warm-season grasses and annuals dominate many areas, should not immediately eliminate a site from consideration as a wetland, because the site may have been dominated by wetland species earlier in the growing season. A site qualifies for further consideration if the plant community at the time of sampling lacks hydrophytic vegetation indicators, but indicators of hydric soil and wetland hydrology are present or known to be disturbed or problematic. The following sampling and analytical approaches are recommended in these situations:

(1) Seasonal Shifts in Plant Communities

(a) If possible, return to the site during the normal wet portion of the growing season (generally in early spring) and re-examine the site for indicators of hydrophytic vegetation.
(b) Examine the site for identifiable plant remains, either alive or dead, or other evidence that the plant community that was present during the normal wet portion of the growing season was hydrophytic.
(c) Use off-site data sources to determine whether the plant community that is normally present during the wet portion of the growing season is hydrophytic. Appropriate data sources include early growing season aerial photography, NWI maps, soil survey reports, remotely sensed data, public interviews, state wetland conservation plans, and previous reports about the site. If necessary, re-examine the site at a later date to verify the hydrophytic vegetation determination.
(d) If the vegetation on the site is substantially the same as that on a wetland reference site having similar soils, landscape position, and known wetland hydrology, then consider the vegetation to be hydrophytic (see step 5c in this procedure for more information).
(e) If the hydrophytic status of the vegetation during the normal wet portion of the growing season in a normal rainfall year cannot be determined, make the wetland determination based on indicators of hydric soil and wetland hydrology.

(2) Prolonged Dry to Drought Conditions (lasting more than one growing season)

(a) Investigate climate records (e.g., WETS tables, drought indices) to determine if the area is under the influence of a drought or prolonged dry conditions (for more information, see the section on Wetlands that Periodically Lack Indicators of Wetland Hydrology later in this chapter). If so, evaluate any off-site data that provide information on the plant community that exists on the site during normal years, including aerial photography, Farm Service Agency annual crop slides, NWI maps, other remote sensing data, soil survey reports, public interviews, NRCS hydrology tools (USDA Natural Resources Conservation Service 1997), and previous site reports. Determine whether the vegetation that is present during normal years is hydrophytic.
(b) If the vegetation on the affected site is substantially the same as that on a wetland reference site in the same general area having similar soils and known wetland hydrology, then consider the vegetation to be hydrophytic (see step 5c in this procedure).
(c) If the hydrophytic status of the vegetation during the normal wet portion of the growing season in a normal rainfall year cannot be determined, make the wetland determination based on indicators of hydric soil and wetland hydrology.

b. *Vernal pools*. Vernal pools are small, seasonal water bodies that pond water during the spring or shortly after snowmelt and into early to mid-summer. The pools may be situated within wetlands or non-wetlands. They are characterized by specialist vernal-pool fauna, particularly amphibians and invertebrates that require the pools to complete their life cycles (Colburn 2004). The vegetation in and around these pools is influenced by the seasonal hydrology. During the early part of the growing season, they may lack herbaceous vegetation due to inundation and it may be necessary to base the hydrophytic vegetation decision solely on woody plants. Where woody vegetation is lacking, herbaceous vegetation should be examined later in the growing season. In pools that retain water for very long periods, vegetation may not become well established even during drier periods. During the driest times of the year, or in drought years, some pools become dominated by upland plants, particularly annuals. The following approaches are recommended for evaluating vernal pools where indicators of hydric soil and wetland hydrology are present, but hydrophytic vegetation is not evident at the time of the site visit.

(1) If the pool is filled with water at the time of the visit, emergent vegetation is absent, and a follow-up site visit is practical, then return to the site soon after seasonal draw-down and check for indicators of hydrophytic vegetation.

(2) If the site is visited during the dry season, vegetation in the potential pool area is dominated by upland species (particularly annuals), and a follow-up site visit is practical, then revisit the site during the normal wet portion of the growing season and check again for indicators of hydrophytic vegetation.

(3) If the hydrophytic status of the vegetation during the normal wet portion of the growing season in a normal rainfall year cannot be determined, make the wetland determination based on indicators of hydric soil and wetland hydrology.

c. *Areas affected by grazing*. Both short- and long-term grazing can cause shifts in dominant species in the vegetation. For instance, trampling by large herbivores can cause soil compaction, altering soil permeability and infiltration rates, and affecting the plant community. Grazers can also influence the abundance of plant species by selectively grazing certain palatable species or avoiding less palatable species. This shift in species composition due to grazing can influence the hydrophytic vegetation determination. Be aware that shifts in both directions, favoring either wetland species or upland species, can occur in these situations. Limited grazing does not necessarily affect the outcome of a hydrophytic vegetation decision. However, the following approaches are recommended in cases where the effects of grazing are so great that the hydrophytic vegetation determination would be unreliable or misleading.

(1) Examine the vegetation on a nearby, ungrazed reference site having similar soils and hydrologic conditions. Ungrazed areas may be present on adjacent properties or in fenced exclosures or streamside management zones. Assume that the same plant community would exist on the grazed site, in the absence of grazing.

(2) If feasible, remove livestock or fence representative livestock exclusion areas to allow the vegetation time to recover from grazing, and reevaluate the vegetation during the next growing season.

(3) If grazing was initiated recently, use offsite data sources such as aerial photography, NWI maps, and interviews with the land owner and other persons familiar with the site or area to determine what plant community was present on the site before grazing began. If the previously ungrazed community was hydrophytic, then consider the current vegetation to be hydrophytic.

(4) If an appropriate ungrazed area cannot be located or if the ungrazed vegetation condition cannot be determined, make the wetland determination based on indicators of hydric soils and wetland hydrology.

d. *Managed plant communities*. Natural plant communities throughout the region have been replaced with agricultural crops or are otherwise managed to meet human goals. Examples include clearing of woody species on grazed pasture land; periodic disking, plowing, or mowing; planting of native and non-native species (including cultivars or planted species that have escaped and become established on other sites); use of herbicides; silvicultural activities; and suppression of wildfires. These actions can result in elimination of certain species and their replacement with other species, changes in abundance of certain plants, and shifts in dominant species, possibly influencing a hydrophytic vegetation determination. The following approaches are recommended if the natural vegetation has been altered through management to such an extent that a hydrophytic vegetation determination is not possible or would be unreliable:

(1) Examine the vegetation on a nearby, unmanaged reference site having similar soils and hydrologic conditions. Assume that the same plant community would exist on the managed site in the absence of human alteration.

(2) For recently cleared or tilled areas (not planted or seeded), leave representative areas unmanaged for at least one growing season with normal rainfall and reevaluate the vegetation.

(3) If management was initiated recently, use offsite data sources such as aerial photography, NWI maps, and interviews with the land owner and other persons familiar with the area to determine what plant community was present on the site before the management occurred.

(4) If the unmanaged vegetation condition cannot be determined, make the wetland determination based on indicators of hydric soil and wetland hydrology.

e. *Areas affected by fires, floods, and other natural disturbances*. Fires, floods, and other natural disturbances can dramatically alter the vegetation on a site. Vegetation can be completely or partially removed, or its composition altered, depending upon the intensity of the disturbance. Limited disturbance does not necessarily affect the investigator's ability to determine whether the plant community is or is not hydrophytic. However, if the vegetation on a site has been removed or made unidentifiable by a recent fire, flood, or other disturbance, then one or more of the following approaches may be used to determine whether the vegetation present before the disturbance was hydrophytic. Additional guidance can be found in the Atypical Situations section of the Corps Manual.

(1) Examine the vegetation on a nearby, undisturbed reference site having similar soils and hydrologic conditions. Assume that the same plant community would exist on the disturbed site in the absence of disturbance.

(2) Use offsite data sources such as aerial photography, NWI maps, and interviews with knowledgeable people to determine what plant community was present on the site before the disturbance.

(3) If the undisturbed vegetation condition cannot be determined, make the wetland determination based on indicators of hydric soil and wetland hydrology.

f. *Areas dominated exclusively by non-vascular plants*. In areas that lack vascular plants but are dominated by peat mosses (*Sphagnum* spp.), the vegetation should be considered to be hydrophytic if indicators of hydric soil and wetland hydrology are present, the landscape position is appropriate for wetlands, and hydrology has not been altered.

5. General Approaches to Problematic Hydrophytic Vegetation. The following general procedures are provided to identify hydrophytic vegetation in difficult situations not necessarily associated with specific vegetation types or management practices, including wetlands dominated by FACU, NI, NO, or unlisted species that are functioning as hydrophytes. The following recommended procedures should be applied only where indicators of hydric soil and wetland hydrology are present (or are absent due to disturbance or other problem situations) and the landscape position is appropriate to collect or concentrate water, but indicators of hydrophytic vegetation are not evident.

   a. *Certain FACU species that commonly dominate wetlands.* The following FACU species occur in and dominate many wetlands in the Eastern Mountains and Piedmont Region and may cause a wetland plant community to fail to meet any of the hydrophytic vegetation indicators described in Chapter 2: eastern hemlock (*Tsuga canadensis*), eastern white pine (*Pinus strobus*), red spruce (*Picea rubens*), osage orange (*Maclura pomifera*), Virginia creeper (*Parthenocissus quinquefolia*), and the following non-native species: multiflora rose (*Rosa multiflora*), Bermuda grass (*Cynodon dactylon*), spiny cocklebur (*Xanthium spinosum*), Chinese privet (*Ligustrum sinense*), tartarian honeysuckle (*Lonicera tatarica*), and Morrow's honeysuckle (*L. morrowii*) (indicator statuses may vary by plant list region). If the potential wetland area lacks hydrophytic vegetation indicators due to the presence of one or more of the FACU species listed above, use the following procedure to make the hydrophytic vegetation determination:

      (1) At each sampling point in the potential wetland, drop any FACU species listed above from the vegetation data, and compile the species list and coverage data for the remaining species in the community.

      (2) Reevaluate the remaining vegetation using hydrophytic vegetation indicators 2 (Dominance Test) and/or 3 (Prevalence Index). If either indicator is met, then the vegetation is hydrophytic.

b. *Direct hydrologic observations*. Verify that the plant community occurs in an area subject to prolonged inundation or soil saturation during the growing season. This can be done by visiting the site at 2- to 3-day intervals during the portion of the growing season when surface water is most likely to be present or water tables are normally high. Hydrophytic vegetation is considered to be present, and the site is a wetland, if surface water is present and/or the water table is 12 in. (30 cm) or less from the surface for 14 or more consecutive days during the growing season during a period when antecedent precipitation has been normal or drier than normal. If necessary, microtopographic highs and lows should be evaluated separately. The normality of the current year's rainfall must be considered in interpreting field results, as well as the likelihood that wet conditions will occur on the site at least every other year (for more information, see the section on "Wetlands that Periodically Lack Indicators of Wetland Hydrology" in this chapter).

c. *Reference sites with known hydrology*. If indicators of hydric soil and wetland hydrology are present, the site may be considered to be a wetland if the landscape setting, topography, soils, and vegetation are substantially the same as those on nearby wetland reference areas whose hydrology is known. Hydrologic characteristics of wetland reference areas should be documented through long-term monitoring or by application of the procedure described in item 5b above. Reference sites should be minimally disturbed and provide long-term access. Soils, vegetation, and hydrologic conditions should be thoroughly documented and the data kept on file in the district or field office. Existing sources of land-cover data (e.g., Southeast Gap Analysis Project [SEGAP] [http://www.basic.ncsu.edu/segap/]) can be helpful in locating suitable reference sites.

d. *Technical literature*. Published and unpublished scientific literature may be used to support a decision to treat specific FACU species or species with no assigned indicator status (e.g., NI, NO, or unlisted) as hydrophytes or certain plant communities as hydrophytic. Preferably, this literature should discuss the species' natural distribution along the moisture gradient, its capabilities and adaptations for life in wetlands, wetland types in which it is typically found, or other wetland species with which it is commonly associated.

Problematic hydric soils

Description of the problem

Soils with faint or no indicators

Some soils that meet the hydric soil definition may not exhibit any of the indicators presented in Chapter 3. These problematic hydric soils exist for a number of reasons and their proper identification requires additional information, such as landscape position, presence or absence of restrictive soil layers, or information about hydrology. This section describes several soil situations in the Eastern Mountains and Piedmont Region that are considered to be hydric if additional requirements are met. In some cases, these hydric soils may appear to be non-hydric due to the color of the parent material from which the soils developed. In others, the lack of hydric soil indicators is due to conditions (e.g., red parent materials) that inhibit the development of redoximorphic features despite prolonged soil saturation and anoxia. In addition, recently developed wetlands may lack hydric soil indicators because insufficient time has passed for their development. Examples of problematic hydric soils in the region include, but are not limited to, the following.

1. **Red Parent Materials.** Soils derived from red parent materials are a challenge for hydric soil identification because the red, iron-rich materials contain minerals that are resistant to weathering and chemical reduction under anaerobic conditions. This inhibits the formation of redoximorphic features and typical hydric soil morphology. These soils are found in scattered locations throughout the region in areas of Paleozoic or Mesozoic geologic materials or alluvium derived from these formations (Figure 34). A transect sampling approach can be helpful in making a hydric soil determination in soils derived from red parent materials. This involves describing the soil profile in an obvious non-wetland location and an obvious wetland location to identify particular soil features that are related to the wetness gradient. Relevant features may include a change in soil matrix chroma (e.g., from 4 to 3) or the presence of redox depletions or reddish-black manganese concentrations. Hydric soil indicators F3 (Depleted Matrix), F8 (Redox Depressions), F12 (Iron-Manganese Masses), and F21 (Red Parent Material) may be useful in identifying hydric soils in areas with red parent materials.

2. **Fluvial Deposits within Floodplains.** These soils commonly occur on vegetated bars within the active channel and/or above the bankfull level of rivers and streams. In some cases, these soils lack hydric soil indicators due to seasonal or annual deposition of new soil material, low iron or manganese content, and/or low organic-matter content. Redox concentrations can sometimes be found between soil stratifications in areas where organic matter gets buried, such as along the fringes of floodplains.

3. **Recently Developed Wetlands.** Recently developed wetlands include mitigation sites, wetland management areas (e.g., for waterfowl), other wetlands intentionally or unintentionally produced by human activities, and naturally occurring wetlands that have not been in place long enough to develop hydric soil indicators.

4. **Seasonally Ponded Soils.** Seasonally ponded, depressional wetlands, including sinkholes, occur throughout the region. Many are perched systems, with water ponding above a restrictive soil layer. Ponded depressions also occur in floodplains where receding floodwaters, precipitation, and local runoff are held above a slowly permeable soil layer. Some of these wetlands lack hydric soil indicators due to the limited saturation depth.

5. **Discharge Areas for Iron-Enriched Groundwater.** Discharge of iron-enriched groundwater occurs in many locations throughout the region. The seasonal input of iron from the groundwater produces soil chromas generally greater than 3 and as high as 6 below the surface layer(s). These soils are usually found in seepage areas, such as foot and toe slopes, springs, and areas with converging slopes, fractured bedrock, or near-surface stratigraphic discontinuities. Investigators should look for redox concentrations and depletions in the layer with high chroma and a depleted matrix below the layer of iron concentration. Wetland hydrology indicator B5 (Iron Deposits) can help to identify the presence of this problem soil (Figure 65).

Figure 65. Red areas in this photograph are iron deposits on the soil surface that are a result of high iron concentrations in the groundwater.

6. **Wetlands on Soils Derived from Coal.** Soils derived from parent materials containing coal are a challenge for hydric soil identification because the dark matrix colors associated with these soils can mask hydric soil features. These soils are found throughout the region in areas where coal-bearing deposits are located or where alluvium derived from these formations is found. These dark materials often form near-surface or shallow subsurface layers, and inhibit the use of indicators based on carbon accumulation (e.g., A5 – Stratified Layers), redox depletions (e.g., A11 – Depleted Below Dark Surface), and redox concentrations (e.g., F8 – Redox Depressions). A transect sampling approach can be useful in these difficult situations. This involves describing the soil in obvious non-wetland and wetland locations, and proceeding across the transition zone documenting any changes in soil color and redoximorphic features that are related to the wetness gradient. These changes may be faint and should be examined carefully. Chemical reagents, such as alpha, alpha-dipyridyl, can also be useful in identifying reducing conditions in these soils. However, caution must be used because chemical reagents require the presence of saturated conditions and sufficient iron content for a reaction to occur.

7. **Very Shallow Mineral Soils.** In areas where bedrock is close to the surface, hydric mineral soils may meet the color requirements but not the thickness requirements of one or more hydric soil indicators. Some

shallow hydric soils in depressions may meet all requirements for indicator TF12 (Very Shallow Dark Surface).

Soils with relict hydric soil indicators

Some soils in the region exhibit redoximorphic features and hydric soil indicators that formed in the recent or distant past when conditions may have been wetter than they are today. These features have persisted even though wetland hydrology may no longer be present. For example, wetlands drained for agricultural purposes starting in the 1700s may contain persistent hydric soil features. Wetland soils drained during historic times are still considered to be hydric, but they may no longer support wetlands. Relict hydric soil features may be difficult to distinguish from contemporary features. However, if indicators of hydrophytic vegetation and wetland hydrology are present, then hydric soil indicators can be assumed to be contemporary.

Relict redoximorphic features are no longer active due to geologic or other changes that have permanently altered the hydrologic regime. Only on close examination is it evident that hydric soil morphologies are not present. Several morphological characteristics that can help distinguish between contemporary and relict redoximorphic features (Vepraskas 1992) are described below.

1. Contemporary hydric soils may have nodules or concretions with diffuse boundaries or irregular surfaces. If surfaces are smooth and round, then red to yellow coronas should be present. Relict hydric soils may have nodules or concretions with abrupt boundaries and smooth surfaces without accompanying coronas.

2. Contemporary hydric soils may have Fe depletions along stable macropores in which roots repeatedly grow that are not overlain by iron-rich coatings (redox concentrations). Relict hydric soils may have Fe depletions along stable macropores in which roots repeatedly grow that are overlain by iron-rich coatings.

3. Contemporary hydric soils may have iron-enriched redox concentrations with Munsell colors of 5YR or yellower and with value and chroma of 4 or more. Relict hydric soils may have iron-enriched redox concentrations with colors redder than 5YR and value and chroma less than 4.

4. Contemporary pore linings may be continuous while relict pore linings may be broken or discontinuous (Hurt and Galbraith 2005).

There are also areas where hydric soil features have developed in former uplands due to human activities, such as the diversion of water for irrigation, soil compaction by vehicular traffic, or other causes. The application of irrigation water to upland areas can create wetland hydrology and, given adequate time, induce the formation of hydric soil indicators. In some cases, a soil scientist can distinguish naturally occurring hydric soil features from those induced by irrigation. Characterizing the naturally occurring hydrology is often important to the determination, and the timing of field observations can be critical. Observations made during the early part of the growing season, when natural hydrology is often at its peak and irrigation has not yet begun, may help to differentiate naturally occurring and irrigation-induced hydric soil features.

Non-hydric soils that may be misinterpreted as hydric

1. **Marl Soils.** In this supplement, the word "marl" is restricted in meaning to the definition given in the *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2010): "An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions, formed primarily under freshwater lacustrine conditions." Marl soils occur on floodplains in the Great Limestone Valley (Hagerstown Valley) in the Valley-and-Ridge Province of Pennsylvania, Maryland, West Virginia, and, perhaps, Virginia. They have also been identified in minor limestone valleys in West Virginia. These soils developed in marl sediments of late Pleistocene to early Holocene age that were deposited in water through precipitation of calcium carbonate by algae (Shaw and Rabenhorst 1997). Marl has a Munsell value of 5 or more and reacts with dilute hydrochloric acid (HCl) to evolve carbon dioxide (CO_2). Marl soils are problematic because the inherent color of precipitated calcium carbonate is gray to white with a matrix chroma of 1 or 2, and they commonly contain distinct or prominent iron-oxide concentrations. These soils can be misinterpreted as having a depleted matrix and, therefore, possibly meeting hydric soil indicator F3 (Depleted Matrix). Typical profiles also contain alternating buried surface layers with varying content of organic carbon.

2. **Soils Derived from Dark and/or Gray Parent Materials.** These soils formed in materials derived from gray or dark-colored shales or fine-

grained sandstones. They have gray matrix colors that were inherited from the parent material. These soils are common in the Piedmont and occur in long, very narrow bands paralleling intrusions of igneous basalt dikes within and adjoining Triassic red shales. Soils in smooth or convex positions on the landscape are easily misinterpreted as hydric because the subsoil has a predominantly gray matrix and commonly contains few to many, very fine pieces of reddish shale that can be misinterpreted as redox concentrations. Potentially hydric soils in concave landscape positions, such as drainageways, often have darker, thicker, organic-rich surface layers and redox concentrations as soft masses, and may meet one or more of the dark-surface hydric soil indicators (e.g., F6 – Redox Dark Surface).

3. **Black Parent Materials.** These soils occur as near-surface, outwash, or erosional deposits from coal and are often found in association with coal mining operations. The surface soil layer is composed mainly of coal particles. The dark color of these soils reflects the color of the parent material and is not related to the organic accumulations typically associated with wetness. Use caution in applying the following hydric soil indicators in these areas: A5 (Stratified Layers), A11 (Depleted Below Dark Surface), A12 (Thick Dark Surface), and S9 (Thin Dark Surface). Some areas of these soils may be wet but do not develop hydric soil indicators because of the lack of organic matter or the continual deposition of new sediment.

Procedure

Soils that are thought to meet the definition of a hydric soil but do not exhibit any of the indicators described in Chapter 3 can be identified by the following recommended procedure. This procedure should be used only where indicators of hydrophytic vegetation and wetland hydrology are present (or are absent due to disturbance or other problem situations), but indicators of hydric soil are not evident.

1. Verify that one or more indicators of hydrophytic vegetation are present or that vegetation is problematic or has been altered (e.g., by tillage or other land alteration). If so, proceed to step 2.

2. Verify that at least one primary or two secondary indicators of wetland hydrology are present or that indicators are absent due to disturbance or other factors. If so, proceed to step 3. If indicators of hydrophytic vegetation and/or wetland hydrology are absent, then the area is probably non-

wetland and no further analysis is required.

3. Thoroughly describe and document the soil profile and landscape setting. Verify that the area is in a landscape position that is likely to collect or concentrate water, such as those listed below. If the landscape setting is appropriate, proceed to step 4.

    a. Concave surface (e.g., depression or swale)
    b. Active floodplain or low terrace
    c. Level or nearly level area (e.g., 0- to 3-percent slope)
    d. Toe slope (Figure 6) or an area of convergent slopes (Figure 5)
    e. Fringe of another wetland or water body
    f. Area with a restrictive soil layer or aquitard within 24 in. (60 cm) of the surface
    g. Area where groundwater discharges (e.g., a seep)
    h. Other (explain in field notes why this area is likely to be inundated or saturated for long periods)

4. Use one or more of the following approaches to determine whether the soil is hydric. In the remarks section of the data form or in the delineation report, explain why it is believed that the soil lacks any of the NTCHS hydric soil indicators described in Chapter 3 and why it is believed that the soil meets the definition of a hydric soil.

    a. Determine whether one or more of the following indicators of problematic hydric soils is present. See the descriptions of each indicator given in Chapter 3. If one or more indicators are present, then the soil is hydric.

        (1) 2 cm Muck (A10) (applicable to MLRA 147 of LRR S)
        (2) Coast Prairie Redox (A16) (applicable to MLRAs 147 and 148 of LRR S)
        (3) Piedmont Floodplain Soils (F19) (applicable to floodplains in MLRA 136 of LRR P, and MLRA 147 of LRR S)
        (4) Very Shallow Dark Surface (TF12) (applicable throughout the Eastern Mountains and Piedmont Region)
        (5) Red Parent Material (F21) (applicable throughout the Eastern Mountains and Piedmont Region in areas containing soils derived from red parent materials) (Figure 34)

b. Determine whether one or more of the following problematic soil situations is present. If present, consider the soil to be hydric.

   (1) Red Parent Materials
   (2) Fluvial Deposits within Floodplains
   (3) Recently Developed Wetlands
   (4) Seasonally Ponded Soils
   (5) Discharge Areas for Iron-Enriched Groundwater
   (6) Wetlands on Soils Derived from Coal
   (7) Very Shallow Mineral Soils
   (8) Other (in field notes, describe the problematic soil situation and explain why it is believed that the soil meets the hydric soil definition)

c. Soils that have been saturated for long periods and have become chemically reduced may change color when exposed to air due to the rapid oxidation of ferrous iron (Fe^{2+}) to Fe^{3+} (i.e., a reduced matrix) (Figures 66 and 67). If the soil contains sufficient iron, this can result in an observable color change, especially in hue or chroma. The soil is hydric if a mineral layer 4 in. (10 cm) or more thick starting within 12 in. (30 cm) of the soil surface that has a matrix value of 4 or more and chroma of 2 or less becomes redder by one or more pages in hue and/or increases one or more in chroma when exposed to air within 30 minutes (Vepraskas 1992).

   Care must be taken to obtain an accurate color of the soil sample immediately upon excavation. The colors should be observed closely and examined again after several minutes. Do not allow the sample to become dry. Dry soils will usually have a different color than wet or moist soils. As always, do not attempt to determine colors while wearing sunglasses. Colors must be obtained in the field under natural light and not under artificial light.

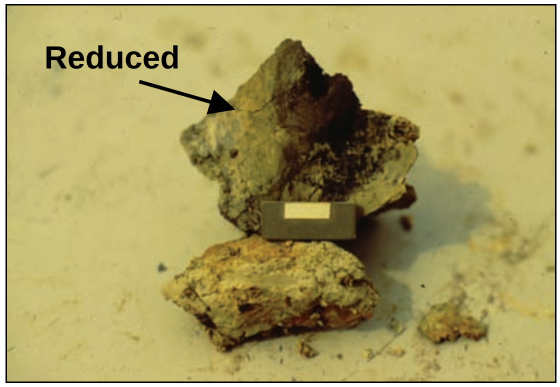

Figure 66. This soil exhibits colors associated with reducing conditions. Scale is 1 cm.

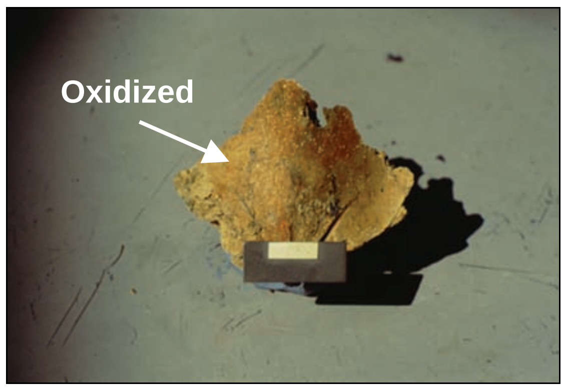

Figure 67. The same soil as in Figure 66 after exposure to the air and oxidation has occurred.

d. If the soil is saturated at the time of sampling, alpha, alpha-dipyridyl can be used in the following procedure to determine if reduced (ferrous) iron is present. If ferrous iron is present as described below, then the soil is hydric.

Alpha, alpha-dipyridyl is a reagent that reacts with reduced iron. In some cases, it can be used to provide evidence that a soil is hydric when it lacks other hydric soil indicators. The soil is likely to be hydric if application of alpha, alpha-dipyridyl to mineral soil material in at least 60 percent of a layer at least 4 in. (10 cm) thick within a depth of 12 in. (30 cm) of the soil surface results in a positive reaction within 30 seconds evidenced by a pink or red coloration to the reagent during the growing season.

Using a dropper, apply a small amount of reagent to a freshly broken ped face to avoid any chance of a false positive test due to iron contamination from digging tools. Look closely at the treated soil for evidence of color change. If in doubt, apply the reagent to a sample of known upland soil and compare the reaction to the sample of interest. A positive reaction will not occur in soils that lack iron and may not occur in soils with high pH. The lack of a positive reaction to the reagent does not preclude the presence of a hydric soil. Specific information about the use of alpha, alpha-dipyridyl can be found in NRCS Hydric Soils Technical Note 8 (http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html).

e. Using gauge data, water-table monitoring data, or repeated direct hydrologic observations, determine whether the soil is ponded or flooded, or the water table is 12 in. (30 cm) or less from the surface, for 14 or more consecutive days during the growing season in most years (at least 5 years in 10, or 50 percent or higher probability) (U.S. Army Corps of Engineers 2005). If so, then the soil is hydric. Furthermore, any soil that meets the NTCHS hydric soil technical standard (NRCS Hydric Soils Technical Note 11, http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html) is hydric.

Wetlands that periodically lack indicators of wetland hydrology

Description of the problem

Wetlands are areas that are flooded or ponded, or have soils that are saturated with water, for long periods during the growing season in most years. If the site is visited during a time of normal precipitation amounts and it is inundated or the water table is near the surface, then the wetland hydrology determination is straightforward. During the dry season, however, surface water recedes from wetland margins, water tables drop, and many wetlands dry out completely. Superimposed on this seasonal cycle is a long-term pattern of multi-year droughts alternating with years of higher-than-average rainfall. Wetlands in general are inundated or saturated at least 5 years in 10 (50 percent or higher probability) over a long-term record. However, some wetlands in the Eastern Mountains and Piedmont Region do not become inundated or saturated in some years and, during drought cycles or prolonged dry conditions, may not inundate or saturate for several years in a row.

Wetland hydrology determinations are based on indicators, many of which were designed to be used during dry periods when the direct observation of surface water or a shallow water table is not possible. However, some wetlands may lack any of the listed hydrology indicators, particularly during the dry season or in a dry year. Examples in the region include some seasonal depressional wetlands (e.g., vernal pools, sinkhole wetlands), wet prairies, sedge meadows, other wet meadows, fens, seeps, and springs. The evaluation of wetland hydrology requires special care on any site where indicators of hydrophytic vegetation and hydric soil are present but hydrology indicators appear to be absent. Among other factors, this evaluation should consider the timing of the site visit in relation to normal seasonal and annual hydrologic variability, and whether the amount of rainfall prior to the site visit has been normal. This section describes a number of approaches that can be used to determine whether wetland hydrology is present on sites where indicators of hydrophytic vegetation and hydric soil are present but hydrology indicators may be lacking due to normal variations in rainfall or runoff, human activities that destroy hydrology indicators, and other factors.

Procedure

1. Verify that indicators of hydrophytic vegetation and hydric soil are present, or are absent due to disturbance or other problem situations. If so, proceed to step 2.

2. Verify that the site is in a landscape position that is likely to collect or concentrate water, such as those listed below. If the landscape setting is appropriate, proceed to step 3.

   a. Concave surface (e.g., depression or swale)
   b. Active floodplain or low terrace
   c. Level or nearly level area (e.g., 0- to 3-percent slope)
   d. Toe slope (Figure 6) or an area of convergent slopes (Figure 5)
   e. Fringe of another wetland or water body
   f. Area with a restrictive soil layer or aquitard within 24 in. (60 cm) of the surface
   g. Area where groundwater discharges (e.g., a seep)
   h. Other (explain in field notes why this area is likely to be inundated or saturated for long periods)

3. Use one or more of the following approaches to determine whether wetland hydrology is present and the site is a wetland. In the remarks section of the data form or in the delineation report, explain the rationale for concluding that wetland hydrology is present even though indicators of

wetland hydrology described in Chapter 4 were not observed.

a. *Site visits during the dry season*. Determine whether the site visit occurred during the normal annual "dry season." The dry season, as used in this supplement, is the period of the year when soil moisture is normally being depleted and water tables are falling to low levels in response to decreased precipitation and/or increased evapotranspiration, usually during late spring and summer. It also includes the beginning of the recovery period in late summer or fall. The Web-Based Water-Budget Interactive Modeling Program (WebWIMP) is one source for approximate dates of wet and dry seasons for any terrestrial location based on average monthly precipitation and estimated evapotranspiration (http://climate.geog.udel.edu/~wimp/). In general, the dry season in a typical year is indicated when potential evapotranspiration exceeds precipitation (indicated by negative values of DIFF in the WebWIMP output), resulting in drawdown of soil moisture storage (negative values of DST) and/or a moisture deficit (positive values of DEF, also called the unmet atmospheric demand for moisture). Actual dates for the dry season vary by locale and year.

   In many wetlands, direct observation of flooding, ponding, or a shallow water table would be unexpected during the dry season. Wetland hydrology indicators, if present, would most likely be limited to indirect evidence, such as water marks, drift deposits, or surface cracks. In some situations, hydrology indicators may be absent during the dry season. If the site visit occurred during the dry season on a site that contains hydric soils and hydrophytic vegetation and no significant hydrologic manipulation (e.g., no dams, levees, water diversions, land grading, etc., and the site is not within the zone of influence of any ditches or subsurface drains), then consider the site to be a wetland. If necessary, revisit the site during the normal wet season and check again for the presence or absence of wetland hydrology indicators, or use one or more of the following evaluation methods.

b. *Periods with below-normal rainfall*. Determine whether the amount of rainfall that occurred in the 2 to 3 months preceding the site visit was normal, above normal, or below normal based on the normal range reported in WETS tables. WETS tables are provided by the NRCS National Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html) and are calculated from long-term (30-year) weather records gathered at National Weather Service meteorological stations. To determine whether precipitation was normal prior to the site visit, actual rainfall in the current month and previous 2 to 3 months should be compared with the normal ranges for each month given in the WETS table (USDA Natural Resources Conservation Service 1997, Sprecher and Warne 2000). The lower and upper limits of the normal range are indicated by the columns labeled “30% chance will have less than” and “30% chance will have more than” in the WETS table. The USDA Natural Resources Conservation Service (1997, Section 650.1903) gives a procedure that can be used to weight the information from each month and determine whether the entire period was normal, wet, or dry.

When precipitation has been below normal, wetlands may not flood, pond, or develop shallow water tables even during the typical wet portion of the growing season and may not exhibit other indicators of wetland hydrology. Therefore, if precipitation was below normal prior to the site visit, and the site contains hydric soils and hydrophytic vegetation and no significant hydrologic manipulation (e.g., no dams, levees, water diversions, land grading, etc., and the site is not within the zone of influence of any ditches or subsurface drains), then consider the site to be a wetland. If necessary, revisit the site during a period of normal rainfall and check again for hydrology indicators, or use one or more of the other evaluation methods described in this section.

c. *Drought years*. Determine whether the area has been subject to drought. Drought periods can be identified by comparing annual rainfall totals with the normal range of annual rainfall given in WETS tables or by examining trends in drought indices, such as the Palmer Drought Severity Index (PDSI) (Sprecher and Warne 2000). PDSI takes into account not only precipitation but also temperature, which affects evapotranspiration, and soil moisture conditions. The index is usually calculated on a monthly basis for major climatic divisions within each state. Therefore, the information is not site-specific. PDSI ranges potentially between –6 and +6 with negative values indicating dry periods and positive values indicating wet periods. An index of –1.0 indicates mild drought, –2.0 indicates moderate drought, –3.0 indicates severe drought, and –4.0 indicates extreme drought. Time-series plots of PDSI values by month or year are available from the National Climatic Data Center at (http://www.ncdc.noaa.gov/oa/climate/onlineprod/drought/xmgr.html#ds). If wetland hydrology indicators appear to be absent on a site that has hydrophytic vegetation and hydric soils, no significant hydrologic manipulation (e.g., no dams, levees, water diversions, land grading, etc., and the site is not within the zone of influence of any ditches or subsurface drains), and the region has been affected by drought, then consider the site to be a wetland. If necessary, revisit the site during a normal rainfall year and check again for wetland hydrology indicators, or use one or more of the other methods described in this section.

d. *Reference sites*. If indicators of hydric soil and hydrophytic vegetation are present on a site that lacks wetland hydrology indicators, the site may be considered to be a wetland if the landscape setting, topography, soils, and vegetation are substantially the same as those on nearby wetland reference areas with known hydrology. Hydrology of wetland reference areas should be documented through long-term monitoring (see item *g* below) or by application of the procedure described in item 5b on page 126 (Direct Hydrologic Observations) of the procedure for Problematic Hydrophytic Vegetation in this chapter. Reference sites should be minimally disturbed and provide long-term access. Soils, vegetation, and hydrologic conditions should be thoroughly documented and the data kept on file in the District or field office.

e. *Hydrology tools*. The "Hydrology Tools" (USDA Natural Resources Conservation Service 1997) is a collection of methods that can be used to determine whether wetland hydrology is present on a potential wetland site that lacks indicators due to disturbance or other reasons, particularly on lands used for agriculture. Generally they require additional information, such as aerial photographs or stream-gauge data, or involve hydrologic modeling and approximation techniques. These methods are not intended to overrule an indicator-based wetland determination on a site that is not disturbed or problematic. A hydrologist may be needed to help select and carry out the proper analysis. The seven hydrology tools are used to:

(1) Analyze stream and lake gauge data
(2) Estimate runoff volumes and determine duration and frequency of ponding in depressional areas, based on precipitation and temperature data, soil characteristics, land cover, and other inputs

(3) Evaluate the frequency of wetness signatures on repeated aerial photography (see item *f* below for additional information)
(4) Model water-table fluctuations in fields with parallel drainage systems using the DRAINMOD model
(5) Estimate the "scope and effect" of ditches or subsurface drain lines
(6) Estimate the effectiveness of agricultural drainage systems using NRCS state drainage guides
(7) Analyze data from groundwater monitoring wells (see item *g* below for additional information)

f. *Evaluating multiple years of aerial photography*. Each year, the Farm Service Agency (FSA) takes low-level aerial photographs in agricultural areas to monitor the acreages planted in various crops for USDA programs. NRCS has developed an off-site procedure that uses these photos, or repeated aerial photography from other sources, to make wetland hydrology determinations (USDA Natural Resources Conservation Service 1997, Section 650.1903). The method is intended for use on agricultural lands where human activity has altered or destroyed other wetland indicators. However, the same approach may be useful in other environments.

The procedure uses five or more years of growing-season photography and evaluates each photo for wetness signatures that are listed in "wetland mapping conventions" developed by NRCS state offices. Wetland mapping conventions can be found in the electronic Field Office Technical Guide (eFOTG) for each state (http://www.nrcs.usda.gov/technical/efotg/). From the national web site, choose the appropriate state, then select any county (the state's wetland mapping conventions are the same in every county). Wetland mapping conventions are listed among the references in Section I of the eFOTG. However, not all states have wetland mapping conventions.

Wetness signatures for a particular state may include surface water, saturated soils, flooded or drowned-out crops, stressed crops due to wetness, differences in vegetation patterns due to different planting dates, inclusion of wet areas into set-aside programs, unharvested crops, isolated areas that are not farmed with the rest of the field, patches of greener vegetation during dry periods, and other evidence of wet conditions (see Part 513.30 of USDA Natural Resources Conservation Service 1994). For each photo, the procedure described in item *b* above is used to determine whether the amount of rainfall in the 2 to 3 months prior to the date of the photo was normal, below normal, or above normal. Only photos taken in normal rainfall years, or an equal number of wetter-than-normal and drier-than-normal years, are used in the analysis. If wetness signatures are observed on photos in more than half of the years included in the analysis, then wetland hydrology is present. Data forms that may be used to document the wetland hydrology determination are given in section 650.1903 of USDA Natural Resources Conservation Service (1997).

g. *Long-term hydrologic monitoring*. On sites where the hydrology has been manipulated by man (e.g., with ditches, subsurface drains, dams, levees, water diversions, land grading) or where natural events (e.g., downcutting of streams) have altered conditions such that hydrology indicators may be missing or misleading, direct monitoring of surface and groundwater may be needed to determine the presence or absence of wetland hydrology. The U.S. Army Corps of Engineers (2005) provides minimum standards for the design, construction, and installation of water-table monitoring wells, and for the collection and interpretation of groundwater monitoring data, in cases where direct hydrologic measurements are needed to determine whether wetlands are present on highly disturbed or problematic sites. This standard calls for 14 or more consecutive days of flooding, ponding, or a water table 12 in. (30 cm) or less below the soil surface during the growing season at a minimum frequency of 5 years in 10 (50 percent or higher probability), unless a different standard has been established for a particular geographic area or wetland type. A disturbed or problematic site that meets this standard has wetland hydrology. This standard is not intended (1) to overrule an indicator-based wetland determination on a site that is not disturbed or problematic, or (2) to test or validate existing or proposed wetland indicators.

Wetland/non-wetland mosaics

Description of the problem

In this supplement, “mosaic” refers to a landscape where wetland and non-wetland components are too closely associated to be easily delineated or mapped separately. These areas often have complex microtopography, with repeated small changes in elevation occurring over short distances. Tops of ridges and hummocks are often non-wetland but are interspersed throughout a wetland matrix having clearly hydrophytic vegetation, hydric soils, and wetland hydrology. Examples of wetland/non-wetland mosaics in the Eastern Mountains and Piedmont Region include ridge-and-swale topography in floodplains, areas containing numerous depressional wetlands, some forested flats, pit-and-mound topography, and areas containing hummocks.

Wetland components of a mosaic are often not difficult to identify. The problem for the wetland delineator is that microtopographic features are too small and intermingled, and there are too many such features per acre, to delineate and map them accurately. Instead, the following sampling approach can be used to estimate the percentage of wetland in the mosaic. From this, the number of acres of wetland on the site can be calculated, if needed.

Procedure

First, identify and flag all contiguous areas of either wetland or non-wetland on the site that are large enough to be delineated and mapped separately. The remaining area should be mapped as “wetland/non-wetland mosaic” and the approximate percentage of wetland within the area determined by the following procedure.

1. Establish one or more continuous line transects across the mosaic area, as needed. Measure the total length of each transect. A convenient method is to stretch a measuring tape along the transect and leave it in place while sampling. If the site is shaped appropriately and multiple transects are used, they should be arranged in parallel with each transect starting from a random point along one edge of the site. However, other arrangements of transects may be needed for oddly shaped sites.

2. Use separate data forms for the swale or trough and for the ridges or hummocks. Sampling of vegetation, soil, and hydrology should follow the general procedures described in the Corps Manual and this supplement. Plot sizes and shapes for vegetation sampling must be adjusted to fit the microtopographic features on the site. Plots intended to sample the troughs should not overlap adjacent hummocks, and vice versa. Only one or two data forms are required for each microtopographic position, and do not need to be repeated for similar features or plant communities.

3. Identify every wetland boundary in every trough or swale encountered along each transect. Each boundary location may be marked with a pin flag or simply recorded as a distance along the stretched tape.

4. Determine the total distance along each transect that is occupied by wetlands and non-wetlands until the entire length of the line has been accounted for. Sum these distances across transects, if needed. Determine the percentage of wetland in the wetland/non-wetland mosaic by the following formula.

$$\%\ wetland = \frac{Total\ wetland\ distance\ along\ all\ transects}{Total\ length\ of\ all\ transects} \times 100$$

An alternative approach involves point-intercept sampling at fixed intervals along transects across the area designated as wetland/non-wetland mosaic. This method avoids the need to identify wetland boundaries in each swale, and can be carried out by pacing rather than stretching a measuring tape across the site. The investigator uses a compass or other means to follow the selected transect line. At a fixed number of paces (e.g., every two steps) the wetland status of that point is determined by observing indicators of hydrophytic vegetation, hydric soil, and wetland hydrology. Again, a completed data form is not required at every point but at least one representative swale and hummock should be documented with completed forms. After all transects have been sampled, the result is a number of wetland sampling points and a number of non-wetland points. Estimate the percentage of wetland in the wetland/non-wetland mosaic by the following formula:

$$\%\ wetland = \frac{Number\ of\ wetland\ points\ along\ all\ transects}{Total\ number\ of\ points\ sampled\ along\ all\ transects} \times 100$$

If high-quality aerial photography is available for the site, a third approach to estimating the percentage of wetland in a wetland/non-wetland mosaic is to use a dot grid, planimeter, or geographic information system (GIS) to determine the percentage of ridges (non-wetlands) and swales (wetlands) through photo interpretation of topography and vegetation patterns. This technique requires onsite verification that most ridges qualify as non-wetlands and most swales qualify as wetlands.

References

Arkansas Multi-Agency Wetland Planning Team. 2003. *Classification of Arkansas wetlands.* (http://www.mawpt.org/wetlands/classification/classes.asp)

Atwood, W. W. 1940. *The physiographic provinces of North America*. Waltham, MA: Blaisdell.

Bailey, R. G. 1995. *Description of the ecoregions of the United States, second edition*. Miscellaneous Publication 1391 (revised). Washington, DC: U.S. Department of Agriculture, Forest Service. (http://www.fs.fed.us/land/ecosysmgmt/ecoreg1_home.html)

Bales, J. D., and D. J. Newcomb. 1996. *North Carolina wetland resources*. Water-Supply Paper 2425. Washington, DC: U.S. Department of the Interior, Geological Survey.

Barbour, M. G., and W. D. Billings, eds. 1988. *North American terrestrial vegetation*. New York, NY: Cambridge University Press.

Barbour, M.G., J. H. Burk, W. D. Pitts, F. S. Gilliam, and M. W. Schwartz. 1999. *Terrestrial plant ecology, third edition*. Toronto, Canada: Addison Wesley.

Barkley, T. M., ed. 1986. *Flora of the Great Plains*. Lawrence, KS: University Press of Kansas.

Brinson, M. M. 1993. *A hydrogeomorphic classification for wetlands*. Technical Report WRP-DE-4. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station. (http://el.erdc.usace.army.mil/wetlands/pdfs/wrpde4.pdf)

Brohman, R. J., and L. D. Bryant, eds. 2005. *Existing vegetation classification and mapping technical guide, version 1.0*. General Technical Report WO-67. Washington, DC: U.S. Department of Agriculture, Forest Service.

Call, G. 2003. Investigation of vegetation and hydric soil indicators in flats and depressions of Arnold Air Force Base, Tennessee. M. S. thesis. Cookeville, TN: Tennessee Technological University.

Carr, D. W., D. A. Leeper, and T. F. Rochow. 2006. Comparison of six biologic indicators of hydrology and the landward extent of hydric soils in west-central Florida, USA, cypress domes. *Wetlands* 26: 1012-1019.

Colburn, E. A. 2004. *Vernal pools: Natural history and conservation*. Blacksburg, VA: McDonald and Woodward.

Cox, G. 1990. *Laboratory manual of general ecology, sixth edition*. Dubuque, IA: William C. Brown.

Dahl, T. E. 1991. *Wetland resources of the United States*. National Wetlands Inventory map. St. Petersburg, FL: U.S. Fish and Wildlife Service.

Darst, M. R., and H. M. Light. 1996. *Georgia wetland resources*. Water-Supply Paper 2425. Washington, DC: U.S. Department of the Interior, Geological Survey.

Environmental Laboratory. 1987. *Corps of Engineers wetlands delineation manual*. Technical Report Y-87-1. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station. (http://el.erdc.usace.army.mil/wetlands/pdfs/wlman87.pdf)

Frankenberger, J., E. Kladivko, G. Sands, D. Jaynes, N. Fausey, M. Helmers, R. Cooke, J. Strock, K. Nelson, and L. Brown. 2006. *Questions and answers about drainage water management for the Midwest*. Report WQ-44. West Lafayette, IN: Purdue University Cooperative Extension Service. (http://www.ces.purdue.edu/extmedia/WQ/WQ-44.pdf)

Freeze, R. A., and J. A. Cherry. 1979. *Groundwater*. Englewood Cliffs, NJ: Prentice-Hall.

Gretag/Macbeth. 2000. *Munsell® color*. New Windsor, NY.

Haag, K. H., and C. J. Taylor. 1996. *Kentucky wetland resources*. Water-Supply Paper 2425. Washington, DC: U.S. Department of the Interior, Geological Survey.

Hayes, M. A. 1996. *Maryland and the District of Columbia wetland resources*. Water-Supply Paper 2425. Washington, DC: U.S. Department of the Interior, Geological Survey.

Heath, R. C. 1984. *Ground-water regions of the United States*. Water-Supply Paper 2242. Washington, DC: U.S. Department of the Interior, Geological Survey.

Hunt, C. B. 1974. *Natural regions of the United States and Canada*. San Francisco, CA: Freeman.

Hurt, G. W., and J. M. Galbraith. 2005. Using soil morphology and soil survey data for restoring and creating wetlands. *Soil Survey Horizons* 46(3): 109-119.

Jones, R. L. 2005. Plant life of Kentucky: An illustrated guide to the vascular flora. Lexington, KY: University Press of Kentucky.

Kartesz, J. T. 2010. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland, second edition. In: J. T. Kartesz, *Floristic synthesis of North America, version 1* (in press).

Keddy, P. A. 2000. *Wetland ecology: Principles and conservation*. New York, NY: Cambridge University Press.

Kent, M., and P. Coker. 1992. Vegetation description and analysis: A practical approach. New York, NY: Wiley.

Küchler, A. W. 1985. *Potential natural vegetation (revised)*. Map sheet in National Atlas of the United States. Reston, VA: U.S. Geological Survey.

Little, M., and M. C. Waldron. 1996. *West Virginia wetland resources*. Water-Supply Paper 2425. Washington, DC: U.S. Department of the Interior, Geological Survey.

Meador, M. R. 1996. *Tennessee wetland resources*. Water-Supply Paper 2425. Washington, DC: U.S. Department of the Interior, Geological Survey.

Megonigal, J. P., S. P. Faulkner, and W. H. Patrick. 1996. The microbial activity season in southeastern hydric soils. *Soil Science Society of America Journal* 60: 1263-1266.

Mueller-Dombois, D., and H. Ellenberg. 1974. *Aims and methods of vegetation ecology*. New York, NY: Wiley.

National Research Council. 1995. *Wetlands: Characteristics and boundaries*. Washington, DC: National Academy Press.

Rabenhorst, M.C. and S. Parikh. 2000. Propensity of soils to develop redoximorphic color changes. *Soil Science Society of America Journal* 64:1904-1910.

Reed, P. B., Jr. 1988. *National list of plant species that occur in wetlands: 1988 national summary*. Biological Report 88(24). Washington, DC: U.S. Fish and Wildlife Service. (http://geo.usace.army.mil/wetland_plants/index.html)

Roberts, T. H., K. L. Morgan, and M. S. Peterson. 2003. *Inventory and classification of wetlands at Kings Mountain National Military Park*. Mammoth Cave, KY: U.S. Department of the Interior, National Park Service, Cumberland Piedmont Network.

Shaw, J. N., and M. C. Rabenhorst. 1997. The geomorphology, characteristics, and origin of the freshwater marl sediments in the Great Limestone Valley, Maryland, USA. *Catena* 30: 41-59.

Society of American Foresters. 1980. *Forest cover types of the United States and Canada*, ed. F. H. Eyre. Washington, DC.

Sprecher, S. W., and A. G. Warne. 2000. *Accessing and using meteorological data to evaluate wetland hydrology*. ERDC/EL TR-WRAP-00-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center. (http://el.erdc.usace.army.mil/elpubs/pdf/wrap00-1/wrap00-1.pdf)

Strausbaugh, P. D., and E. L. Core. 1978. *Flora of West Virginia, second edition*. Morgantown, WV: Seneca Books.

Tiner, R. W. 1990. *Pennsylvania's wetlands: Current status and recent trends*. Newton Corner, MA: U.S. Fish and Wildlife Service.

Tiner, R. W. 1996. *Current status of West Virginia's wetlands: Results of the National Wetlands Inventory*. Hadley, MA: U.S. Fish and Wildlife Service.

Tiner, R. W. 1999. *Wetland indicators: A guide to wetland identification, delineation, classification, and mapping*. Boca Raton, FL: Lewis Publishers.

Tiner, R. W., and D. G. Burke. 1995. *Wetlands of Maryland*. Cooperative publication. Hadley, MA: U.S. Fish and Wildlife Service, and Annapolis, MD: Maryland Dept. of Natural Resources. (http://library.fws.gov/Wetlands/MD_wetlands85.pdf)

U.S. Army Corps of Engineers. 2005. *Technical standard for water-table monitoring of potential wetland sites*. ERDC TN-WRAP-05-02. Vicksburg, MS: U.S. Army Engineer Research and Development Center. (http://el.erdc.usace.army.mil/wrap/pdf/tnwrap05-2.pdf)

U.S. Army Corps of Engineers. 2008. *Interim regional supplement to the Corps of Engineers wetland delineation manual: Atlantic and Gulf Coastal Plain Region*. ed. J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-08-30. Vicksburg, MS: U.S. Army Engineer Research and Development Center. (http://el.erdc.usace.army.mil/elpubs/pdf/trel08-30.pdf)

U.S. Army Corps of Engineers. 2010. National wetland plant list. (http://geo.usace.army.mil/wetland_plants/index.html).

USDA Natural Resources Conservation Service. 1994. *National food security act manual, third edition* (as amended). Washington, DC.

USDA Natural Resources Conservation Service. 1997. *Hydrology tools for wetland determination*. Chapter 19, Engineering Field Handbook. Fort Worth, TX: U.S. Department of Agriculture. (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/wetlands/boundaries)

USDA Natural Resources Conservation Service. 1999. *Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys*. Agriculture Handbook 436. Washington, DC: U.S. Department of Agriculture. (http://soils.usda.gov/technical/classification/taxonomy/)

USDA Natural Resources Conservation Service. 2002. *Field book for describing and sampling soils, Version 2.0*. ed. P. J. Schoeneberger, D. A. Wysocki, E. C. Benham, and W. D. Broderson. Lincoln, NE: National Soil Survey Center. (http://soils.usda.gov/technical/fieldbook/)

USDA Natural Resources Conservation Service. 2005. *National soil survey handbook, part 629, glossary*. Washington, DC: U.S. Department of Agriculture. (ftp://ftp-fc.sc.egov.usda.gov/NSSC/Soil_Survey_Handbook/629_glossary.pdf)

USDA Natural Resources Conservation Service. 2006. *Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin*. Agriculture Handbook 296. Washington, DC: U.S. Department of Agriculture. (http://soils.usda.gov/survey/geography/mlra/index.html)

USDA Natural Resources Conservation Service. 2010. *Field indicators of hydric soils in the United States, version 7.0*. ed. L. M. Vasilas, G. W. Hurt, and C. V. Noble. Washington, DC: USDA NRCS in cooperation with the National Technical Committee for Hydric Soils. (http://soils.usda.gov/use/hydric/)

USDA Soil Conservation Service. 1994. *Changes in hydric soils of the United States*. Federal Register 59(133): 35680-35681, July 13, 1994.

USDI Bureau of Land Management. 1996. *Sampling vegetation attributes*. BLM/RS/ST-96/002+1730. Denver, CO.

U.S. Geological Survey (USGS). 2004. *A tapestry of time and terrain*. Web application accessed 14 August 2008 (http://tapestry.usgs.gov/Default.html).

Vepraskas, M. J. 1992. *Redoximorphic features for identifying aquic conditions*. Technical Bulletin 301. Raleigh, NC: North Carolina Agricultural Research Service, North Carolina State Univ.

Vepraskas, M. J., and S. W. Sprecher. 1997. *Aquic conditions and hydric soils: The problem soils*. Special Publication Number 50. Madison, WI: Soil Science Society of America.

Wakeley, J. S., and R. W. Lichvar. 1997. Disagreement between plot-based prevalence indices and dominance ratios in evaluations of wetland vegetation. *Wetlands* 17: 301-309.

Wentworth, T. R., G. P. Johnson, and R. L. Kologiski. 1988. Designation of wetlands by weighted averages of vegetation data: A preliminary evaluation. *Water Resources Bulletin* 24: 389-396.

Wharton, C. H., W. M. Kitchens, E. C. Pendleton, and T. W. Sipe. 1982. *The ecology of bottomland hardwood swamps of the Southeast: A community profile.* FWS/OBS-81/37. Washington, DC: U.S. Fish and Wildlife Service.

Winter, T. C., and M. Woo. 1990. Hydrology of lakes and wetlands. In *The geology of North America: Surface water hydrology*, ed. M. G. Wolman and H. C. Riggs, 159-187. Boulder, CO: Geological Society of America.

Wolfe, W. J. 1996. Karst wetlands of The Barrens, a geomorphic control of wetland hydrology and plant distribution on the Highland Rim of Tennessee. Ph. D. diss. Worcester, MA: Clark University.

Appendix A: Glossary

This glossary is intended to supplement those given in the Corps Manual and other available sources. See the following publications for terms not listed here:

- Corps Manual (Environmental Laboratory 1987) (http://el.erdc.usace.army.mil/wetlands/pdfs/wlman87.pdf) or current version.
- Field Indicators of Hydric Soils in the United States (USDA Natural Resources Conservation Service 2010) (http://soils.usda.gov/use/hydric/).
- National Soil Survey Handbook, Part 629 (USDA Natural Resources Conservation Service 2005) (ftp://ftp-fc.sc.egov.usda.gov/NSSC/Soil_Survey_Handbook/629_glossary.pdf).

Absolute cover. In vegetation sampling, the percentage of the ground surface that is covered by the aerial portions (leaves and stems) of a plant species when viewed from above. Due to overlapping plant canopies, the sum of absolute cover values for all species in a community or stratum may exceed 100 percent. In contrast, “relative cover” is the absolute cover of a species divided by the total coverage of all species in that stratum, expressed as a percent. Relative cover cannot be used to calculate the prevalence index.

Aquitard. A layer of soil or rock that retards the downward flow of water and is capable of perching water above it. For the purposes of this supplement, the term aquitard also includes the term aquiclude, which is a soil or rock layer that is incapable of transmitting significant quantities of water under ordinary hydraulic gradients. Examples of aquitards include fragipans, cemented layers, lacustrine deposits, and clay layers.

Contrast. The color difference between a redox concentration and the dominant matrix color. Differences are classified as faint, distinct, or prominent and are defined in the glossary of USDA Natural Resources Conservation Service (2010) and illustrated in Table A1.

Table A1. Tabular key for contrast determinations using Munsell notation.

Hues are the same (Δ h = 0)			Hues differ by 2 pages (Δ h = 2)		
Δ Value	Δ Chroma	Contrast	Δ Value	Δ Chroma	Contrast
0	≤1	Faint	0	0	Faint
0	2	Distinct	0	1	Distinct
0	3	Distinct	0	≥2	Prominent
0	≥4	Prominent	1	≤1	Distinct
1	≤1	Faint	1	≥2	Prominent
1	2	Distinct	≥2	---	Prominent
1	3	Distinct			
1	≥4	Prominent			
≤2	≤1	Faint			
≤2	2	Distinct			
≤2	3	Distinct			
≤2	≥4	Prominent			
3	≤1	Distinct			
3	2	Distinct			
3	3	Distinct			
3	≥4	Prominent			
≥4	---	Prominent			
Hues differ by 1 page (Δ h = 1)			**Hues differ by 3 or more pages (Δ h ≥ 3)**		
Δ Value	Δ Chroma	Contrast	Δ Value	Δ Chroma	Contrast
0	≤1	Faint	Color contrast is prominent, except for low chroma and value.		Prominent
0	2	Distinct			
0	≥3	Prominent			
1	≤1	Faint			
1	2	Distinct			
1	≥3	Prominent			
2	≤1	Distinct			
2	2	Distinct			
2	≥3	Prominent			
≥3	---	Prominent			

Note: If both colors have values of ≤3 and chromas of ≤2, the color contrast is Faint (regardless of the difference in hue).

Adapted from USDA Natural Resources Conservation Service (2002)

Depleted matrix. The volume of a soil horizon or subhorizon from which iron has been removed or transformed by processes of reduction and translocation to create colors of low chroma and high value. A, E, and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix. However, they are excluded from the concept of depleted matrix unless common or many, distinct or prominent redox concentrations as soft masses or pore linings are present. In some places the depleted matrix may change color upon exposure to air (reduced matrix); this phenomenon is included in the concept of depleted matrix. The following combinations of value and chroma identify a depleted matrix:

- Matrix value of 5 or more and chroma of 1, with or without redox concentrations occurring as soft masses and/or pore linings, or
- Matrix value of 6 or more and chroma of 2 or 1, with or without redox concentrations occurring as soft masses and/or pore linings, or
- Matrix value of 4 or 5 and chroma of 2, with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings, or
- Matrix value of 4 and chroma of 1, with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings (USDA Natural Resources Conservation Service 2010).

Common (2 to less than 20 percent) to many (20 percent or more) redox concentrations (USDA Natural Resources Conservation Service 2002) are required in soils with matrix colors of 4/1, 4/2, and 5/2 (Figure A1). Redox concentrations include iron and manganese masses and pore linings (Vepraskas 1992). See “contrast” in this glossary for the definitions of “distinct” and “prominent.”

Diapause. A period during which growth or development is suspended and physiological activity is diminished, as in certain aquatic invertebrates in response to drying of temporary wetlands.

Distinct. See Contrast.

Episaturation. Condition in which the soil is saturated with water at or near the surface, but also has one or more unsaturated layers below the saturated zone. The zone of saturation is perched on top of a relatively impermeable layer.

Figure A1. Illustration of values and chromas that require 2 percent or more distinct or prominent redox concentrations and those that do not, for hue 10YR, to meet the definition of a depleted matrix. *Due to inaccurate color reproduction, do not use this page to determine soil colors in the field.* Background image from the Munsell Soil Color Charts reprinted courtesy of Munsell Color Services Lab, a part of X-Rite, Inc. (Gretag/Macbeth 2000).

Fragmental soil material. Soil material that consists of 90 percent or more rock fragments; less than 10 percent of the soil consists of particles 2 mm or smaller (USDA Natural Resources Conservation Service 2010).

Gleyed matrix. A gleyed matrix has one of the following combinations of hue, value, and chroma and the soil is not glauconitic (Figure A2):

Figure A2. For hydric soil determinations, a gleyed matrix has the hues and chroma identified in this illustration with a value of 4 or more. *Due to inaccurate color reproduction, do not use this page to determine soil colors in the field.* Background image from the Munsell Soil Color Charts reprinted courtesy of Munsell Color Services Lab, a part of X-Rite, Inc. (Gretag/Macbeth 2000).

- 10Y, 5GY, 10GY, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value of 4 or more and chroma of 1; or
- 5G with value of 4 or more and chroma of 1 or 2; or
- N with value of 4 or more (USDA Natural Resources Conservation Service 2010).

Growing season. In the Eastern Mountains and Piedmont Region, growing season dates are determined through onsite observations of the following indicators of biological activity in a given year: (1) above-ground growth and development of vascular plants and/or (2) soil temperature (see Chapter 4 for details). If onsite data gathering is not practical, growing season dates may be approximated by using WETS tables available from the NRCS National Water and Climate Center to determine the median dates of 28 °F (−2.2 °C) air temperatures in spring and fall based on long-term records gathered at the nearest appropriate National Weather Service meteorological station.

High pH. pH of 7.9 or higher. Includes Moderately Alkaline, Strongly Alkaline, and Very Strongly Alkaline (USDA Natural Resources Conservation Service 2002).

Hummock. A low mound, ridge, or microtopographic high. In wet areas, plants growing on hummocks may avoid some of the deleterious effects of inundation or shallow water tables.

Marl. An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions, formed primarily under freshwater lacustrine conditions (USDA Natural Resources Conservation Service 2010).

Nodules and concretions. Irregularly shaped, firm to extremely firm accumulations of iron and manganese oxides. When broken open, nodules have uniform internal structure whereas concretions have concentric layers (Vepraskas 1992).

Prominent. See Contrast.

Red parent material. Parent material with a natural inherent reddish color attributable to the presence of iron oxides occurring as coatings on and occluded within the mineral grains. Soils that formed in red parent material have conditions that greatly retard the development and extent of the redoximorphic features that normally occur under prolonged aquic conditions. Most commonly, the material consists of dark red, consolidated Mesozoic or Paleozoic sedimentary rocks, such as shale, siltstone, and sandstone, or alluvial materials derived from such rocks. Assistance from a local soil scientist may be needed to determine where red parent material occurs.

Reduced matrix. Soil matrix that has a low chroma in situ due to presence of reduced iron, but whose color changes in hue or chroma when exposed to air as Fe^{2+} is oxidized to Fe^{3+} (Vepraskas 1992).

Saturation. For wetland delineation purposes, a soil layer is saturated if virtually all pores between soil particles are filled with water (National Research Council 1995, Vepraskas and Sprecher 1997). This definition includes part of the capillary fringe above the water table (i.e., the tension-saturated zone) in which soil water content is approximately equal to that below the water table (Freeze and Cherry 1979).

Throughflow. Lateral movement of groundwater in saturated substrates, such as on sloping terrain.

Tussock. A plant growth form, generally in grasses or sedges, in which plants grow in tufts or clumps bound together by roots and elevated above the substrate.

Appendix B: Point-Intercept Sampling Procedure for Determining Hydrophytic Vegetation

The following procedure for point-intercept sampling is an alternative to plot-based sampling methods to estimate the abundance of plant species in a community. The approach may be used with the approval of the appropriate Corps of Engineers District to evaluate vegetation as part of a wetland delineation. Advantages of point-intercept sampling include better quantification of plant species abundance and reduced bias compared with visual estimates of cover. The method is useful in communities with high species diversity, and in areas where vegetation is patchy or heterogeneous, making it difficult to identify representative locations for plot sampling. Disadvantages include the increased time required for sampling and the need for vegetation units large enough to permit the establishment of one or more transect lines within them. The approach also assumes that soil and hydrologic conditions are uniform across the area where transects are located. In particular, transects should not cross the wetland boundary. Point-intercept sampling is generally used with a transect-based prevalence index (see below) to determine whether vegetation is hydrophytic.

In point-intercept sampling, plant occurrence is determined at points located at fixed intervals along one or more transects established in random locations within the plant community or vegetation unit. If a transect is being used to sample the vegetation near a wetland boundary, the transect should be placed parallel to the boundary and should not cross either the wetland boundary or into other communities. Usually a measuring tape is laid on the ground and used for the transect line. Transect length depends upon the size and complexity of the plant community and may range from 100 to 300 ft (30 to 90 m) or more. Plant occurrence data are collected at fixed intervals along the line, for example every 2 ft (0.6 m). At each interval, a “hit” on a species is recorded if a vertical line at that point would intercept the stem or foliage of that species. Only one “hit” is recorded for a species at a point even if the same species would be intercepted more than once at that point. Vertical intercepts can be determined using a long pin or rod protruding into and through the various vegetation layers, a sighting device (e.g., for the canopy), or an imaginary vertical line. The total number of "hits" for each species along the transect is then determined. The result is a list of species and their frequencies of occurrence along the line (Mueller-Dombois and Ellenberg 1974, Tiner 1999). Species are then categorized by wetland indicator status (i.e., OBL, FACW, FAC, FACU, or UPL), the total number of hits determined within each category, and the data used to calculate a transect-based prevalence index. The formula is similar to that given in Chapter 2 for the plot-based prevalence index (see Indicator 3), except that frequencies are used in place of cover estimates. The community is hydrophytic if the prevalence index is 3.0 or less. To be valid, more than 80 percent of "hits" on the transect must be of species that have been identified correctly and placed in an indicator category.

The transect-based prevalence index is calculated using the following formula:

$$PI = \frac{F_{OBL} + 2F_{FACW} + 3F_{FAC} + 4F_{FACU} + 5F_{UPL}}{F_{OBL} + F_{FACW} + F_{FAC} + F_{FACU} + F_{UPL}}$$

where:

PI = prevalence index
F_{OBL} = frequency of obligate (OBL) plant species;
F_{FACW} = frequency of facultative wetland (FACW) plant species;
F_{FAC} = frequency of facultative (FAC) plant species;
F_{FACU} = frequency of facultative upland (FACU) plant species;
F_{UPL} = frequency of upland (UPL) plant species.

Appendix C: Data Form Incorporating Four Vegetation Strata

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: ______________________ City/County: ______________ Sampling Date:

Applicant/Owner: ______________________________ State: ______ Sampling Point:

Investigator(s): ______________________ Section, Township, Range:

Landform (hillslope, terrace, etc.): ____________ Local relief (concave, convex, none): __________ Slope (%):

Subregion (LRR or MLRA): ________ Lat: ____________ Long: ____________ Datum:

Soil Map Unit Name: ______________________________ NWI classification:

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation _____, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No

Are Vegetation _____, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _______ No	**Is the Sampled Area within a Wetland? Yes _______ No**
Hydric Soil Present?	Yes _______ No	
Wetland Hydrology Present?	Yes _______ No	

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No _____	Depth (inches):	
Water Table Present?	Yes _____	No _____	Depth (inches):	
Saturation Present? (includes capillary fringe)	Yes _____	No _____	Depth (inches):	**Wetland Hydrology Present? Yes ______ No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point:____________

Tree Stratum (Plot size: ____________)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	______ = Total Cover		

Sapling/Shrub Stratum (Plot size:____________)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	______ = Total Cover		

Herb Stratum (Plot size: ____________)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	______ = Total Cover		

Woody Vine Stratum (Plot size: ____________)			
1.			
2.			
3.			
4.			
5.			
6.			
	______ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: __________ (A)

Total Number of Dominant Species Across All Strata: __________ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: __________ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	________	x 1 =
FACW species	________	x 2 =
FAC species	________	x 3 =
FACU species	________	x 4 =
UPL species	________	x 5 =
Column Totals:	________ (A)	________ (B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** _____ **No**

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point:______________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ 2 cm Muck (A10) **(LRR N)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7)
___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
___ Thin Dark Surface (S9) **(MLRA 147, 148)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
___ Umbric Surface (F13) **(MLRA 136, 122)**
___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10) **(MLRA 147)**
___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type:

Depth (inches):

Hydric Soil Present? Yes ______ No

Remarks:

Appendix D: Data Form Incorporating Five Vegetation Strata

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: ________________ City/County: ________________ Sampling Date:
Applicant/Owner: ________________ State: ________ Sampling Point:
Investigator(s): ________________ Section, Township, Range:
Landform (hillslope, terrace, etc.): ________________ Local relief (concave, convex, none): ________________ Slope (%):
Subregion (LRR or MLRA): ________ Lat: ________________ Long: ________________ Datum:
Soil Map Unit Name: ________________ NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ______ No Hydric Soil Present? Yes ______ No Wetland Hydrology Present? Yes ______ No	**Is the Sampled Area within a Wetland?**	**Yes ______ No**
Remarks:		

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No _____	Depth (inches):	
Water Table Present?	Yes _____	No _____	Depth (inches):	
Saturation Present? (includes capillary fringe)	Yes _____	No _____	Depth (inches):	**Wetland Hydrology Present? Yes ______ No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point:____________

Tree Stratum (Plot size: ________)	Absolute % Cover	Dominant Species?	Indicator Status
1.______			
2.______			
3.______			
4.______			
5.______			
6.______			
7.______			
	________ = Total Cover		

Sapling Stratum (Plot size: ________)			
1.______			
2.______			
3.______			
4.______			
5.______			
6.______			
7.______			
	________ = Total Cover		

Shrub Stratum (Plot size: ________)			
1.______			
2.______			
3.______			
4.______			
5.______			
6.______			
7.______			
	________ = Total Cover		

Herb Stratum (Plot size: ________)			
1.______			
2.______			
3.______			
4.______			
5.______			
6.______			
7.______			
8.______			
9.______			
10.______			
11.______			
12.______			
	________ = Total Cover		

Woody Vine Stratum (Plot size: ________)			
1.______			
2.______			
3.______			
4.______			
5.______			
	________ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ________ (A)

Total Number of Dominant Species Across All Strata: ________ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ________ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 =
FACW species	______	x 2 =
FAC species	______	x 3 =
FACU species	______	x 4 =
UPL species	______	x 5 =
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** ______ **No**

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: ____________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type:

Depth (inches):

Hydric Soil Present? Yes ______ No

Remarks:

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
April 2012

2. REPORT TYPE
Final report

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
U.S. Army Corps of Engineers

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Research and Development Center
Environmental Laboratory
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

8. PERFORMING ORGANIZATION REPORT NUMBER
ERDC/EL TR-12-9

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Headquarters, U.S. Army Corps of Engineers
Washington, DC 20314-1000

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved to public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual, which provides technical guidance and procedures for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act. The development of Regional Supplements is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. This supplement is applicable to the Eastern Mountains and Piedmont Region, which consists of all or portions of the District of Columbia and 20 states: Alabama, Arkansas, Delaware, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Missouri, North Carolina, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia.

15. SUBJECT TERMS

Delineation	Plant communities	Vegetation
Hydrology	Soil	Wetlands

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		179	