Guidance for Stream Restoration Based on Key Wildlife Habitats:

Piedmont and Coastal Plain Streams with Associated Wetlands

2023

Prepared by:

Maryland Department of the Environment

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Introduction

This guidance has been developed to help address a specific management need for stream restoration projects proposed under the approved watershed implementation plan (WIP) for the Chesapeake Bay and the State of Maryland and its local jurisdictions to meet waste load allocations for reducing nutrients and sediment. Certain practices eligible for credit toward load reductions (stream restoration, shoreline stabilization, and wetland restoration) typically require MDE authorizations, and hundreds to thousands of additional applications are anticipated over the next few years. Although MDE relies on existing policies, methods, guidance and tools to process incoming applications in a timely manner, MDE is seeking to continuously improve its methods, approaches and tools to ensure that these activities are effective in their restoration goals and that the processes MDE uses to review these activities are predictable and efficient for applicants.

This updated guidance for stream restoration projects with adjacent wetlands replaces previous guidance and an assessment for the Upper Coastal Plain (Western Shore), completed in 2021. This new guidance covers similar projects in the Piedmont physiographic region, as well as the entire Coastal Plain (Western and Eastern Shore), including slow flowing blackwater streams found primarily on the Lower Coastal Plain (Eastern Shore) of Maryland and some areas occurring in the Upper Coastal Plain of the Western Shore.

Most stream restoration projects are proposed in areas clearly degraded as a result of excessive stormwater flows and/or other nutrient and sediment inputs from eroding banks. This often results in an incised stream channel as it adjusts to higher discharges and a disconnection between streamflow and the floodplain, along with subsequent loss or decline of associated processes for retention of transported sediment and retention/transformation of nutrients. Floodplains and wetlands within the riparian area may have been altered by changes in inundation and saturation, resulting in plant community shifts that represent less beneficial habitat. However, there are areas where the stream and associated wetland resources in the riparian area have more limited degradation and still provide habitat benefits that would potentially be lost if the restoration design did not consider the existing resource condition. The debate over tradeoffs between a design objective of maximizing reduction of nutrients and sediment versus improving a riparian corridor as an integrated system with multiple benefits can lead to delays in the approval and construction of a project.

Especially in sensitive areas like wetlands, basic restoration principles should be followed, such as:

- Do no harm;
- Minimize disturbance and maintain existing function/services through the use of minimally invasive techniques;
- Create or maintain landscape and hydrologic connections and, where site conditions allow, restore an area to the natural vegetation community/hydrogeomorphic (HGM) type appropriate for the site.

- Special care should be taken in areas with rare species, rare vegetation communities, and high ecological integrity sites. Complex ecosystems and associated habitat features cannot be created via simple and artificial construction of selected components.
- Ecological restoration requires a holistic approach that cannot be achieved through isolated manipulations of individual elements, but through approaches ensuring that natural ecological processes occur and can be sustained over time.
- Natural structure and function should be restored and work should be done in the context of the landscape and watershed for the greatest long-term benefit.

This guidance, a rapid assessment method for habitat condition, and recommendations have been prepared to ensure that restoration projects are designed to protect aquatic/wetland resources that may be present or dependent on the site while still allowing for projects which can receive credit toward nutrient and sediment reduction. The rapid assessment method, presented in a separate document, was developed to classify and provide information on the condition of the vegetation communities of Key Wildlife Habitats (KWH), which support designated Species of Greatest Conservation Need according to the Maryland State Wildlife Action Plan, with corresponding HGM classifications. The assessment includes a description of target wetland KWH excerpted from the Maryland Wildlife Action Plan with accompanying photos, and a desktop and field assessment to characterize wetland condition in relation to reference communities of KWH.

Here we present recommendations for restoration based on the extent of degradation and condition of the KWH riparian wetland resources. This guidance is intended for restoration practitioners, planners, and regulators. It is assumed that the user is familiar with requirements of "Wetland Delineation Manual" and regional supplements used in Maryland. Information on the condition of the KWH at the project site from the rapid assessment should be taken into account.

Key Wildlife Habitat Classification and Descriptions

The Maryland State Wildlife Action Plan forms the blueprint for the conservation of priority species and habitats over a 10-year period. The plan identifies 610 animal species considered to be Species of Greatest Conservation Need (SGCN), including all state- and federally listed Threatened or Endangered species, rare species, endemic species, declining species, and responsibility species for which Maryland harbors a significant portion of the overall population. Because of the strong tie between species and habitats, it is critical to identify those habitats that support SGCN in order to conserve them. In general, the term "habitat" is described as the physical and biological environment that provides the necessary food, shelter, and other needs of a particular animal, plant, or other organism. KWH are no different in concept with the exception that the species dependent upon those habitats are considered SGCN. These habitats serve as critical foundations and support networks not only for SGCN but for all plant and animal species in Maryland.

KWH are structured as ecological cover types based primarily on vegetation for most habitats, since vegetation typically reflects biological and ecological patterns across the landscape. Wetland and terrestrial KWH are organized into a simple classification scheme which is scalable, allowing for compatibility with other ecological classifications (see Key Wildlife Classification Keys below). In riparian areas, terrestrial and wetland KWH are associated with stream and river habitats. These aquatic habitats are characterized into KWH types based on variables known to influence stream and river habitats at various spatial scales such as stream slope, size, elevation, climate, and geology.

Statewide general location maps and county distributions for KWH are presented in this document (Appendix A), along with statewide examples of public lands to visit, signature state rare plants, and state rare natural communities where relevant. These maps should be viewed as only generalized range maps (rather than depicting the full and complete distribution of habitats), especially for small wetland areas.

While the guidance has been developed for stream restoration qualifying for Chesapeake Bay TMDL reduction credit, the method and guidance are also useful for selecting and designing mitigation or voluntary restoration projects.

Maryland Key Wildlife Habitat Classification Key for non-tidal wetland habitats of the Piedmont, including HGM Class

For descriptions and examples of KWH, see Appendix A. HGM classes are defined in Smith et al., 1995.

1a. Wetlands bordering streams and rivers with overland, non-tidal flooding regimes (*i.e.*, floodplains). Distinct alluvial landforms (*e.g.*, backswamps, levees, terraces) and indicators present (*e.g.*, scour marks, recent sediment deposition, vegetation damaged/bent in one direction, soils with alternating deposits, channel banks with flood marks). Structurally and compositionally diverse vegetation present ranging from closed mixed forests to open, beaver-created pools with floating aquatics**……MONTANE-PIEDMONT FLOODPLAIN** HGM Class: Riverine

1b. Wetlands primarily controlled via groundwater discharge often associated with depressional and slope geomorphic features as well as the margins of small stream (1st and 2nd order) floodplain wetlands.

2a. Wetlands associated with toe slopes and floodplains of small streams of the Piedmont where groundwater discharge is a major contributing input source (mixed hydrological regime: occurs in very narrow part of the groundwater driven complex that is influenced by overbank flooding) with alluvial landform a minor part of the complex; smaller order stream floodplain margins where groundwater input also contributes to overall hydrology. These areas are generally small features along streams and are usually not as well-developed as seepage swamps in larger stream systems……**PIEDMONT SEEPAGE WETLAND (WET MEADOW/FEN)** HGM Class: Riverine or Slope

2b. Wetlands associated with distinct depressional and slope geomorphic features.

3a. Isolated basin wetlands, depressions, or very flat areas with evidence of ponded water, unidirectional flow not evident, lacks natural outlet, maintained by high water tables and seasonal precipitation. Hydrologic regimes range from saturated to seasonally flooded.

4a. Located over shallow bedrock or clay hardpans with seasonally perched water tables…….. **PIEDMONT UPLAND DEPRESSION SWAMP** HGM Class- Depression

4b. Small (<0.1 ha- 2 ha) shallow pools with a well-defined, discrete basin overlying a clay hardpan or other impermeable soil or rock layer impeding drainage, may or may not have vegetation in basin**……VERNAL POOL** HGM Class: Depression

3b. Slope wetlands associated with groundwater discharge zones (*i.e.*, seeps, springs) and perennial, unidirectional flow towards a natural outlet such as a stream.

6a. Small (usually <1m^2), localized area of groundwater discharge, point source, generally mountain and piedmont regions only…..**SPRING** HGM Class: Slope

6b. Larger wetland systems with diffuse drainage patterns, widespread.

7a. Saturated forests of sloping small stream headwaters, large spring seeps, lateral seeps in ravines and rocky stream bottoms with diffuse drainage patterns. Perennial seepage flow allows for year-round saturation. Braided stream channels, muck-filled depressions, areas of coarse gravel and cobble deposition, and hummock-and-hollow microtopographic features evident……..**MONTANE-PIEDMONT SEEPAGE SWAMP** HGM Class: Slope

7b. Open, graminoid-dominated meadows and shrub swamps of Piedmont hillside toeslopes and margins of small stream floodplains where saturated conditions persist due to groundwater discharge. Surficial soils predominately organic muck…….**PIEDMONT SEEPAGE WETLAND (WET MEADOW/FEN)** HGM Class: Riverine or Slope

Table 1. Maryland Key Wildlife Habitat Characteristic Species by Vegetation Layer: Piedmont Wetlands*

Key Wildlife Habitat	Trees	Shrubs	Herbs	Vines	Indicator**
Montane- Piedmont Floodplain (Piedmont section)	*Platanus occidentalis, Juglans nigra, Acer negundo, Acer rubrum, Ulmus americana, Liriodendron tulipifera, Fraxinus pennsylvanica, Carya cordiformis, Celtis occidentalis, Quercus bicolor, Quercus palustris, Nyssa sylvatica*	*Lindera benzoin, Asimina triloba, Ilex opaca, Ilex verticillata, Carpinus caroliniana*	*Hydrophyllum canadense, Ranunculus abortivus, Amauropelta (Thelypteris) noveboracensis, Mitchella repens, Arisaema triphyllum, Boehmeria cylindrica, Saururus cernuus, Cinna arundinacea, Galium circaezans, Medeola virginiana, Thalictrum thalictroides, Impatiens capensis, Glyceria striata*	*Toxicodendron radicans, Parthenocissus quinquefolia, Campsis radicans*	*Platanus occidentalis, Fraxinus pennsylvanica, Acer rubrum/negundo, Boehmeria cylindrica, Impatiens capensis, Arisaema triphyllum*

Piedmont Seepage Wetland (Wet Meadow/ Fen)	*Acer rubrum, Salix nigra (trees may not be present)*	*Lindera benzoin, Rosa palustris, Viburnum dentatum, Alnus serrulata, Spirea spp.*	*Carex stricta, Symplocarpus foetidus, Impatiens capensis, Onoclea sensibilis, Cinna arundinacea, Leersia oryzoides, Juncus effusus, Thelypteris palustris, Scirpus cyperinus, Persicaria (Polygonum) spp.*		*Carex stricta, Symplocarpus foetidus, Salix nigra*
Piedmont Upland Depression Swamp	*Quercus phellos, Quercus palustris, Quercus michauxii, Quercus bicolor, Fraxinus pennsylvanica, Acer rubrum, Nyssa sylvatica*	--	*Carex spp.*	*Smilax rotundifolia*	*Quercus phellos, Quercus michauxii, Quercus palustris*
Montane-Piedmont Seepage Swamp (Piedmont section)	*Nyssa sylvatica, Acer rubrum, Liriodendron tulipifera, Magnolia virginiana, Fraxinus americana, Fraxinus pennsylvanica, Carpinus caroliniana*	*Vaccinium corymbosum, Rhododendron viscosum, Ilex verticillata, Viburnum nudum, Viburnum dentatum, Alnus serrulata, Lindera benzoin, Rubus hispidus*	*Symplocarpus foetidus, Veratrum viride, Osmundastrum cinnamomeum, Impatiens capensis, Pilea pumila, Carex folliculata, Chelone glabra, Amauropelta (Thelypteris) noveboracensis, Osmunda regalis, Viola cucullata, Thalictrum pubescens, Arisaema triphyllum, Glyceria striata, Cinna arundinacea, Boehmeria cylindrica, Lycopus virginicus*	*Smilax rotundifolia, Toxicodendron radicans, Parthenocissus quinquefolia*	*Sphagnum spp., Symplocarpus foetidus, Veratrum viride, Magnolia virginiana*
Vernal Pools and Springs have limited to sparse herbaceous and/or shrub vegetation in the wetland basin. Some Springs have *Sphagnum* species. The surrounding vegetation will represent one of the KWH listed here. Vernal Pools and Springs are most likely to be embedded in Montane-Piedmont Floodplain, Montane-Piedmont Upland Depression Swamp, or Montane-Piedmont Seepage Swamp.					

*Species listed in each stratum represent species with high constancy values (>75%) for finer community types (*i.e.*, association level) of Key Wildlife Habitats.

**Indicator species = High diagnostic value to type, high fidelity, and relative cover

Maryland Key Wildlife Habitat Classification Key for non-tidal wetland habitats of the Coastal Plain, including HGM Class

For descriptions and examples of KWH, see Appendix A. HGM classes are defined in Smith et al., 1995.

1a. Wetlands bordering streams and rivers with overland, non-tidal flooding regimes (*i.e.*, floodplains). Distinct alluvial landforms (*e.g.*, backswamps, levees, terraces) and indicators present (*e.g.*, scour marks, recent sediment deposition, vegetation damaged/bent in one direction, soils with alternating deposits, channel banks with flood marks). Likely to be 3rd order and higher but may be braided systems. Structurally and compositionally diverse vegetation present ranging from closed mixed forests to floodplain pools to open, beaver-created pools with floating aquatics**……COASTAL PLAIN FLOODPLAIN** HGM Class: Riverine

1b. Wetlands primarily controlled via groundwater discharge often associated with depressional and slope geomorphic features as well as the margins of small stream (1st and 2nd order) floodplain wetlands.

2a. Wetlands associated with toe slopes and floodplains of small streams of the Coastal Plain where groundwater discharge is a major contributing input source (mixed hydrological regime: occurs in very narrow part of the groundwater driven complex that is influenced by overbank flooding) with alluvial landform a minor part of the complex; smaller order stream floodplain margins where groundwater input also contributes to overall hydrology. These areas are generally small features along streams and are usually not as well-developed as seepage swamps in larger stream systems……**COASTAL PLAIN FLOODPLAIN** HGM Class: Riverine or Slope

2b. Wetlands associated with distinct depressional and slope geomorphic features.

3a. Basin wetlands, depressions, or very flat areas with evidence of ponded water, unidirectional flow not evident, lacks natural outlet, maintained by high water tables and seasonal precipitation. Hydrologic regimes range from saturated to seasonally flooded.

4. Seasonally flooded to saturated forested flats and depressions of broad coastal plain terraces (*i.e.*, "wet flatwoods") with fluctuating water levels and intermittently ponded depressions. Soils are silt, sand, and clay loams, sometimes with a thin (< 30 cm [12 in]) mantle of coarse, fibric peat.

5a. Located on flat terraces and shallow depressions with seasonally perched water tables and braided channels……**COASTAL PLAIN FLATWOOD AND DEPRESSION SWAMP** Flatwood: HGM Class- Flat; Depression Swamp: HGM Class- Depression

5b. Small (<0.1 ha- 2 ha) shallow pools with a well-defined, discrete basin overlying a clay hardpan or other impermeable soil or rock layer impeding drainage, may or may not have vegetation in basin……**VERNAL POOL** HGM Class: Depression

3b. Slope wetlands associated with groundwater discharge zones (*i.e.*, seeps, springs) and perennial, unidirectional flow towards a natural outlet such as a stream.

6a. Small (usually <1m^2), localized area of groundwater discharge, point source, rare in Coastal Plain…..**SPRING** HGM Class: Slope

6b. Larger wetland systems with diffuse drainage patterns, widespread.

7a. Open wetlands characterized by predominately shrub and herbaceous vegetation and localized groundwater discharge zones. (*note. Lack of natural disturbances [e.g., fire, beaver activity, grazing] in these habitats often promote woody plant succession.)* Saturated "bog-like" wetlands along gently sloping headwater streams, seepage toe-slopes, and oligotrophic spring-heads with considerable accumulation of peat mosses (*Sphagnum spp*.) at varying depths, soils acidic and infertile (*note. The term "bog" applied here is a technical misnomer since none of these wetland systems in Maryland are ombrotrophic.)*…….**COASTAL PLAIN SEEPAGE BOG AND FEN (rare)** HGM Class: Organic Soil Flat; Slope

7b. Saturated forests of sloping stream headwaters, large spring seeps, lateral seeps in ravines and stream bottoms with diffuse drainage patterns. Braided stream channels, muck-filled depressions, and hummock-and-hollow microtopographic features evident……**COASTAL PLAIN SEEPAGE SWAMP** HGM Class: Slope

Table 2. Maryland Key Wildlife Habitat Characteristic Species by Vegetation Layer: Coastal Plain Wetlands*.

Key Wildlife Habitat	Trees	Shrubs	Herbs	Vines	Indicator**
Coastal Plain Floodplain	*Platanus occidentalis, Liquidambar styraciflua, Liriodendron tulipifera, Quercus michauxii, Fraxinus pennsylvanica, Betula nigra, Acer rubrum Additional for Blackwater Streams: Taxodium distichum, Nyssa sylvatica, Chamaecyparis thyoides (rare)*	*Lindera benzoin, Asimina triloba, Ilex opaca, Ilex verticillata, Carpinus caroliniana*	*Amauropelta(Thelypteris) noveboracensis, Mitchella repens, Arisaema triphyllum, Boehmeria cylindrica, Saururus cernuus, Cinna arundinacea, Galium circaezans, Medeola virginiana, Thalictrum thalictroides, Impatiens capensis, Glyceria striata*	*Toxicodendron radicans, Parthenocissus quinquefolia, Campsis radicans*	*Platanus occidentalis, Betula nigra, Amauropelta(Thelypteris) noveboracensis, Saururus cernuus, Cinna arundinacea Additional for Blackwater Streams: Taxodium distichum, Nyssa sylvatica, Chamaecyparis thyoides (rare)*
Coastal Plain Flatwood and Depression Swamp	*Quercus phellos, Quercus palustris, Quercus michauxii, Quercus pagoda, Liquidambar styraciflua*	*Eubotrys racemosa, Vaccinium corymbosum, Clethra alnifolia*	*Woodwardia areolata, Osmunda cinnamomea, Mitchella repens, Osmunda regalis, Chasmanthium laxum*	*Smilax rotundifolia*	*Quercus pagoda, Quercus michauxii, Vaccinium corymbosum*
Coastal Plain Seepage Bog and Fen	*Nyssa sylvatica, Acer rubrum, Pinus rigida*	*Rhododendron viscosum, Toxicodendron vernix, Rubus hispidus, Ilex glabra, Clethra alnifolia*	*Carex atlantica, Andropogon glomeratus, Rhynchospora gracilenta, Eupatorium pilosum, Dichanthelium dichotomum var. dichotomum*	*Smilax pseudochina*	*Smilax pseudochina, Pinus rigida, Andropogon glomeratus, Rhynchospora gracilenta*
Coastal Plain Seepage Swamp	*Nyssa sylvatica, Acer rubrum, Magnolia virginiana*	*Clethra alnifolia, Viburnum nudum, Rhododendron viscosum*	*Woodwardia areolata, Osmunda cinnamomea, Osmunda regalis, Carex folliculata*	*Smilax rotundifolia*	*Magnolia virginiana, Clethra alnifolia, Viburnum nudum*
Vernal Pools and Springs have limited to sparse herbaceous and/or shrub vegetation in the wetland basin. Some Springs have *Sphagnum* species. The surrounding vegetation will represent one of the KWH listed here. Vernal Pools and Springs are most likely to be embedded in Coastal Plain Floodplain, Coastal Plain Flatwood and Depression Swamp, or Coastal Plain Seepage Swamp.					

*Species listed in each stratum represent species with high constancy values (>75%) for finer community types (*i.e.*, association level) of Key Wildlife Habitats.

**Indicator species = High diagnostic value to type, high fidelity, and relative cover

Recommendations and Management Practices

In general, restoration techniques for Chesapeake Bay TMDL credit should be designed and constructed according to the assessment results and following guidance. For floodplain reconnection projects, projects may be designed to put more water on the floodplain by:

- raising bed by using fill
- placing structures (*e.g.* stone, logs, berms)
- excavating to buried soil layers
- re-shaping channel geometry

The removal or lessening of stressors in the contributing watershed, such as undersized road crossings or impervious surface, is highly recommended. Correction of offsite stressors which may allow natural recovery of the stream should be considered. The following approaches may be needed to improve restoration success:

- properly size pipes/culverts for non-erosive flows
- upland treatments for stormwater management
- soil treatments (*e.g.*, organic amendments and techniques to remediate compaction).

Given the characteristics of the wetland Key Wildlife Habitats and the species of concern that they support, the following recommendations are made based on the results of the KWH condition assessment and general best practices for stream restoration projects.

Pre-Construction: Planning and Site Selection

1) Restoration should focus on identified degraded areas. Projects which continue to support or improve high quality habitat may also be considered, but should involve minimal disturbance to the existing project area.

2) Restoration projects in areas that are known or found to have sensitive species or rare habitats are known as high quality areas and should be designed to support or improve the high quality habitat. The characteristics and ecological processes which resulted in the area being designated as having significant plant or wildlife value should be maintained or improved.

3) Consultation with MDE, DNR, and federal agencies is strongly encouraged when proposing a stream restoration project in areas that may contain high quality resources.

4) The entity and prospective designers/contractors should utilize the Watershed Resources Registry (WRR) to identify high quality resources and other features which may be potential constraints on design or need specialized construction practices. The WRR also has identified priority areas for restoration and protection.

   The WRR shows designated areas such as sensitive species project review areas, forest interior dwelling species (FIDS) habitat, targeted ecological areas, nontidal wetlands of special State

concern, or some of the other nontidal wetlands having significant plant or wildlife value (see COMAR 26.23.01.01B(80). These include the following nontidal wetlands:

(i) Bogs***,

(ii) Areas with bald cypress (*Taxodium distichum*), Atlantic white cedar (*Chamaecyparis thyoides*), red spruce (*Picea rubens*), balsam fir (*Abies balsamea*), or American larch (*Larix laricina*) that contain at least 20 percent of these species in any strata as determined by the Federal Manual****;*

(iii) Delmarva bays***; or

(iv) With water discharge that maintains minimum stream base flow important for maintaining plant and wildlife species (springs***);

(v) With threatened or endangered species, or species in need of conservation;

(vi) Nontidal wetlands of special State concern;

(vii) Adjacent (meaning bordering, neighboring, or contiguous) to, or within the 100-year floodplain of to Class III or Class IV waters.

***not mapped in WRR by this designation

5) Climate change considerations: Applicants may be required to demonstrate to the Department's satisfaction that they have taken into account future physical climate change-related risks associated with storm surges, sea-level rise or projected changes in the duration, frequency and magnitude of rainfall events. Specific requirements have not yet been developed. MDE strongly encourages jurisdictions to use "supersized" upland treatment facilities and, for MS-4 counties, receive additional impervious surface credit reduction through the Watershed Management Credit. In addition to improving pollutant removal, these upsized stormwater control practices will capture more runoff volume to enhance climate change resilience to localized flooding. Another benefit besides helping to address climate change is that the additional quantity treatment will reduce the increased discharges from urban runoff which would otherwise continue to degrade streams. However, over design and excessive disturbance for stream restoration within channels and floodplains is not generally justified as a basis for future climate adaptation.

Some stream restoration practices use impervious structures within channels and sometimes floodplains to retain water and transported nutrients and sediment. While typically not meeting the definition of "dams," these structures are vulnerable to damage and failure from increased storm events. Lower structures which do not excessively impound water are desirable both for climate adaptation to protect against flood damages and to maintain habitat including trees.

The Scientific and Technical Advisory Committee (STAC) to the Chesapeake Bay Program noted in their 2023 report "Rising Watershed and Bay Water Temperatures-Ecological Implications and Management Responses" that coldwater resources are particularly vulnerable to rising temperatures

from climate change. In general, the report noted "Warmer temperatures will negatively impact aquatic habitats and threaten many ecologically and economically important species." In addition to higher water temperatures, declines of dissolved oxygen may occur, and algal blooms and bacterial/viral outbreaks may increase.

Practices such as increased infiltration, maintaining or increasing riparian forest cover, and support of coldwater discharge to streams will be increasingly important to maintain coldwater resources. These practices are strongly encouraged and may be required for stream restoration projects.

More specific guidance may be developed in the future to incorporate climate change considerations into stream restoration designs, but the following are recommended as part of the STAC report on temperature:

a. Tree retention and increasing riparian forest cover

b. Protect forested watersheds with high quality coldwater habitat

c. Infiltration

d. Improve access to thermal refugia

e. Improve connections between suitable habitat patches

6) MDE does not authorize increases in flood levels on adjacent properties without permission of the affected landowners.

7) Headwater systems typically transport materials downstream to higher order streams, and are often on a steeper slope than found on higher order streams. The conversion of a headwater which is transporting material to a retention reach may result in additional adverse impacts to water quality, particularly since extensive interventions may have an amplified effect on small streams due to their size. For example, dissolved oxygen increases with increasing flow. In restoration, a common goal is to slow flow and allow sediments to settle. However, slowing flow too much may result in reducing dissolved oxygen below the minimum standard of 5 mg/l. Undefined channel or dynamic channels areas are best restored when they naturally have a slope change to allow flow to disperse and perform as depositional areas.

8) For projects in the Piedmont, check for presence of karst topography which may limit certain types of activities. See Appendix E for more detailed information.

9) Pre-colonial conditions: Some past projects have been designed to restore a site to pre-colonial conditions, often with shrub/emergent communities and poorly defined channels. Maryland has high quality waters (*e.g.* those designated as Tier II), nontidal wetlands of special State concern, as well as other waters with currently high-valued resources that were disturbed by human activity in the past. Other more degraded areas are often fragmented by land use and infrastructure, which are ongoing stressors. Pre-colonial conditions may not be sustainable in all areas. MDE focuses on the

resources which are currently valued, rather than a pre-colonial condition and does not support extensive alterations or conversion of less-disturbed functioning stream ecosystems and their supporting riparian areas to another system. Use of the assessment accompanying this guidance will indicate the condition of the resource and suitability as existing habitat. Areas that are highly disturbed with little or no habitat, such as farm fields, may be more suitable for resource alterations and conversions to different resource types when there are not anticipated resource tradeoffs.

10) Legacy sediment removal: Maryland's landscape has been altered extensively by human activity, so most of the land has sediment deposits resulting from past human disturbance. However, there are degrees of disturbance. In some areas excessive sediment deposition, such from a historic dam failure, have resulted in burial of hydric soils and subsequently, erosion of these excess deposited sediments and disconnections of streams from floodplains. Restoration of these areas may involve removal of legacy sediment deposits in the floodplains. This is an extensive disturbance and is best done in areas with highly degraded riparian areas. Additional monitoring is typically needed for design and discussed in the Pre-design Assessment and Monitoring and Pre-Application sections of this document.

11) Special provisions for low energy (*e.g.* blackwater) streams: Streams in very flat landscapes, such as blackwater streams, are noted for having slow-flowing waters. Channelization is common on the lower Eastern Shore, where blackwater streams are generally found, resulting in exposed banks and incised streams. However, despite the presence of exposed banks, little erosion may occur due to the low energy, slow flows even during storm events. For project proponents seeking credit for reducing sediment in TMDLs, restoration in these areas will provide little benefit for that purpose.

12) Be sure to note wide riparian valleys can have both active floodplain areas as well as areas fed primarily by groundwater seepage.

Pre-Design Assessment and Monitoring

Note: Information in this section should accompany other channel measures used to assess bank stability and erosion.

1) Identification of stressors and mapped natural and water resources influencing the project area should be conducted. In addition to sources such as the WRR, old aerial photos, maps, and information on failed dams/ponds can also provide information on sources of degradation which have persistent effects on resource condition.

2) An assessment of the condition of the stream as well as the riparian area is required. The accompanying assessment "Field Manual for Rapid Ecological Integrity Assessment of Wetlands in Riparian Areas in Maryland" in the Piedmont or Coastal Plain is encouraged, but other options may be used if accepted by MDE. Riparian assessment should evaluate existing hydrology and plant community characteristics. Stream channel assessments should evaluate extent and severity of existing erosion, and likelihood of erosive flow in the channel, bed and bank characteristics, and vertical and lateral connectivity.

3) Aquatic life in the channel should be assessed by persons currently certified by DNR for Maryland Biological Stream Survey procedures. IBI scores should be taken in the project reach. Information from the closest existing MBSS sample point can also be considered. Sample points can be found on the WRR or with more detailed information at https://dnr.maryland.gov/streams/Pages/r3reportintro.aspx.

   A list of certified persons is found at the following link

   https://dnr.maryland.gov/streams/Pages/mbssregistry.aspx

4) Consultation with DNR is highly recommended when the desktop or field assessment indicates the presence of sensitive species. Additional specialized monitoring may be required to identify rare species and a design which supports any sensitive species or high quality habitats, as described in the Special Notes and Design Standards and Considerations sections.

5) Identify sources of degradation and other plans to address these sources which may be undertaken in the future. Measures taken to reduce stressors and sources of degradation after stream restoration design is proposed may negate the previous design. Therefore, reduction of stressors and sources of degradation outside of the stream channel should preferably be undertaken prior to stream restoration.

6) Examination of historic maps, photos, and other sources are useful in determining if legacy sediment is present. If the site and historical source investigation indicates that there has been excessive legacy sediment deposition as a major reason for a degraded channel, additional onsite monitoring is needed if sediment removal is under consideration. Since the excavation is a major disturbance and a system change, consult with MDE and DNR on the feasibility of the approach at the specific site.

   Additional monitoring includes geological investigations to avoid increasing sinkhole risk and determining depth to buried soils. Tile probes and trenching have been used to determine the presence and depth to basal gravel layers. Analysis of basal gravel layers to predict ultimate post-design bed substrate and movement from new shear stresses would be needed during design.

Pre-Application

1) Entities should contact regulatory agencies to participate in field visits at sites under consideration for restoration. Project proponents should be able to identify sources of degradation affecting the stream/riparian/wetland area proposed for restoration. An assessment of the existing stream condition, as documented by IBIs or measures of stream stability and erosion, should be performed prior to application submission. While the associated assessment for this guidance is not specifically mandatory, MDE will require an assessment of riparian floodplain condition for TMDL stream restoration projects. MDE also recommends that

applicant consultants perform the associated ecological integrity assessment for this grant project, as described in:

- "Field Manual for Rapid Ecological Integrity Assessments in Wetlands of Riparian Areas in Maryland: Piedmont Version 1.0"

- "Field Manual for Rapid Ecological Integrity Assessments in Wetlands of Riparian Areas in Maryland: Coastal Plain Version 1.0"

2) Comments and recommendations from regulatory agencies should be used in planning the design of the project.

3) Consider how planned upland treatment may alleviate some stressors and thus influence the approach for achieving additional improvements to the stream.

4) Upland treatments are preferably implemented prior to designing and constructing a restoration project in the stream.

5) Note that water quality and improvements to aquatic life may require more than the specific stream restoration project. Treatment in the contributing watershed and addressing other stressors may be necessary for overall ecological restoration.

6) Have early meetings with contractors, designers, regulators to understand performance standards and anticipated requirements.

7) To reduce the spread of non-native invasive species (NNIS), inventory for and locate NNIS infestations consistent with the scale and intensity of the proposed activity (U.S. Forest Service 2012). The extent and intensity of inventorying should be appropriate to the threat posed by NNIS in or likely to be in the area, and by the potential effect of the activities on the spread, release, or control of those species. Focus inventories for NNIS plants at likely introduction sites such as access points, landings, skid trails, and other areas to be disturbed during the project. Determine a plan for action if needed based on the degree of invasiveness of the species found, severity of the current infestation, potential impacts of the project, and feasibility of control with available methods and resources. If pre-treatment of NNIS is warranted, consider postponing the activity until the infestation can be treated. Consider practical seasonal timing options that minimize the risk of introducing or moving an NNIS.

8) If the entire reach is not experiencing problematic erosion, do spot fixes in areas showing more than moderate erosion.

9) Legacy sediment removal: A legacy sediment removal project should still retain at least one base flow channel for aquatic life. Channels should be designed to have hydraulic characteristics which will minimize movement of basal gravels while mobilizing, transporting, and depositing finer sediments into the floodplain.

If assessment results indicate low value resources on the site, the stream is incised, and there is other evidence supporting excessive legacy sediment (*e.g.* from maps or aerial photographs, soil likely to have springs or buried hydric soil layer) and legacy sediment removal is considered as an option, further investigations should be performed. Exploratory trenches should be dug to determine if there are buried hydric soils over a basal gravel layer.

10) Regardless of channel condition, designs at project sites with IBI scores of fair or better must be designed and constructed to maintain or improve the IBI abundance, diversity, and balance of pollution intolerant vs. tolerant species at the site.

    IBI scores should be taken in the project reach. Information from the closest existing MBSS sample point can also be considered. Sample points can be found on the WRR or with more detailed information at: https://dnr.maryland.gov/streams/Pages/r3reportintro.aspx.

    The extent of work in the degraded channel requires consideration of effects on the riparian area and biota in the stream. When there is a higher quality riparian area and biota, the design and construction should support or improve the condition of these resources. Progressively more extensive alteration may be appropriate as the riparian area/wetlands and stream biota approach poor condition.

Use of the KWH Ecological Integrity Assessment

Overall Hydrology Scores Good - Excellent

When the hydrology, hydroperiod, channel condition, and hydrologic connectivity scores range from "Good" to "Excellent," the stream channel overtops its banks frequently, lacks widespread and severe erosion, and restoration would be of little benefit. If Key Wildlife Habitat and vegetation scores range from "Good – Excellent," the riparian area should be protected, especially in areas with "Good – Excellent" landscape condition.

Scores of "Fair" or "Poor" for Key Wildlife Habitat and vegetation may indicate the utility of structural and/or vegetation enhancements in the form of coarse woody debris additions or other structural enhancements, plantings, or removal of invasive species in the riparian/wetland area depending on the KWH type.

Hydrology Scores Fair

Channel condition and hydrologic connectivity scoring as "Fair" condition generally indicate that there is some level of channel or bank instability and that the stream overtops its banks so water enters the floodplain less frequently (e.g., at 10-year recurrence interval storms) than if it were less disturbed. Limited in-channel work may be needed to improve stream functions with slight water level increases. In-channel structures should mimic natural features of the stream in its physiographic region. Some minor changes to channel geometry and work close to the channel may be appropriate.

Extent of work in the riparian area, if any, should be commensurate with level of degradation. Habitat structure and vegetation scores of "Good-Excellent" for KWH type indicate only minor, if any, alterations within the floodplain may be appropriate, especially if landscape condition is "Good – Excellent".

Post-construction water levels should generally mimic the hydroperiod of the soil type. Information on water levels and duration of particular soils is available from the Natural Resources Conservation Service web soil survey: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Hydrology Scores Poor

Channel condition and hydrologic connectivity scoring as "Poor" condition generally indicate that the stream bank and channel are highly eroded, deeply incised and flooding rarely, if ever, occurs.

Re-connection to the floodplain should ideally be achieved by only in-channel work or minor changes to channel geometry when Key Wildlife Habitat and vegetation scores are "Good-Excellent." Restored hydroperiod should reflect indicators in reference soil profiles, as indicated in Natural Resource Conservation service (NRCS) web soil survey or determined by a certified soil scientist.

Vegetation scores of "Fair" may indicate the utility of vegetation enhancements in the form of plantings or removal of invasive species in the riparian/wetland area. Habitat structure scores of "Fair" or "Poor" may indicate the utility of structural enhancements. Consult with regulatory agencies about potential for legacy sediment removals prior to selecting this as a design approach. Also, when not working in nontidal wetlands having significant plant or wildlife value or other priority ecological designations, consult with MDE to determine when designs other than those which support the historic KWH onsite may be appropriate for the site. Upland treatment is always preferred when quantity through increased discharge from stormwater is contributing to the degradation.

Vegetation scores of "Poor" also indicate the need for vegetation enhancements. However, when not working in nontidal wetlands having significant plant or wildlife value or other priority ecological designations, consult with MDE to determine when designs other than those which support the historic KWH onsite may be appropriate for the site.

Additional work in the riparian area may be more extensive than in higher scoring sites. However, care should be taken for the uncommon circumstances where biological integrity scores are still fair – good/excellent/functioning to prevent further degradation of the living resources. Upland treatment is always preferred when quantity through increased discharge from stormwater is contributing to the degradation.

The presence of limited native vegetation may support additional grading in the floodplain. Construction practices to prevent soil compaction should be used when soil scores range from "Fair-Excellent."

Design Standards and Considerations

Entities procuring contractors to design and/or build restoration projects are encouraged to seek experienced contractors and designers. Ask for:

- Experience and references on successful projects, including photographs and monitoring results
- History of additional site remediation, and how past projects met performance standards.
- If the project site is known or suspected to have sensitive resources, seek practitioners with experience in maintaining or improving habitat for sensitive resources.
- Familiarity and experience with different types of design and success in their use
- Description of equipment to be used. Entities doing the hiring may wish to specify certain types of equipment to reduce impacts. A range of equipment sizes is desirable, with smaller machinery more likely to result in fewer construction impacts.

The following standards are recommended and may be required. Project-specific deviations may be allowed, when justified for specific projects.

1) Design to maintain or improve areas already designated as having important habitat: nontidal wetlands of Special State Concern; nontidal wetlands having significant plant or wildlife value; forest interior habitat; targeted ecological areas; areas designated in the WRR as having sensitive species, and sites in the Biodiversity Conservation Network, or in Tier II watersheds. Appendix C shows an example of a plan set for a restoration project (Pocomoke River restoration) with sensitive resources.

2) Design to support other Chesapeake Bay Agreement goals beyond nutrient and sediment reduction. Goals include stream health, improving IBI scores, riparian forest buffer, fish passage, and wetland acreage and functional gains.

3) When fish are present, design in-stream structures to allow for movement of aquatic life over, around, through or under structures to avoid creating a new blockage to passage of aquatic life.

4) Design riffles to have continuous surface flow throughout the entire riffle length under baseflow conditions.

5) A drop of no more than 6" from a structure to the water surface is appropriate for trout. Preferably, there should be no drop if it can be avoided, as even a drop of a few inches can be a barrier for herring, shad, and other species. If a drop is unavoidable, drops should reflect conditions of the comparable reference reach for the stream.

6) Design stream restoration to maintain or improve habitats for other sensitive species, their habitats, and rare communities.

7) Regardless of channel condition, designs at project sites with IBI scores of fair or better must be designed and constructed to maintain or improve the IBI abundance, diversity, and balance of pollution intolerant vs. tolerant species at the site.

8) Some restoration projects propose alterations which may permanently convert flowing stream channels to resources such as:

- Long-term impoundments;
- Single thread channels to multi-thread channels; or
- Defined channels to undefined or self-forming, potentially frequently shifting channels

Restorations of this type, while they can increase connection between streams and adjacent areas, may not improve habitat and aquatic life measures in all cases. There may be a loss and conversion of an existing water/wetland/aquatic resource type or reduction or increase in channel depth and flow which may or may not be desirable for living resources.

Partial flow diversions, when new channels are allowed to form while a baseflow channel remains with adequate flow, may be allowed provided that the conditions in Items i and ii in this section are met. However, the flow should not be diverted in a volume which would adversely affect existing aquatic life in the original base flow channel.

Areas best suited for naturally forming more diffuse channels are those associated with a change in slope to a flatter riparian area/stream valley, as well as those which have dry channels due to loss of flow. The WRR hillshade layers are helpful in identifying relict channels.

Conversions should only be proposed when documentation of the following has been accepted by MDE:

i) A pre-construction assessment for macroinvertebrate and fish communities according to DNR standards under the Maryland Biological Stream Survey;

ii) Description of potential resource tradeoffs and net anticipated benefits, and documentation is provided that the following is not expected to occur:

a. Aquatic life measures do not further decline;

b. Perennial streams downstream and at the project site must remain perennial;

c. The defined channel remains downstream on adjacent property;

d. There is not increased risk to public safety or infrastructure from dispersing the flow;

e. There are not undesirable impacts to the riparian area, its wetlands or sensitive living resources;

f. There will not be a decline in water quality downstream or at the project site; and

g. Water quality standards must be met.

9) Regardless of channel condition, designs at project sites with IBI scores of fair or better must be designed and constructed to maintain or improve the IBI abundance, diversity, and balance of pollution intolerant vs. tolerant species at the site.

10) The extent of work in the degraded channel requires consideration of effects on the riparian area and biota in the stream. When there is a higher quality riparian area and biota, the design and construction should support or improve the condition of these resources. Progressively more extensive alteration may be appropriate as the riparian area/wetlands and stream biota approach poor condition.Post-construction water levels are generally recommended to mimic the hydroperiod of the soil type, however, increased water levels and flood frequency may be approved provided there are no increases in flooding on adjacent properties without permission, and the design approach satisfies any MDE concerns and requirements.

11) Designer, construction manager, agency, and other required environmental inspectors/monitors should walk the site together to identify trees to be cut, removed, and protected, and where access points and staging areas should be located.

12) Design for a minimal limit of disturbance.

13) Limit disturbance of strongly, very strongly, or extremely acidic soils.

14) Design and place instream structures based on channel slope, rather than at set intervals.

15) Maintain or enhance a stable undercut channel features suitable for fish and benthos with following characteristics:

i) Has water under the undercut;

ii) Has roots within the undercut feature in contact with water for prolonged periods;

iii) Channel shear maintains the undercut. These areas would usually be at the outside or meander bends; and composed of the following in order of preference: sod; wood and sod; bedrock/boulder if native to the region and sod or wood and sod options are not feasible,

16) Include the following features in the design where feasible and appropriate to the landscape setting:

i) Provide in-channel overhead cover in at least each meander bend;

ii) Provide micropools and other flow diversity features in each riffle, through the addition of random boulders and other substrates;

iii) Provide compound and diverse pools, including side pools as seen in the reference locations used for the site.

iv) Provide greater pool variability, including the addition of at least ten additional thermal refugia /overwintering pools greater than three feet static depth (larger streams); and

v) Preserve existing habitats identified in reference locations;

17) Projects designed to have valley-wide grade controls (preferably wood) which are below ground will need monitoring to ensure that groundwater is at desired depths for the desired duration. Prolonged saturation to the surface may result in undesirable tree loss and conversion to another wetland type. If forest is to be retained, the below ground structures will have to be modified to lower water levels and/or the duration of saturation at or near the surface. Selection and design of below ground structures must allow for their modification to adjust groundwater levels.

18) Do not overdesign. Minimal alterations in areas of limited degradation help to maintain the quality of existing natural and water resources. Likewise, in heavily degraded areas, intensive disturbance may further worsen aquatic life conditions and other water quality or habitat parameters (Hilderbrand et al., 2018, Filoso et al. 2015, Palmer et al. 2014). Minimizing soil disturbance can also help to prevent the spread of NNIS. Consider the impacts of different types of equipment, and, where feasible, plan to use equipment that minimizes soil and vegetation disturbance. Retain native vegetation in and around the activity area to the greatest extent possible. Consider the option not to carry out an activity where the spread of NNIS is likely to negatively impact the restoration project (U.S. Forest Service 2012).

19) To minimize the spread of NNIS, use existing roads to the extent possible. Avoid constructing new roads, skid trails and landings in areas infested with NNIS where possible and limit the number, width, and length of roads, skid trails and landings to help minimize soil disturbance and to limit the risk of unintentionally transporting NNIS into non- infested areas.

20) Most nontidal wetland KWH types associated with Coastal Plain and Piedmont streams are forested. Designs should follow the Maryland Wildlife Action Plan recommendations for these habitat types to be managed to maintain closed or semi-open canopy. The exception is the Piedmont Seepage Wetland (Wet meadow/fen) category, which has shrub/emergent communities and the Coastal Plain Seepage Bog and Fen.

21) Approach the restoration project without a predetermined design. Site-specific considerations should determine the type of design appropriate for the site.

22) Sites with field, measured, or modeled indicators of recent overbank flooding (2- year recurrence interval) storms should limit increasing additional inundation of floodplain.

Flooding at 10-year recurrence intervals may have some additional increased connection, without increasing flooding on adjacent properties or threatening survival of desired species.

23) Legacy sediment removal projects involve a high amount of disturbance and remove existing surface vegetation. The practice is generally not desirable in forested systems, and requires additional justification. Existing riparian wetland areas with low-scoring assessments, and existing trees in poor condition, extensive coverage of invasive species, adjacent to deeply incised streams with a buried organic soil layer, may be considered for approval. Legacy sediment removal should not be done over existing underground infrastructure. When legacy sediment removal is appropriate, apply the following standards when suitable to the site:

    i) Furnished materials shall mimic that size mixture of native basal gravels that are of a well-graded mixture with multiple size classes useful to biology;

    ii) Design for retention of native substrates in gravel basal layer material; and

    iii) If riparian area size and amount of new perennial flow allow, establish additional small channels for refugia.

24) If restoration out of type is necessary, this may be best in the most degraded sites or where there are other constraints.

Construction Specifications

1) Oversight

An environmental monitor/inspector, and agency participation is highly recommended during construction and may be required, depending upon the sensitivity and condition of the resources and detailed design requirements. Cleaning of clothing, footwear, and equipment should be considered in order to limit the introduction and spread of non-native invasive plant species as well as introduced diseases that affect reptiles and amphibians (*e.g.*, ranavirus). Preferred locations for cleaning equipment are those where monitoring can be conducted at a later date, equipment is unloaded and loaded, non-native species are less likely to spread from cleaned equipment or where they are already established. Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting invasive species. Routinely remove soil, seeds, vegetative matter, or other debris from shoes, clothing, and tools. To avoid the transport of disease organisms, such as ranavirus and chytrid, proper disinfection procedures should be followed between sites. After removing mud and debris, field equipment and footwear should be disinfected between sites by rinsing or soaking them with a 10% bleach and water solution, letting them sit for 5 minutes, then rinsing with fresh water. Felt sole boots/waders should not be used. Skin that comes into contact with eggs, tadpoles, or water in the field should be cleaned with alcohol-based hand sanitizer as part of the disinfection procedure. Disinfection

should be done at least 50' away from wetlands or streams to avoid chlorine kills of amphibian and fish larvae.

2) Completed grade control structures should have flow over the apex during baseflow conditions with consistent arm slopes up from the apex to a stable sill tie-in at bankfull into existing ground. Riffles shall have surface flow along the thalweg throughout the entire riffle length and tie-up to bankfull on both banks. The contractor is responsible for ensuring smooth transitions at upstream and downstream ends of work areas and between the streambed and its banks.

3) Equipment selection

   Use the smallest equipment practicable that can safely be used for construction. Some sites may be accessed by smaller motorized vehicles such as ATVs, or entry and material placement by hand-operated equipment. Applicants may be asked to provide rationale for their equipment selection in some cases to ensure that adverse and unnecessary impacts are reduced. Larger equipment which may have lower operating psi, may be allowed if justified to agency satisfaction.

4) Construction techniques for minimizing impacts should be selected and post construction adjustments, *e.g.*, from too much water, blockage from structural movement, may be necessary.

5) Use smaller pipes and pumps where practicable to reduce the limit of disturbance.

6) Access

   When designing access for construction, identify the trees either to be removed or retained. It may be necessary to design a meandering access path to maximize tree retention. Look for gaps between trees onsite and locate the access road in these areas to minimize tree removal.

   Access roads, if necessary, should be designed and constructed to prevent soil compaction and protect tree roots. Roots subject to heavy equipment disturbance may be damaged and unable to have air exchange necessary for tree survival. Placement of adequate mulch (generally minimum of 6"), mats on top of mulch, and another layer of mulch may help prevent compaction. An additional standard of < 8 psi may be required in sensitive areas. See details from M-NCPPC in Appendix C. Contact MDE to determine the information requirements necessary to justify alternate methods, lesser amounts of mulch, and other specifications for equipment access. Documentation must demonstrate that equipment operation will not result in compaction nor damage to tree roots based on site conditions, including soil properties.

   i) Mulch from the access road can be retained and spread to a depth of 2" across the project area after construction is completed.

   ii) Access roads are generally limited to < 12 feet in width. If MDE determines that the width is not appropriate, the width may be increased or further narrowed.

iii) Staging areas may have limited excavations after use is completed to create microtopography.

iv) Operating equipment in stream channels must be pre-approved and at selected locations only, if approving agencies determine that it is preferable to additional riparian area disturbance.

v) Set up activity boundaries to exclude travel through areas infested with non-native invasive species that could be moved by equipment and personnel. Consider options for the sequence of operations within the activity area and, where feasible, plan to enter areas infested with non-native invasive plant species last.

7) For legacy sediment removal projects, ensure that the construction plans show the historic wetland soil and basal gravel elevations and include details on keeping and protecting those layers in the construction narrative.

8) Tree Retention

i) If trees must be removed, select smaller trees < 24" or those which are not healthy. Pine plantations may be removed.

ii) Do not grub trees after cutting except in specifically approved areas. Cut the stump to the ground to allow the root system to remain. Use the remaining part of the tree as an instream structure, where appropriate. If wood is not used onsite for instream structures, retain material in the riparian area as woody debris. Plans should indicate where trees must be cut flush to the ground or when complete removal of tree and roots is allowed.

iii) When tree removal is needed for access, push selected trees down, so some roots remain in contact with soil.

iv) Install protection measures such as tree planking, root aeration mats, protective fencing before construction equipment enters the work site to protect remaining trees.

v) Tree roots must not be cut to install trenches for erosion control and silt fences. Prune tree roots as necessary for placement of erosion control structures. See sample drawing in Appendix C.

vi) In designing new slopes for channel banks (*e.g.* 3:1) the slope does not have to be homogeneous. The grading for the bank should not be continuous if trees are on the Bank, and ratios for slopes may be adjusted along the bank. Selected trees on the bank should be retained and bank grading should resume outside of area of influence of remaining trees.

9) Stabilization

i) Stabilization is required at the end of each day as construction progresses to reduce exposed bare soil. Cover bare soil at the end of each day with erosion control matting or mulch, which can be removed for the next day's work.

ii) If a pump is used for stream diversions, and the pump is removed each day, stabilize the site at the end of each work day. Cease operation of the pump at the end of the working day.

iii) Permanent stabilization mixes shall be of native wetland or riparian seed mix appropriate for the physiographic region. Straw mulch must be certified by the supplier as being weed-free.

iv) Mulch from the access road may be spread through the site to a maximum depth of 2 inches to help build organic matter.

Project Performance Standards

1) A performance bond or other assurance can be required to ensure that projects are constructed as approved.

2) Projects shall be designed and constructed to allow for further modification if performance standards are not met.

3) Design and install instream structures so that aquatic life can pass over, around, or through the structure at base flow. Use certified weed-free mulch, if needed, to prevent the introduction of non-native invasive plants. Ensure, to the extent practical, that fill and gravel are free of non-native invasive species and their propagules.

4) Water levels must not exceed authorized increases on other properties.

5) Design the project to restore hydroperiods which are appropriate for the site and soil type. Most forested wetland have fluctuating water levels; soil properties can be indicative of previously existing hydroperiods.

6) Fill placed in streams or floodplains to raise elevation of stream beds must not reduce existing spring flow contributions to the stream.

7) Structures must maintain integrity and not result in additional erosion.

Vegetation Performance Standards

1) MDE may specify that remaining forested wetlands remain predominantly forested or at a certain amount of forest canopy cover post-construction, and after water level increases.

Structures and other features which raise water levels to result in unacceptable tree mortality or plant community changes shall be modified to restore desirable water levels and hydroperiod in the wetland. Example: retain 40 square feet of basal area, evenly distributed without major gaps, per acre. This is commonly used in forest harvest practices in streamside management zones.

2) Additional plantings or seeding may be recommended to restore missing or limited plant strata. Protection will likely be necessary to prevent herbivory.

Special Habitat Standards

1) MDE may require site-specific conditions and standards to protect or improve habitat for rare species or plant communities, or areas of high quality natural or aquatic resources.

2) Onsite monitors/inspectors may be required in highly sensitive areas with specific protection measures. Monitors may be required to report and consult with regulatory agencies throughout construction and prior to deviating from any approved plans.

Post-Construction

1) After final construction is complete, confirm that flow will be non-erosive as designed through the altered channel and its structures. Adjust channel geometries as necessary if flow was found to be erosive.

2) Straw mulch should consist of wheat, barley, oat or rye straw, and should not be musty, dusty, or of low quality. See details in Appendix C for mulch application.

3) Plantings must be species native to the physiographic region. Tree and shrub plantings must be protected from herbivory, and replaced as needed. Repeated monitoring, maintenance, and remediation may be necessary to achieve success of planted vegetation. After the activity is completed, it may be necessary to monitor for NNIS and follow up with treatments. Plan ahead to obtain resources to monitor the site for new NNIS or the spread of existing populations, and to treat NNIS as needed.

4) While some species are less prone to herbivory by deer (sycamore *Platanus occidentalis,* spicebush *Lindera benzoin),* avoid homogenization of riparian areas and include additional species, preferably mast-producing trees. Protection from white-tailed deer and other herbivores may be necessary to protect tree plantings. Recommendations are summarized in Bulletin 354 Managing Deer Damage in Maryland, Maryland Cooperative Extension: https://extension.umd.edu/resource/deer-damage

5) In order to help address concerns due to loss of larger trees, when trees are removed, planting of some larger of 2" DBH is encouraged among smaller stock. Protective measures should use cages or fencing.

6) Modify structures as needed to ensure that surface and groundwater are at approved and desired levels to maintain desired vegetation.

7) Modify, repair, or replace failed structures. Remove material which may threaten infrastructure.

Temporary Impacts and "Relocation"

1) Temporary impacts in nontidal wetlands shall be monitored by protocols demonstrating that the same type of wetland vegetation community (*e.g.* forested) will be established, surface and groundwater levels are at approved elevations for approved durations. While not necessarily required for non-mitigation projects, protocols and performance standards for mitigation sites may be a useful template. Protocols and standards for nontidal wetland mitigation projects are in Appendix D.

2) The raising of water levels may need to be done in stages to minimize shock to existing vegetation.

Monitoring

1) Submit required monitoring reports to MDE on the specified schedule in the authorization and include all required information.

2) Reports should include background information and previous assessments used, as well as photos pre-and post-construction.

3) Monitor to ensure that temporarily disturbed wetlands have been restored, or will re-establish, the desired nontidal wetland vegetation and hydrology.

4) Reports must indicate pre- and post-construction flow regime (perennial, intermittent, or ephemeral).

5) Use monitoring measures and standards required in the authorization.

6) For streams: Provide information on structural integrity, longitudinal profiles and cross sections; photos, pebble counts; canopy cover over stream. Summary stream geomorphologic data presented in a side by side analysis for the design, reference, and as-built channels should be provided. Flow should be evaluated to ensure passage over, around, or through structures at base flow.

7) Biological: A quantitative survey for benthic macroinvertebrates and fish habitat assessment shall be conducted at designated monitoring locations using a modified MBSS methodology for specified projects. Persons with current certifications are listed at the following Maryland Department of Natural Resources webpage: https://dnr.maryland.gov/streams/Pages/mbssregistry.aspx

8) Physical stream habitat: An assessment of stream habitat using a method approved by MDE shall be performed.

9) Special monitoring requirements may be required, such as stream water temperature and presence of rare species.

Maintenance

a) Cages or fencing are preferred over tubes, especially for tree health and aesthetic concern. However, for certain species such as sycamore, which are less palatable, or areas on steep slopes may not need additional protections from deer.

b) Remove invasive species.

c) Re-plant as needed to meet performance standards.

d) Adjust structures to meet appropriate and approved water levels to meet performance standards for stream channel and riparian area vegetation.

Next Steps

This guidance is subject to revision as new information becomes available and user feedback and recommendations are considered. User feedback is encouraged. MDE may modify the assessment method as a result of testing and new information. Other modifications to the assessment may be made by MDE in the future for consistency with other assessments for stream mitigation and regulatory nontidal wetland impacts under development by the U.S. Army Corps of Engineers and partnering agencies.

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Appendix A

Key Wildlife Habitats

Appendix A-1
Key Wildlife Habitats for the Piedmont

The Maryland State Wildlife Action Plan forms the blueprint for the conservation of priority species and habitats over a 10-year period (2015-2025; Maryland Department of Natural Resources 2015 https://dnr.maryland.gov/wildlife/Pages/plants_wildlife/SWAP_Submission.aspx). The plan identifies 610 animal species considered to be Species of Greatest Conservation Need (SGCN), including all state- and federally listed Threatened or Endangered species, rare species, endemic species, declining species, and responsibility species for which Maryland harbors a significant portion of the overall population. Because of the strong tie between species and habitats, it is critical to identify those habitats that support SGCN in order to conserve them. In general, the term "habitat" is described as the physical and biological environment that provides the necessary food, shelter, and other needs of a particular animal, plant, or other organism. Key Wildlife Habitats are no different in concept with the exception that the species dependent upon those habitats are considered Species of Greatest Conservation Need (SGCN). These habitats serve as critical foundations and support networks not only for SGCN but for all plant and animal species in Maryland.

Key Wildlife Habitats (KWH) are structured as ecological cover types based primarily on vegetation for most habitats, since vegetation typically reflects biological and ecological patterns across the landscape. Wetland and terrestrial KWH are organized into a simple classification scheme which is scalable, allowing for compatibility with other ecological classifications. At the local level, this classification scheme is closely related to Maryland's natural community classification (Harrison 2016). This classification is a relatively fine-scaled classification system that uses an ecologically-based hierarchy and grouping of vegetation associations from the U.S. National Vegetation System (Federal Geographic Data Committee 2008) as the foundation.

In riparian areas, terrestrial and wetland Key Wildlife Habitats are associated with stream and river habitats. These aquatic habitats are characterized into KWH types based on variables known to influence stream and river habitats at various spatial scales such as stream slope, size, elevation, climate, and geology. Stream and river KWH descriptions, as well as lists of SGCN associated with all KWH types, can be found at https://dnr.maryland.gov/wildlife/Documents/SWAP/SWAP_Chapter4.pdf

The best available current information regarding the description, condition, and distribution of wetland and stream Key Wildlife Habitats in the Piedmont is provided below (Maryland DNR 2015). Statewide general location maps and county distributions for KWH are presented in this document, along with statewide examples of public lands to visit, signature state rare plants, and state rare natural communities where relevant. These maps should be viewed as only generalized range maps, rather than depicting the full and complete distribution of habitats, especially for small wetland areas.

Montane-Piedmont Floodplain

Richard Wiegand, MD DNR

The Montane-Piedmont Floodplain key wildlife habitat encompasses a wide variety of floodplain habitats along small streams and large river systems in the Piedmont and mountain regions of Maryland. These habitats are very diverse with species distributions influenced by geology, soil properties, and flooding regimes. Temporarily and intermittently flooded bottomland forests are prominent along many of the rivers and are frequently characterized by species such as sycamore *(Platanus occidentalis)*, silver maple *(Platanus occidentalis)*, black walnut *(Juglans nigra)*, river birch *(Betula nigra)*, boxelder *(Acer negundo)*, pawpaw *(Asimina triloba)*, and American elm *(Ulmus americana)*. Distinct alluvial landforms such as gravel bars, levees, terraces, old oxbows, and sloughs are usually present at varying scales along larger rivers. Young, flood-scoured woodlands sometimes occur along shoreline areas and islands, especially in high-gradient rocky sections and along flood-deposited sand and gravel bars. Such areas are frequently dominated by dense, nearly pure stands of small (2-8 m tall) sycamore *(Platanus occidentalis)*, boxelder *(Acer negundo)*, river birch, and green ash *(Fraxinus pennsylvanica)* trees. Frequently embedded within floodplain forests are floodwater pools and seasonally flooded backswamps and sloughs dominated by red maple *(Acer rubrum)*, silver maple, sweetgum *(Liquidambar styraciflua)*, and hydrophytic oaks such as pin oak *(Quercus palustris)* and swamp white oak *(Quercus bicolor)*. These backwater areas usually exhibit distinctive hummock-and-hollow microtopography with maximum flood depths of 50-70 cm. along smaller, higher gradient streams, where the floodplain is narrower and alluvial landforms develop at much smaller scales, mesophytic species may occur. Commonly encountered is a mixture of bottomland and mesophytic species which include tulip-poplar *(Liriodendron tulipifera)*, sugar maple *(Acer saccharum)*, basswood *(Tilia americana)*, American beech *(Fagus grandifolia)*, and white pine *(Pinus strobus)*. At higher elevations, eastern hemlock *(Tsuga canadensis)*, black cherry *(Prunus serotina)*, yellow birch, and dense thickets of great laurel *(Rhododendron maximum)* are usually prominent.

County Distribution: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Washington

Places to Visit: C&O National Historical Park, Gunpowder Falls State Park, Patapsco Valley State Park, Susquehanna State Park

Signature State Rare Plants: Harperella (*Harperella nodosa*), Virginia mallow (*Sida hermaphrodita*), valerian (*Valeriana pauciflora*), Blue Monkshood (*Aconitum unciniatum*), Snowy Campion (*Silene nivea*), winged loosestrife (*Lythrum alatum*), blue wild indigo (*Baptisia australis*)

State Rare Natural Communities: River Scour Woodland, Riverside Prairie

Mapped Locations of Montane-Piedmont Floodplains in Maryland. Sources: MD DNR, FEMA.

Montane-Piedmont Seepage Swamps

Richard Orr

Jessica McPherson

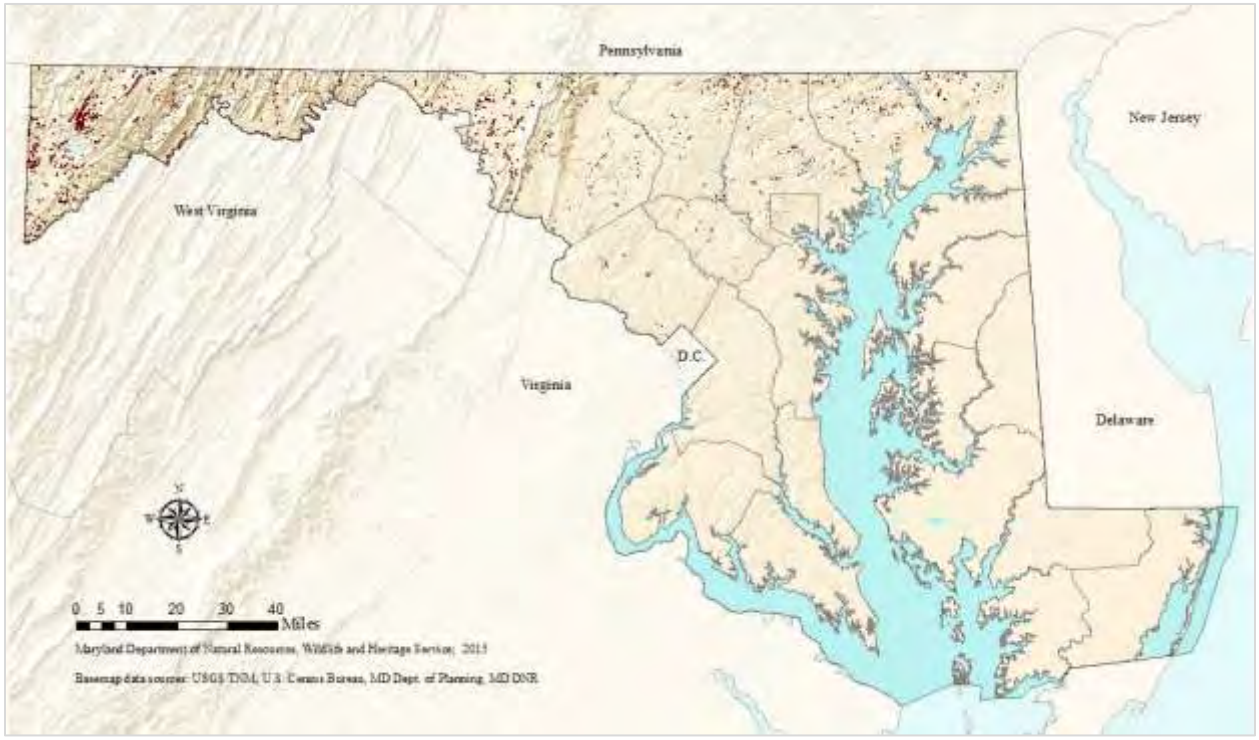
The Montane-Piedmont Acidic Seepage Swamp key wildlife habitat of the Piedmont and mountain regions is characterized by gently sloping seepage swamps of small headwaters, large spring seeps, ravine bottoms, and toe-slopes. Seepage swamps develop where groundwater is forced to the surface along an impermeable clay or rock layer due to hydrostatic pressure resulting from gravity or artesian flow. They often have a diffuse drainage pattern of braided channels and rivulets that typically remain saturated throughout the year due to perennial groundwater seepage. The soils are acidic and derived from the weathering of sandstone, quartzite, and granitic bedrock. In this case, the hydrology and acidic soils of seepage swamps in the Piedmont and mountain regions combine to support a very distinctive flora. Acidic Seepage Swamps are structurally forests and woodlands with canopies ranging from closed to semi-open canopy. Canopy trees commonly include red maple *(Acer rubrum)*, tulip-poplar *(Liriodendron tulipifera)*, black gum *(Nyssa sylvatica)*, and yellow birch *(Betula alleghaniensis)*, red spruce *(Picea rubens)*, eastern hemlock *(Tsuga canadensis)* at higher elevations. Small openings of shrubs and herbs are typical in areas of windfall or beaver activity. Shrubs vary depending on the region and elevation but common species may include winterberry *(Ilex verticillata)*, swamp azalea *(Rhododendron viscosum)*, highbush blueberry *(Vaccinium corymbosum)*, great-laurel *(Rhododendron maximum)*, mountain-laurel *(Kalmia latifolia)*, speckled alder *(Alnus incana* spp. *rugosa)*, and southern arrow-wood *(Viburnum dentatum)*. The forest floor is comprised of sphagnum moss covered hummocks and mucky hollows frequently dominated by skunk cabbage *(Symplocarpus foetidus)*, American false-hellebore *(Veratrum viride)*, and cinnamon fern *(Osmunda cinnamomea)*. Other common associates may include long sedge *(Carex folliculata)*, gray bog sedge *(Carex canescens)*, three-seed sedge *(Carex trisperma var. trisperma)*, white-edged sedge *(Carex debilis)*, marsh-marigold *(Caltha palustris)*, and various orchids, buttercups, and asters.

County Distribution: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Washington

Places to Visit: Cranesville Swamp (The Nature Conservancy), Finzel Swamp (The Nature Conservancy), Mt. Nebo Wildlife Management Area, Savage River State Forest, Sugarloaf Mountain

Signature State Rare Plants: Nannyberry (*Viburnum lentago),* Clinton lily *(Clintonia borealis)*

State Rare Natural Communities: High Elevation Seepage Swamp, Montane-Piedmont Acidic Seepage Swamp



Mapped Locations of Montane-Piedmont Acidic Seepage Swamps in Maryland. Sources: MD DNR, NETWHCS, Terrestrial Ecological System for the U.S., USFWS.

The Montane-Piedmont Basic Seepage Swamp key wildlife habitat is characterized by saturated deciduous forests of gently sloping stream headwaters, large spring seeps, and lateral areas in ravines and stream bottoms where groundwater emerges at the base of slopes. Habitats are underlain by metabasalt (greenstone), base-rich granite, calcareous shale, and limestone, and usually have considerable cover of bouldery, cobbly, and gravelly alluvium; braided seeps and stream channels; moss (*Sphagnum* spp.) covered hummocks; and muck-filled depressions. Soils range from strongly acidic to circumneutral, with moderately high calcium and magnesium levels.

Jason Harrison, MD DNR

County Distribution: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Washington

Places to Visit: Catoctin Mountain Park, Gunpowder Falls State Park, Patapsco Valley State Park

Signature State Rare Plants: Glade spurge/Darlington's spurge (*Euphorbia purpurea),* queen-of-the-prairie (*Filipendula rubra), s*wamp lousewort (*Pedicularis lanceolata)*

State Rare Natural Community: Montane-Piedmont Basic Seepage Swamp

Mapped Locations of Montane-Piedmont Basic Seepage Swamps in Maryland. Sources: MD DNR, USFWS.

Piedmont Seepage Wetland

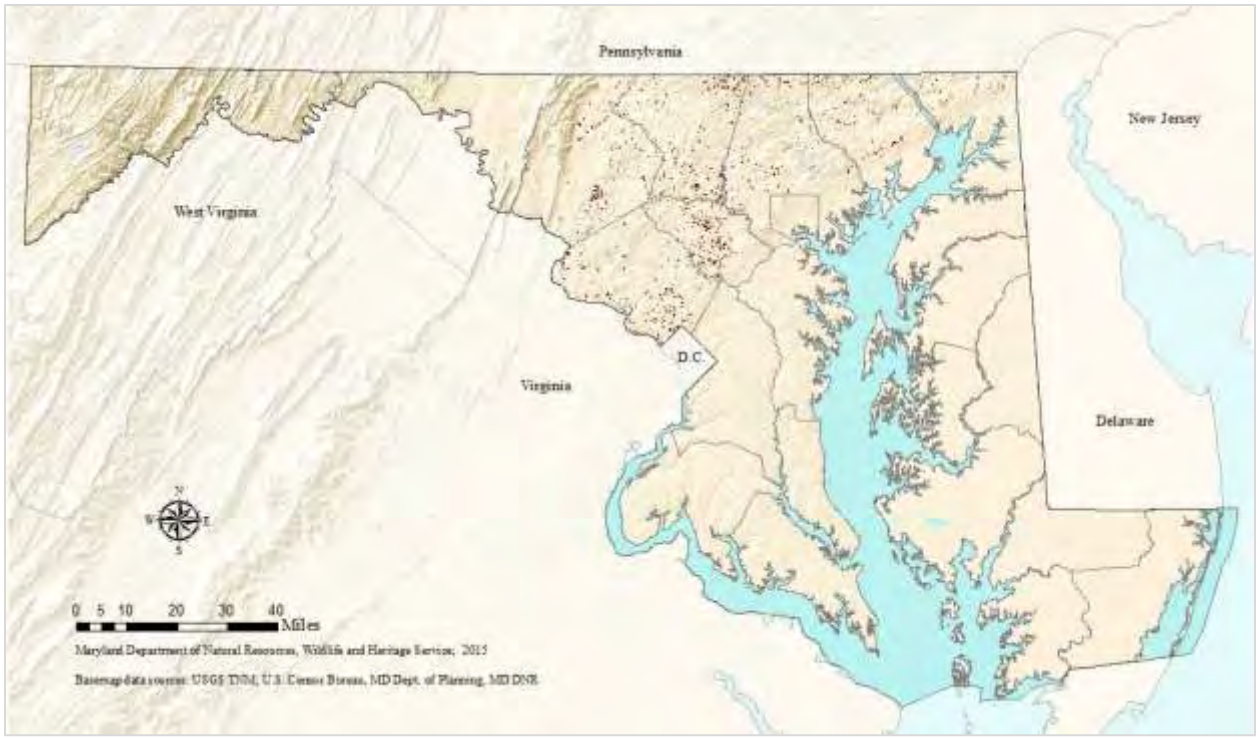
Bonnie Ott

The Piedmont Seepage Wetland key wildlife habitat encompasses open, graminoid-dominated meadows and shrub swamps scattered throughout low stream valleys of the Piedmont. They are common features at the toeslopes of rolling hills and margins of floodplains where groundwater seepage can be found throughout much of the year. The water table is usually at or near the surface throughout much of the growing season causing most habitats to remain saturated, but conditions may vary yearly from site to site. The substrates of Piedmont Seepage Wetlands are primarily comprised of mineral soils with mucky, organic surficial layers. The vegetation structure varies from graminoid-dominated meadows of tussock sedge *(Carex stricta)*, common rush *(Juncus effusus)*, wood reedgrass *(Cinna arundinacea)*, and rice cutgrass *(Leersia oryzoides)* to a patchwork of shrub swamps dominated by alder *(Alnus* spp.*)*, meadowsweet *(Spiraea* spp.*)*, southern arrow-wood *(Viburnum dentatum)*, buttonbush *(Cephalanthus occidentalis)*, spicebush *(Lindera benzoin)*, marsh rose *(Rosa palustris)*, and black willow *(Salix nigra)*. Other common species include jewelweed *(Impatiens* spp.*)*, skunk cabbage *(Symplocarpus foetidus)*, sensitive fern *(Onoclea sensibilis)*, wood reedgrass *(Cinna arundinacea)*, woolgrass *(Scirpus cyperinus)*, Joe pye-weed *(Eupatorium dubium)*, American golden saxifrage *(Chrysosplenium americanum)*, sallow sedge *(Carex lurida*), tearthumbs *(Polygonum* spp.*)*, and marsh fern *(Thelypteris palustris var. pubescens)*. In addition, purple loosestrife *(Lythrum salicaria)*, common reed *(Phragmites australis)*, Japanese stilt-grass *(Microstegium vimineum)*, and reed canary grass *(Phalaris arundinacea)* are frequently reported non-native invasive plants in these habitats. Though trees are relatively unimportant in these habitats, woody plant succession of red maple *(Acer rubrum)* is a common problem that usually indicates a cessation of grazing or other forms of disturbance.

County Distribution: Baltimore, Carroll, Cecil, Frederick, Harford, Howard, Montgomery
Places to Visit: Fair Hill Natural Resource Management Area, Rocks State Park, Eden Mill Nature Center, Gunpowder Falls State Park, Little Bennett Regional Park

Signature State Rare Plants: Canada burnet (*Sanguisorba canadensis)*

State Rare Natural Community: Montane **-** Piedmont Wet Meadow/Fen



Mapped Locations of Piedmont Seepage Wetlands in Maryland. Sources: MD DNR, NETWHCS.

Piedmont Upland Depression Swamp

Jason Harrison, MD DNR

The Piedmont Upland Depression Swamp key wildlife habitat includes seasonally flooded forested wetlands characterized by shallow bedrock or clay hardpans that impede soil drainage. This results in standing water throughout the early part of the growing season, followed by a period of drawdown. The hydroperiods are variable between swamps and largely depend on rainfall and drought cycles. The forested canopy structure of Upland Depression Swamps ranges from open to closed and is primarily oak dominated with other hardwoods less frequent. Common tree species include willow oak *(Quercus phellos)*, pin oak *(Quercus palustris)*, swamp chestnut oak *(Quercus michauxii)*, swamp white oak *(Quercus bicolor)*, green ash *(Fraxinus pennsylvanica)*, red maple *(Acer rubrum)*, and black gum *(Nyssa sylvatica)*. In the understory, shrubs and vines are common but variable, often including an abundance of common greenbrier. The herbaceous layer is often sparse and may include species of sedges, manna-grasses, and rushes. Slightly elevated hummocks of *Sphagnum* mosses frequently form large patches. Piedmont Upland Depression Swamps are isolated wetlands subject to major disturbances such as logging, draining, and development. In Maryland, many finer-scale plant communities associated with Piedmont Upland Depression Swamps are considered rare.

County Distribution: Baltimore, Carroll, Cecil, Frederick, Harford, Howard, Montgomery

Places to Visit: C&O Canal National Historical Park, Hoyles Mill Conservation Park

State Rare Natural Community: Upland Depression Swamp

Mapped Locations of Piedmont Upland Depression Swamps in Maryland. Source: MD DNR.

Vernal Pool

James McCann, MD DNR

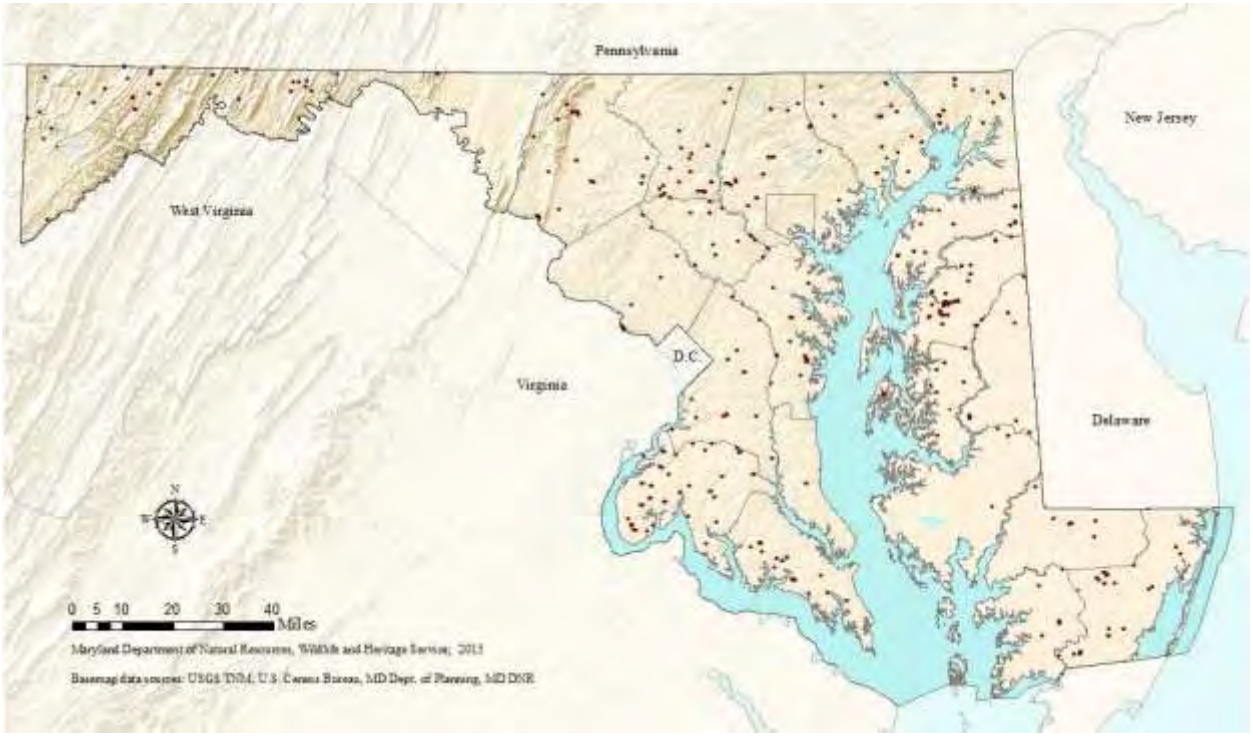
The Vernal Pool key wildlife habitat is defined as small (~0.1-2 ha), non-tidal palustrine forested wetlands. They exhibit a well-defined, discrete basin and lack a permanent, above-ground outlet. The basin overlies a clay hardpan or some other impermeable soil or rock layer that impedes drainage. As the water table rises in fall and winter, the basin fills forming a shallow pool. By spring, the pool typically reaches maximum depth (~0.5-2.5 m) following snowmelt and the onset of spring rains. By mid- to late summer, the pool usually dries up completely, although some surface water may persist in relatively deep basins, especially in years with above average precipitation. This periodic seasonal drying prevents fish populations from becoming established, an important biotic feature of Vernal Pools. Many species have evolved to use these temporary, fish-free wetlands. Some are obligate vernal pool species, so-called because they require a Vernal Pool to complete all or part of their life cycle. Vernal Pools occur throughout the state as scattered, isolated habitats. They are most numerous on the Lower Coastal Plain, especially on the mid to upper Eastern Shore, and uncommon west of the Fall Line. They are typically situated in low areas or depressions in a

forest, but they can also occur in floodplain forests as isolated floodwaters, among backwaters of old beaver impoundments, old sinkholes, or as perched spring- or seep-fed basins along mountain slope benches, or at the base of slopes. Vernal Pools may persist in cleared areas such as cropland, pastures, and clearcuts, but usually in a highly degraded ecological state. Because Vernal Pools occur throughout the state in a variety of forest types and settings, the vegetation in and around these habitats varies considerably. However, many Vernal Pools exhibit similar vegetative structure. For example, Pools tend to have a semi-open to closed forest canopy around them and the degree of canopy closure generally decreases with increasing pool size. The basin substrate consists of dense mats of submerged leaf litter and scattered, coarse woody debris. Herbaceous vegetation is usually absent to sparse in and around the basin, although small mossy patches frequently occur along the basin edge. A dense shrub layer may occur along the shoreline or in small patches within the basin, especially on the Coastal Plain, but many Pools also lack a well-developed shrub layer.

County Distribution: Statewide

Places to Visit: Seth Demonstration Forest

State Rare Natural Community: Vernal Pool



Mapped Locations of Vernal Pools in Maryland. Source: MD DNR.

Spring


MD DNR

The Spring key wildlife habitat is a concentrated discharge of groundwater at a small (usually < 1 m^2), distinct site or opening in the ground. Springs are uncommon, isolated features and most occur west of the Fall Line. They provide critical habitat for highly rare aquatic snails and subterranean invertebrates, salamanders, crayfish and other invertebrates. Because some Springs discharge directly into streams or wetlands, they also play a vital role in maintaining the ecological integrity of these habitats which, in turn, may harbor species of conservation concern (e.g., pearl dace, brook trout, rare dragonflies and damselflies). Springs emit groundwater due to hydrostatic pressure resulting from gravity or artesian flow, although other physical forces may play a role (e.g., buoyant effect of dissolved gases). Several types of Spring key wildlife habitats exist in Maryland including contact, scree, and fault Springs. Perhaps the most common type is fracture or crevice springs. Here, groundwater moves downward due to gravity, flowing through fractures and crevices underneath the ground and emerging as a spring where a major fracture in a rock formation occurs at the earth's surface, usually along a ravine or swale. The flow or discharge rates of Maryland's Springs range from less than one gallon per minute to nearly 10,000 gallons per minute. Springs differ from seeps in that the latter appear on the ground surface as broad, diffuse zones of wetness or percolation rather than distinct discharge sites. Also, seeps and associated wetlands often support distinct plant communities while springs are essentially aquatic and geological features.

County Distribution: Statewide

Places to Visit: Henryton Spring, Annapolis Rock Spring

Mapped Locations of Springs in Maryland. Sources: MD DNR, Geographic Names Information System (USGS).

Coldwater Stream

Richard Wiegand, MD DNR

Coldwater Streams comprise approximately 2,750 miles of Maryland's freshwater streams and are unique in their form, function, and biota. They are most common in the Appalachian Plateau and Ridge and Valley physiographic provinces, particularly in the Youghiogheny and North Branch Potomac drainages, but are also found in the Piedmont physiographic province within the Middle Potomac, Susquehanna, Gunpowder, and Patapsco drainages. Characterized by a maximum daily mean water temperature of less than 20° C and dissolved oxygen levels greater than 5 mg/L, these streams are typically found only in the headwater reaches of a watershed. Most are riffle-dominated, high gradient (>2%) streams with well-shaded riparian canopies allowing for mechanical aeration and regulation of water temperature. Fallen trees and submerged logs play an important role in shaping Coldwater Stream channels, creating pools and slow-water areas beneficial to aquatic species. Logs and leaf litter are also a primary source of organic matter forming the base of the food web in these streams. Beaver activity along Coldwater Streams represents an important form of natural disturbance and creates habitat heterogeneity. Beaver impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife species of greatest conservation need. Compared to downstream and warm water streams, aquatic biodiversity and productivity are low, with few fish and benthic

macroinvertebrate species, often occurring in low abundance. Brook trout, Maryland's only native trout species, are found in these streams along with introduced brown and rainbow trout. Common nongame species include mottled and Blue Ridge sculpin, longnose dace, and creek chub. Stoneflies of the genera *Sweltsa* and *Tallaperla* are considered coldwater obligate taxa – found only in these habitats. Mayflies of the genera *Ephemerella, Epeorus, Stenonema*, and *Paraleptophlebia* and stoneflies often dominate the benthic macroinvertebrate community. In contrast to the low diversity of fish species, Coldwater Streams support the greatest diversity of aquatic and semi-aquatic salamanders in the State, including spring *(Gyrinophilus porphyriticus)*, seal, and Allegheny mountain dusky salamanders *(Desmognathus ochrophaeus)*.

The quantity and quality of Coldwater Stream habitats have declined as a result of disturbance associated with agriculture and urban development. Although the historical extent of Coldwater Streams in Maryland is not known, this type of stream habitat was likely more widespread. Based on fish and benthic macroinvertebrate community assessments (MBSS 2007-2009), Coldwater Streams in Maryland are on average in fair condition, meaning that many of these streams are at least partially degraded. Seven percent of Coldwater Stream habitats are considered to be severely degraded and no longer support many of the species that make this key wildlife habitat unique. Thirty-six percent are in good condition and 7% of the approximately 2,750 miles of Coldwater Streams are considered "high quality waters" as designated in Maryland's Anti-degradation regulation (COMAR 26.08.02.04-1).

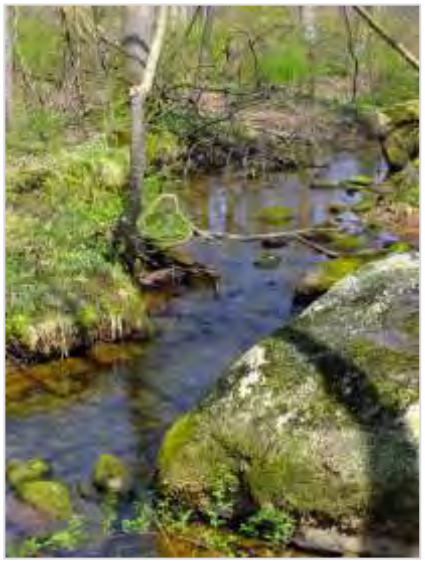
County Distribution: Allegany, Anne Arundel, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Prince George's, Washington

Places to Visit: Savage River State Forest, Big Run State Park, Gunpowder Falls State Park

Fig

Location of Coldwater Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR

Limestone Stream



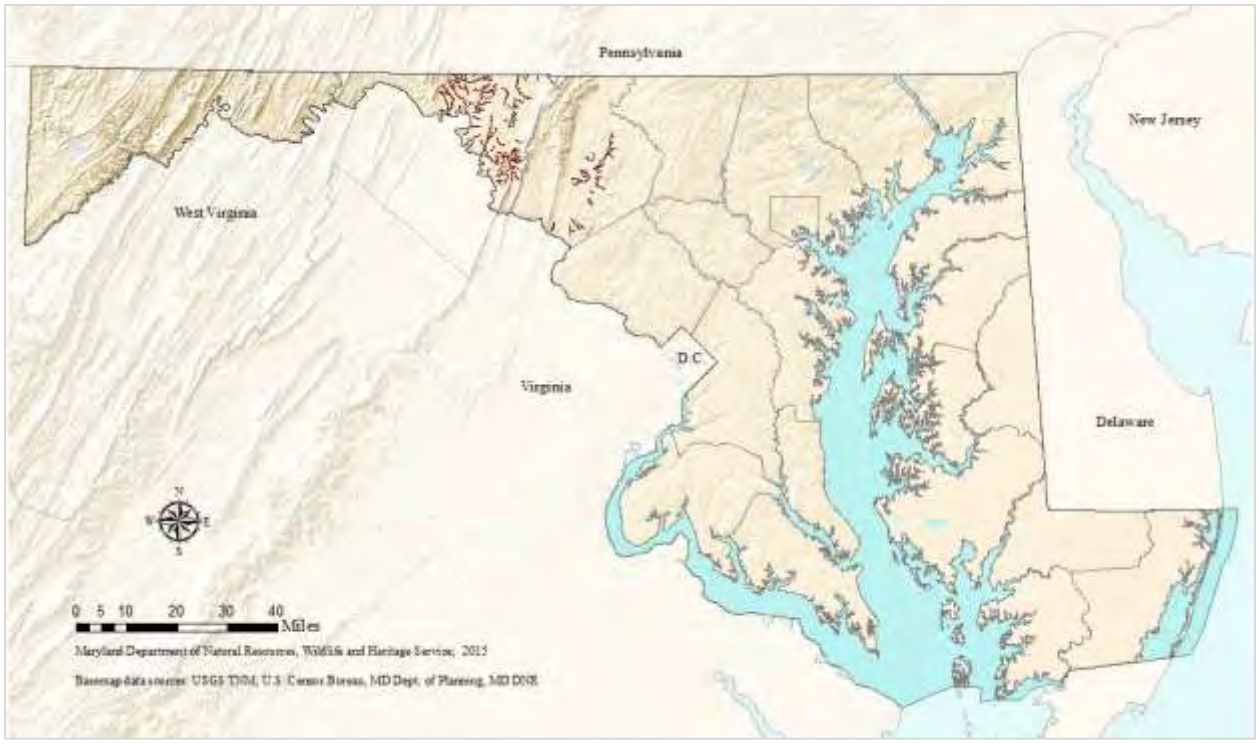
Wikimedia Commons

Limestone Streams are strongly influenced by the underlying geology of the Ridge and Valley physiographic province of Maryland, resulting in systems that are physically and chemically distinct from freestone (non-limestone) streams. Fractures, cracks, and channels are abundant in limestone, making springs and seeps common. This connectivity between groundwater and surface water serves to stabilize pH and water temperature. Submerged logs and tree roots are important features in Limestone Streams that shape stream channels, create pools and other slow-water areas beneficial to aquatic species. Logs and leaf litter form the base of the food web in these streams. Limestone Streams are also biologically unique. Plants, such as watercress *(Rorippa nasturtium-aquaticum)* and waterweed *(Elodea* spp.*)* are abundant, especially near spring sources and groundwater seeps. Fish and benthic macroinvertebrate communities tend to exhibit low diversity, but maintain high abundance in response to the stable water chemistry. Beaver activity along Limestone Streams represents an important form of natural disturbance and creates habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife species of greatest conservation need. Fish species common in Limestone Streams include checkered sculpin and pearl dace. In contrast to the region's freestone streams, which are dominated by mayfly and stonefly taxa, the benthic macroinvertebrate communities of Limestone Streams tend to be dominated by crustaceans, like scuds and aquatic sow bugs. An estimated 256 miles of Maryland's streams are limestone systems.

The majority of Maryland's Limestone Streams are located in the Ridge and Valley physiographic province, a predominately agricultural area that is under increasing pressure from suburban development. Agricultural land use practices have altered many of these streams by chemical and physical degradation. Based on fish and benthic macroinvertebrate community assessments (MBSS 2007-2009), the average condition of Limestone Streams in Maryland is fair. Twenty-five percent of Limestone Streams are considered degraded and no longer support many of the species that make these habitats unique.

County Distribution: Frederick, Washington

Places to Visit: Chesapeake and Ohio National Park at Antietam Creek, South Mountain State Park



Location of Limestone Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Piedmont Stream

Jay Kilian, MD DNR

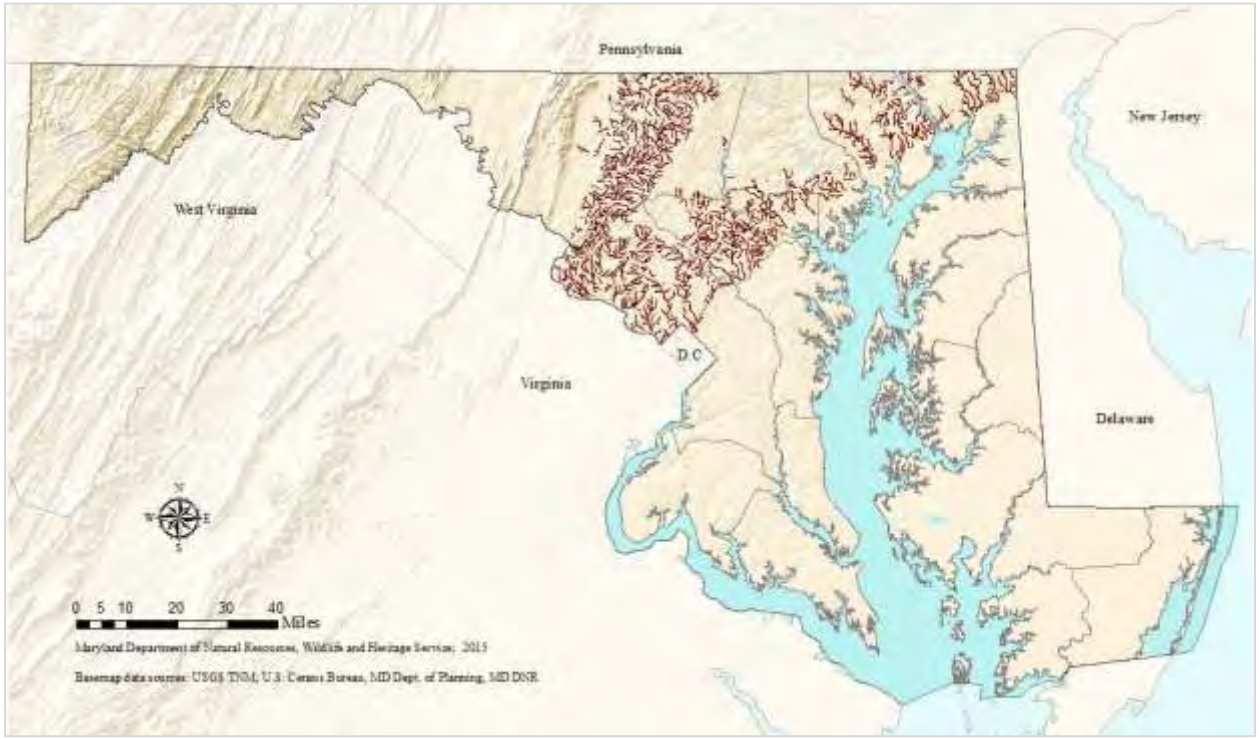
Piedmont Streams, located from the western boundary of the Catoctin Mountains in Frederick County to the eastern border at the Fall Line, are among the most biologically productive systems in the State. The physical and chemical nature of Piedmont Streams is governed largely by the varying topography and geology of the Piedmont physiographic province. Streams along the eastern edge share similar physical characteristics with the neighboring Coastal Plain. Here, streams are typically low to moderate in gradient (1-2%) with silt, sand, and gravel substrates. High gradient streams west of the Fall Line are characterized by cobble-boulder substrates with bedrock outcrops. Beaver activity along Piedmont Streams represents an important form of natural disturbance and creates habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife species of greatest conservation need. Fish species commonly found in Piedmont Streams include American eel, tessellated darter *(Etheostoma olmstedi)*, blacknose dace *(Rhinichthys atratulus)*, Blue Ridge sculpin *(Cottus caeruleomentum)*, common shiner *(Luxilus*

cornutus), longnose dace *(Rhinichthys cataractae)*, and bluntnose minnow *(Pimephales notatus)*. Streamside trees, roots, and submerged logs shape the stream channel and banks, creating pools and slow-water areas and important cover habitat for a variety of aquatic species. Logs and leaf litter are also a primary source of organic matter, forming the base of the food web in these streams. River basins with Piedmont Streams draining into Chesapeake Bay include Susquehanna, Elk, Bush, Gunpowder, Patapsco, the upper portion of the Patuxent River, Middle Potomac, and the eastern portion of the Potomac Washington Metro basins. There are approximately 1,800 miles of Piedmont Streams in Maryland.

Maryland's Piedmont physiographic province has been the center of urban and suburban development in the state. Stream degradation associated with urbanization has reduced biodiversity and ecological integrity of many Piedmont Streams draining urban centers. Based on fish and benthic macroinvertebrate community assessments (MBSS 2007-2009), the overall condition of Piedmont Streams on average is fair. Approximately 42% of Piedmont Streams are considered degraded. Only 12% of Piedmont Streams are considered to be in good biological condition. Approximately 54 of 1,800 miles of Piedmont Streams are considered "high quality waters" as designated by Maryland's Anti-degradation regulation (COMAR 26.08.02.04-1).

County Distribution: Anne Arundel, Baltimore, Carroll, Cecil, Frederick, Harford, Howard, Montgomery, Prince George's

Places to Visit: Gunpowder State Park, Patapsco Valley State Park, Seneca Creek State Park



Location of Piedmont Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Piedmont River

Jay Kilian, MD DNR

Large rivers of the Piedmont physiographic province represent transitional habitats between headwater streams and tidal portions of Chesapeake Bay. Physically, Piedmont Rivers consist of large riffle/run and pool sequences with substrate ranging from large boulders to sand and silt. As transition zones between upland habitats and lowlands of the Coastal Plain, Piedmont Rivers are home to a diverse aquatic fauna, often consisting of a mixture of piedmont and lowland species. Chemical, physical, and hydrologic stability typical of large Piedmont Rivers also contribute to high species diversity. Fish species common to Piedmont Rivers include American eel *(Anguilla rostrate)*, river chub *(Nocomis micropogon)*, spottail shiner *(Notropis hudsonius),* common shiner, white sucker *(Luxilus cornutus)*, pumpkinseed *(Lepomis gibbosus),* redbreast sunfish *(Lepomis auritus),* bluegill *(Lepomis macrochirus),* rock bass *(Ambloplites rupestris)*, quillback *(Carpiodes cyprinus),* margined madtom *(Noturus insignis),* and channel catfish *(Ictalurus punctatus).* Popular game fishes include smallmouth bass *(Micropterus dolomieu)* and largemouth bass *(Micropterus salmoides)*. Piedmont Rivers provide spawning habitat for many migratory fish species of the Chesapeake Bay such as blueback herring *(Alosa aestivalis),* alewife *(Alosa pseudoharengus),* white perch *(Morone americana),* yellow perch *(Perca flavescens)*, striped bass *(Morone saxatilis),* and several species of shad. Piedmont Rivers also serve as wintering habitats for migratory waterfowl. Although logs and leaf litter continue to play a large role in the food base of these systems, open tree canopies allow for the growth of periphyton, phytoplankton, and aquatic macrophytes providing additional sources of energy to the food chain. Connectivity between river channels and the adjacent floodplain is important for the movement and exchange of organic matter in these systems. Floodplains also provide refuge for aquatic species during periods of high flows. Piedmont River habitat can be found in portions of the Susquehanna, Gunpowder, and Patapsco Rivers, the upper portion of the Patuxent River, and the eastern portion of the Potomac Washington Metro, and Middle Potomac basins. There are approximately 270 miles of Piedmont River habitat in these basins.

Piedmont Rivers are located in highly urbanized portions of Maryland. Stressors associated with urbanization have had negative effects on these habitats. Combined sewer overflows designed to carry domestic, commercial, and industrial wastewater often deliver untreated sewage to Piedmont Rivers during storm flows. These outflows can reduce the biological health of these habitats. As with Highland Rivers, Piedmont Rivers have been impounded for drinking water reservoirs and for hydroelectric power generation. Impoundments have reduced the available habitat for several fish and mussel SGCN and also reduced upstream access to spawning grounds by many migratory fishes. The degradation of Piedmont and Coldwater Streams has negatively affected downstream Piedmont Rivers.

County Distribution: Baltimore, Carroll, Cecil, Frederick, Harford, Howard, Montgomery

Places to Visit: Patapsco Valley State Park, Gunpowder Falls State Park, Susquehanna State Park

Figure 0.1 Location of Piedmont Rivers in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Appendix A-2
Key Wildlife Habitats for the Coastal Plain

The Maryland State Wildlife Action Plan forms the blueprint for the conservation of priority species and habitats over a 10-year period (2015-2025; Maryland Department of Natural Resources 2015 https://dnr.maryland.gov/wildlife/Pages/plants_wildlife/SWAP_Submission.aspx). The plan identifies 610 animal species considered to be Species of Greatest Conservation Need (SGCN), including all state- and federally listed Threatened or Endangered species, rare species, endemic species, declining species, and responsibility species for which Maryland harbors a significant portion of the overall population. Because of the strong tie between species and habitats, it is critical to identify those habitats that support SGCN in order to conserve them. In general, the term "habitat" is described as the physical and biological environment that provides the necessary food, shelter, and other needs of a particular animal, plant, or other organism. Key Wildlife Habitats are no different in concept with the exception that the species dependent upon those habitats are considered Species of Greatest Conservation Need (SGCN). These habitats serve as critical foundations and support networks not only for SGCN but for all plant and animal species in Maryland.

Key Wildlife Habitats (KWH) are structured as ecological cover types based primarily on vegetation for most habitats, since vegetation typically reflects biological and ecological patterns across the landscape. Wetland and terrestrial KWH are organized into a simple classification scheme which is scalable, allowing for compatibility with other ecological classifications. At the local level, this classification scheme is closely related to Maryland's natural community classification (Harrison 2016). This classification is a relatively fine-scaled classification system that uses an ecologically-based hierarchy and grouping of vegetation associations from the U.S. National Vegetation System (Federal Geographic Data Committee 2008) as the foundation.

In riparian areas, terrestrial and wetland Key Wildlife Habitats are associated with stream and river habitats. These aquatic habitats are characterized into KWH types based on variables known to influence stream and river habitats at various spatial scales such as stream slope, size, elevation, climate, and geology. Stream and river KWH descriptions, as well as lists of SGCN associated with all KWH types, can be found at https://dnr.maryland.gov/wildlife/Documents/SWAP/SWAP_Chapter4.pdf

The best available current information regarding the description, condition, and distribution of wetland and stream Key Wildlife Habitats in the Coastal Plain is provided below (Maryland DNR 2015). Statewide general location maps and county distributions for KWH are presented in this document, along with statewide examples of public lands to visit, signature state rare plants, and state rare natural communities where relevant. These maps should be viewed as only generalized range maps, rather than depicting the full and complete distribution of habitats, especially for small wetland areas.

Coastal Plain Floodplain

The Coastal Plain Floodplain key wildlife habitat is characterized by a variety of flooded habitats that border Coastal Plain streams and rivers. These floodplain habitats are influenced by temporary or seasonal overbank flooding, groundwater seepage, and beaver activity. The vegetation of Coastal Plain Floodplains is both structurally and compositionally diverse, and often occurs as a mosaic of forests, woodlands, shrublands, and herbaceous communities. Species composition varies widely with stream order, soil type, and flooding regime. Floodplain forests of small intermittent streams and braided streams may support combinations of sycamore *(Platanus occidentalis)*, green ash *(Fraxinus pennsylvanica)*, red maple *(Acer rubrum)*, sweetgum *(Liquidambar styraciflua)*, black gum *(Nyssa sylvatica)*, river birch *(Betula nigra)*, swamp chestnut oak *(Quercus michauxii)*, and willow oak *(Quercus phellos)*. Diverse understories are often present and characterized by mixtures of American hornbeam *(Carpinus caroliniana)*, pawpaw *(Asimina triloba)*, American elm *(Ulmus americana)*, American holly *(Ilex opaca var. opaca)*, spicebush *(Lindera benzoin)* and herbs of Jack-in-the-pulpit *(Arisaema triphyllum)*, false nettle *(Boehmeria cylindrical)*, poison-ivy *(Toxicodendron radicans)*, Virginia creeper *(Parthenocissus quinquefolia)*, wood reedgrass *(Cinna arundinacea)*, and various sedges. Similarly, floodplain forests of larger Coastal Plain Rivers with well-drained terraces or natural levees will often support species such as tulip-poplar *(Liriodendron tulipifera)*, beech *(Fagus grandifolia)*, and box elder *(Acer negundo)*. Poorly drained floodplains, backswamps, and depressions of small Coastal Plain streams and rivers may support seasonally flooded swamps dominated by green ash, red maple *(Acer rubrum)*, and plants tolerant of fluctuating water levels such as lizard's-tail. Bald Cypress Swamps and Atlantic White Cedar Swamps are rare natural communities that are also associated with poorly drained settings in seasonally flooded floodplains. Both are associated with slow-moving Blackwater Streams such as those in the Pocomoke and Nanticoke River watersheds. Only 6 acres have been identified by the Maryland Department of Natural Resources as old growth on state lands.

Richard Wiegand, MD DNR

Floodplain pools, beaver ponds, and other open water habitats are also characteristic of Coastal Plain Floodplains. These habitats are subjected to irregular disturbances that change water levels, such as the breaching of beaver dams and storm events. These habitats are highly variable in size, structure, and species composition. They often support a variety of floating aquatic, emergent, and woody vegetation. Species common to these habitats include white water-lily *(Nymphaea odorata)*, spatterdock *(Nuphar advena)*, pondweeds *(Potamogeton* spp.*)*, duckweeds *(Lemna* spp.*)*, bladderworts *(Utricularia* spp.*)*, rice cutgrass *(Leersia oryzoides)*, common woodrush *(Luzula multiflora)*, smartweeds *(Polygonum* spp.*)*, pickerelweed *(Pontederia cordata)*, arrow-arum *(Peltandra virginica)*, three-way sedge *(Dulichium arundinaceum)*, broad-leaved cattail *(Typha latifolia)*, American bur-reed *(Sparganium americanum)*, swamp loosestrife *(Decodon verticillatus)*, and common buttonbush *(Cephalanthus occidentalis)*.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Kent, Prince George's, Queen Anne's, St. Mary's, Somerset, Talbot, Wicomico, Worcester

Places to Visit: Merkle Wildlife Sanctuary, Idylwild Wildlife Management Area, Pocomoke State Forest

Signature State Rare Plants: Flat-stem Spikerush (*Eleocharis compressa*), water-plantain spearwort (*Ranunculus ambigens*), catchfly cutgrass (*Leersia lenticularis*), veined skullcap (*Scutellaria nervosa*), red turtlehead (*Chelone obliqua*)

State Rare Natural Communities: Bald Cypress Swamp, Atlantic White Cedar Swamp

Mapped Locations of Coastal Plain Floodplains in Maryland. Sources: MD DNR, FEMA.

Coastal Plain Seepage Swamp

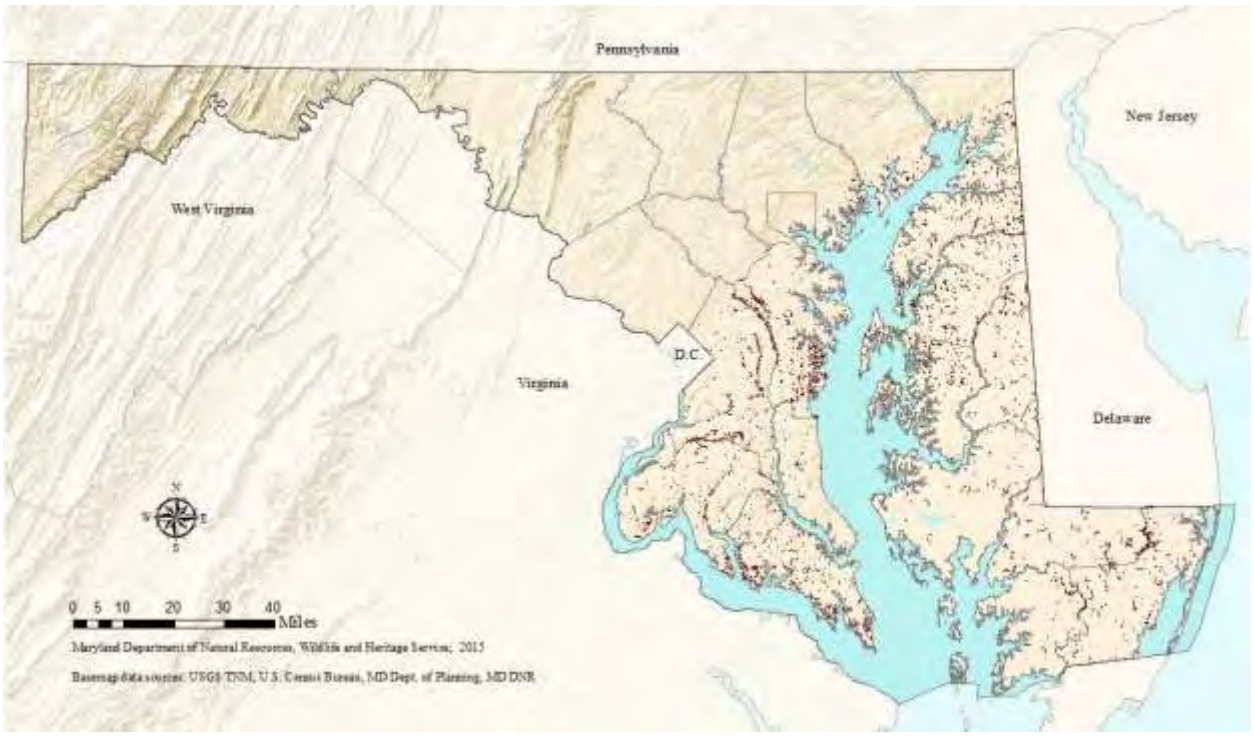
Richard Wiegand, MD DNR

The Coastal Plain Seepage Swamp key wildlife habitat is characterized by gently sloping forests of small headwaters, ravine bottoms, and toe-slopes where groundwater is discharged at ground surface and carried away as stream flow. Often the groundwater seepage is perennial and characterized by diffuse drainage and braided channels with sand, gravel, or peaty substrates. Soils are typically moderately to strongly acidic and nutrient-poor; however, basic seepage swamps may develop in ravines that have downcut into tertiary-aged shell marl deposits. Coastal Plain Seepage Swamps are associated with mostly closed to semi-open canopies of red maple *(Acer rubrum)*, black gum *(Nyssa sylvatica)*, tulip-poplar *(Liriodendron tulipifera)*, sweetbay magnolia *(Magnolia virginiana)*, green ash *(Fraxinus pennsylvanica)*, white ash *(Fraxinus americana)*, and pitch pine *(Pinus rigida)*. The shrub and herbaceous layers in many Coastal Plain Seepage Swamps are diverse and recognized by dense patches of skunk cabbage *(Symplocarpus foetidus)* and colonies of ferns such as cinnamon fern *(Osmunda cinnamomea)*, marsh fern *(Thelypteris palustris var. pubescens)*, royal fern *(Osmunda regalis var. spectabilis)*, New York fern *(Thelypteris noveboracensis)*, and netted chain fern *(Woodwardia areolata)*. Other notable plants include jewelweed *(Impatiens* spp.*)*, small green wood orchid *(Platanthera clavellata)*, Virginia bugleweed *(Lycopus virginicus)*, Jack-in-the-pulpit *(Arisaema triphyllum)*, false nettle *(Boehmeria cylindrical)*, and numerous sedges. In addition, hummocks of peat mosses can be quite abundant and diagnostic to Coastal Plain Seepage Swamps of acidic substrates. The shrub layer may include winterberry *(Ilex verticillata)*, sweet pepper-bush *(Clethra alnifolia)*, swamp azalea *(Rhododendron viscosum)*, spicebush *(Lindera benzoin)*, possum-haw *(Viburnum nudum)*, highbush blueberry *(Vaccinium corymbosum)*, and vines of poison-ivy *(Toxicodendron radicans)*, greenbrier *(Smilax* spp.*)*, and Virginia creeper *(Parthenocissus quinquefolia)*. Coastal Plain Seepage Swamps are naturally small-patched habitats vulnerable to hydrological disturbances, beaver activity, logging, and surface runoff.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester
Places to Visit: Elk Neck State Forest, Tuckahoe State Park, Pocomoke State Forest

Signature State Rare Plants: Swamp pink (*Helonias bullata),* dwarf huckleberry (*Gaylussacia dumosa)*

State Rare Natural Community: Coastal Plain-Piedmont Acidic Seepage Swamp



Mapped Locations of Coastal Plain Seepage Swamps in Maryland. Sources: MD DNR, USFWS.

Coastal Plain Flatwood and Depression Swamp

Scott Smith, MD DNR

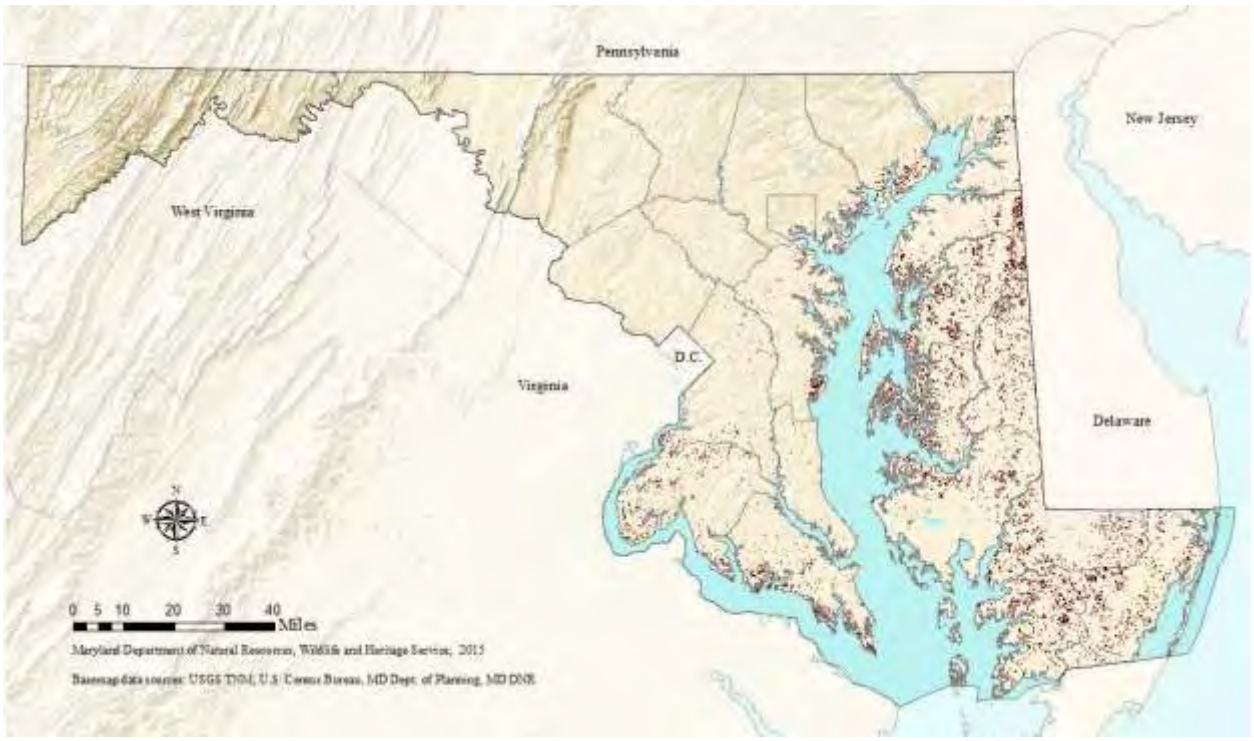
The Coastal Plain Flatwood and Depression Swamp key wildlife habitat includes seasonally flooded flatwoods and depressions of the Coastal Plain. These habitats develop on flat terraces and shallow depressions with seasonally perched water tables. This results in standing water throughout the early part of the growing season followed by a period of drawdown. Hydroperiods are variable between swamps and largely dependent on rainfall and drought cycles. The forested canopy structure of flatwoods and depression swamps range from open to closed with composition ranging from hardwood dominated to a mixtures of hardwoods and pines. Swamps dominated by oak species such as willow oak *(Quercus phellos)*, pin oak *(Quercus palustris)*, swamp chestnut oak *(Quercus michauxii)*, and cherrybark oak *(Quercus pagoda)* are generally considered as higher quality because much of today's remaining stands are characterized by successional hardwoods such as red maple *(Acer rubrum)*, sweetgum *(Liquidambar styraciflua)*, black gum *(Nyssa sylvatica),* and American holly *(Ilex opaca var. opaca)*. Loblolly pine *(Pinus taeda)* is a prominent component of many flatwoods on the lower Coastal Plain. Other species commonly encountered in these habitats include green ash *(Fraxinus pennsylvanica)*, overcup oak *(Quercus lyrata)*, and swamp tupelo *(Nyssa biflora)*. State rare natural communities within this key wildlife habitat include depressions with mixtures of Atlantic white cedar *(Chamaecyparis thyoides)*, swamp tupelo, pond pine *(Pinus serotina)*, and sweetbay magnolia *(Magnolia virginiana)*. In the understory, shrubs and vines are common but variable, often including an abundance of common greenbrier *(Smilax rotundifolia)*. The herbaceous layer is often sparse and may include species of sedges, manna-grasses, and rushes. Slightly elevated hummocks of sphagnum mosses frequently form large patches. Coastal Plain Flatwoods and Depression Swamps have been greatly reduced in extent in Maryland through ditching, draining, logging, and conversion to agriculture and pine plantations.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Blackwater National Wildlife Refuge, LeCompte Wildlife Management Area, Millington Wildlife Management Area, Third Haven Woods (The Nature Conservancy)

Signature State Rare Plants: Three-angle spikerush (*Eleocharis tricostata),* southern waxy sedge (*Carex glaucescens),* white-bracted boneset (*Eupatorium leucolepis)*

State Rare Natural Communities: Coastal Plain Non-Riverine Hardwood Swamps, Atlantic White Cedar Swamp, Upland Depression Swamp



Mapped Locations of Coastal Plain Flatwoods and Depression Swamps in Maryland. Source: MD DNR

Coastal Plain Seepage Bog and Fen

Wesley Knapp, MD DNR

The Coastal Plain Seepage Bog and Fen key wildlife habitat is a rare, small-patched habitat associated with seepage toeslopes, small stream bottoms, and the margins of long established millponds and sandpits. They typically develop at the base of sand and gravel terraces near streams where groundwater seepage is abundant and forced to the surface by an impermeable clay lens or aquiclude. The soils are usually peaty or sandy, very acidic, infertile, and often covered by dense mats of mosses (*Sphagnum* spp.) that support a unique flora. The term "bog" as applied to these wetlands, is a technical misnomer, since not all of these habitats are true peatlands and none is an ombrotrophic (i.e., fed by rainwater) system. This term, however, is now so widely used in the southeastern United States as a descriptor for open, acidic seepage wetlands that we have adopted it here for consistency. In Maryland, Coastal Plain Seepage Bogs and Fens exist in a variety of open settings and many are relicts of older, larger systems. Many natural examples have been destroyed by hydrologic alterations (e.g., ditching, draining, and impoundment construction), beaver activity, and a long history of fire suppression across the landscape. Remaining sites that support bog flora persist in artificially maintained habitats such as millponds, powerline rights-of-way, and sandpits where woody plant succession is usually controlled. The vegetation of Coastal Plain Seepage Bogs and Fens is very heterogeneous and patchy with scattered shrubs and graminoid dominated patches. The small openings found along the margins of slow-moving streams, millponds, and abandoned sandpits often support shrubs such as leatherleaf *(Chamaedaphne calyculata)*, big cranberry *(Vaccinium macrocarpon)*, sweet pepper-bush *(Clethra alnifolia)*, swamp loosestrife *(Decodon verticillatus)*, and giant cane *(Arundinaria gigantean)*. Hummocks of *Sphagnum* mosses are characteristic and usually support species such as northern pitcher-plant *(Sarracenia* spp.*)*, white beak-sedge *(Rhynchospora alba)*, rose pogonia *(Pogonia ophioglossoides)*, St. John's-wort *(Hypericum* spp.*)*, and Virginia meadow-beauty *(Rhexia virginica)*. Orchids, sundews *(Drosera* spp.*)*, bladderworts *(Utricularia* spp.*)*, and yellow-eyed grasses *(Xyris* spp.*)* are also common. Near the fall-line, globally rare Magnolia Bogs occur and share many floristic similarities to the New Jersey Pine Barrens region. Unlike true bogs, Magnolia Bogs are not characterized by accumulations of peat or organic soils. Nutrient poor and acidic seepage flow from groundwater often forms mucky depressions and braided channels around hummocks of sphagnum mosses. Historic accounts of Magnolia Bogs describe these areas with sweet bay and various shrubs fringing and forming clumps within a more open center dominated by herbaceous plants. Today, remaining examples exist mostly as open woodlands of black gum *(Nyssa sylvatica)* and sweet bay *(Magnolia virginiana)* with very dense shrubs and very small, scattered herbaceous patches. Shrubs common to these habitats include sweet bay, swamp azalea *(Rhododendron viscosum)*, highbush

blueberry *(Vaccinium fuscatum)*, fetterbush *(Leucothoe racemosa)*, dangleberry *(Gaylussacia frondosa)*, poison sumac *(Toxicodendron vernix)*, and Southern wild raisin *(Viburnum nudum).* Herbaceous openings include species such as cinnamon fern *(Osmunda cinnamomea)*, woolly panicgrass *(Dichanthelium acuminatum)*, partridge berry *(Mitchella repens)*, halberd-leaved greenbrier *(Smilax pseudochina)*, wild yam *(Dioscorea* spp.*)*, Indian cucumber-root *(Medeola virginiana)*, and primrose-leaved violet *(Viola primulifolia)*. Regionally uncommon or rare "bog" species persisting in Magnolia Bogs include bog goldenrod *(Solidago uliginosa var. uliginosa)*, ten-angled pipewort *(Eriocaulon decangulare)*, Long's rush *(Juncus longii)*, spoon-leaved sundew *(Drosera intermedia)*, red milkweed *(Asclepias rubra)*, and sheep-laurel *(Kalmia angustifolia)*.

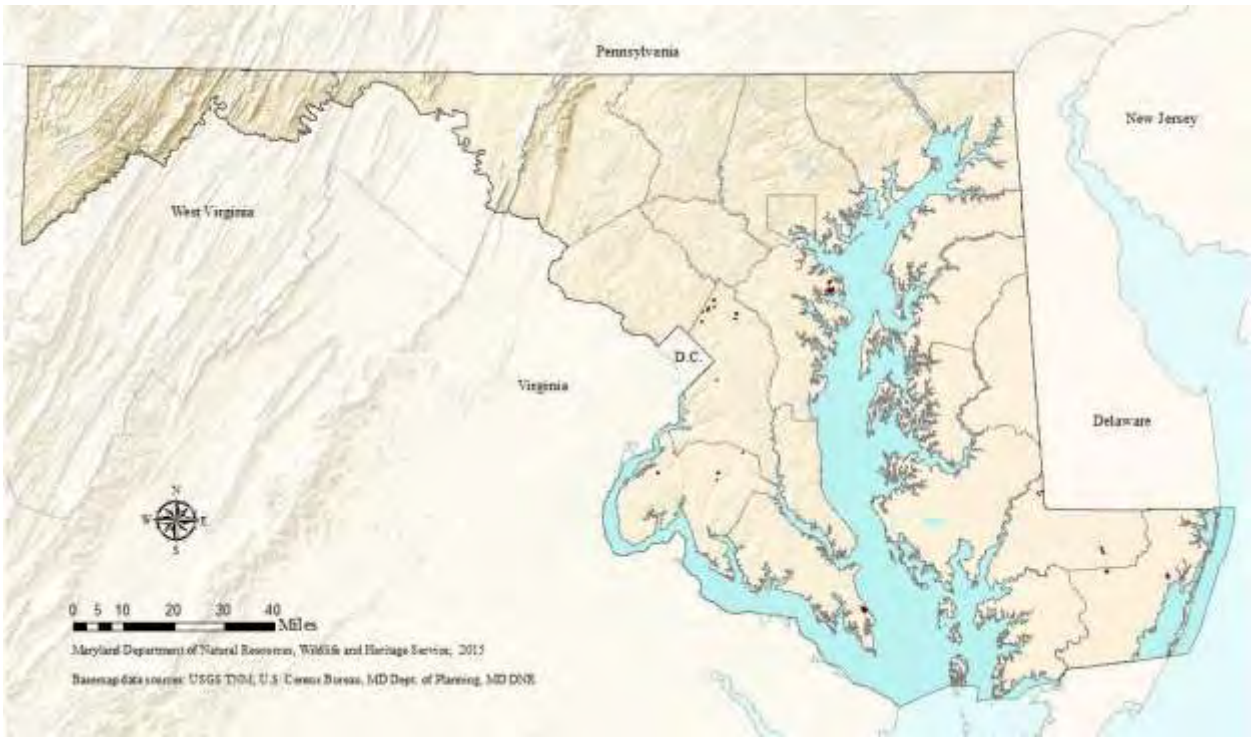
Sea-level Fens are small maritime seepage wetlands that occur above the high tide line at the bases of slopes where abundant groundwater discharges along the upper edges of estuarine bays. The hydrology of these sites is best characterized as saturated, although shallow standing water and small, muck-filled pools are locally present at all sites. Soils are characterized as organic and nutrient-poor. The vegetation exhibits characteristics of both inland seepage bogs and slightly brackish tidal marshes. Stands are generally a physiognomic mosaic of open woodland, scrub, and herbaceous patches. Woody species include red maple *(Acer rubrum)*, black gum *(Nyssa sylvatica)*, sweet bay *(Magnolia virginiana)*, and southern bayberry *(Morella cerifera)*. Characteristic herbs include twig rush *(Cladium mariscoides)*, beaked spikerush *(Eleocharis rostellata)*, white beaksedge *(Rhynchospora alba)*, spoon-leaved sundew *(Drosera intermedia)*, ten-angled pipewort *(Eriocaulon decangulare)*, coinleaf *(Centella erecta)*, brown-fruited rush *(Juncus pelocarpus)*, and bladderworts *(Utricularia* spp.*)*. Because of their small size and association with tidal salt marshes, Sea-level Fens are included as part of the Tidal Salt Marsh and Shrubland key wildlife habitat.

County Distribution: Anne Arundel, Calvert, Caroline, Cecil, Charles, Dorchester, Prince George's, Somerset, Wicomico, Worcester

Places to Visit: Suitland Bog

Signature State Rare Plants: New Jersey rush (*Juncus caesariensis),* Long's rush (*Juncus longii),* red milkweed (*Asclepias rubra),* leatherleaf (*Chamaedaphne calyculata),* brown-fruit rush (*Juncus pelocarpus),* northern pitcher plant (*Sarracenia purpurea)*

State Rare Natural Community: Coastal Plain-Piedmont Acidic Seepage Bog/Fen



Mapped Locations of Coastal Plain Seepage Bogs and Fens in Maryland. Sources: MD DNR, USFWS.

Vernal Pool


James McCann, MD DNR

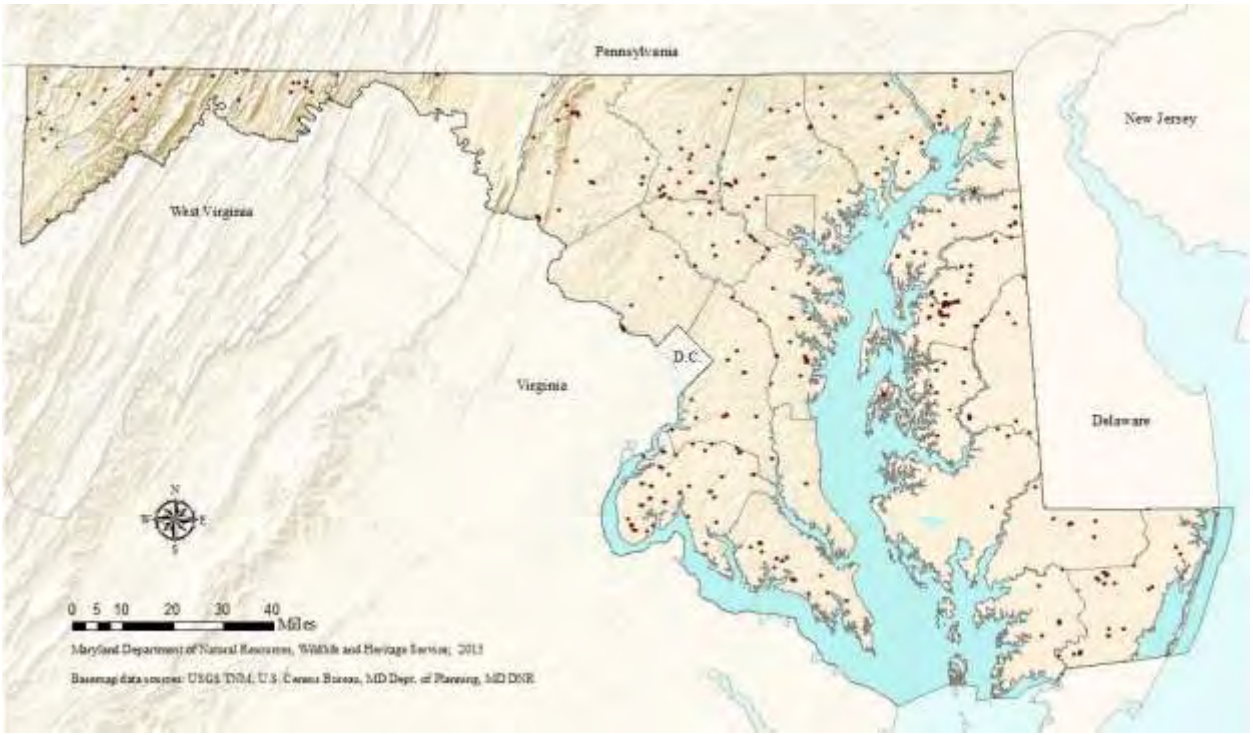
The Vernal Pool key wildlife habitat is defined as small (~0.1-2 ha), non-tidal palustrine forested wetlands. They exhibit a well-defined, discrete basin and lack a permanent, above-ground outlet. The basin overlies a clay hardpan or some other impermeable soil or rock layer that impedes drainage. As the water table rises in fall and winter, the basin fills forming a shallow pool. By spring, the pool typically reaches maximum depth (~0.5-2.5 m) following snowmelt and the onset of spring rains. By mid- to late summer, the pool usually dries up completely, although some surface water may persist in relatively deep basins, especially in years with above average precipitation. This periodic seasonal drying prevents fish populations from becoming established, an important biotic feature of Vernal Pools. Many species have evolved to use these temporary, fish-free wetlands. Some are obligate vernal pool species, so-called because they require a Vernal Pool to complete all or part of their life cycle. Vernal Pools occur throughout the state as scattered, isolated habitats. They are most numerous on the Lower Coastal Plain, especially on the mid to

upper Eastern Shore, and uncommon west of the Fall Line. They are typically situated in low areas or depressions in a forest, but they can also occur in floodplain forests as isolated floodwaters, among backwaters of old beaver impoundments, old sinkholes, or as perched spring- or seep-fed basins along mountain slope benches, or at the base of slopes. Vernal Pools may persist in cleared areas such as cropland, pastures, and clearcuts, but usually in a highly degraded ecological state. Because Vernal Pools occur throughout the state in a variety of forest types and settings, the vegetation in and around these habitats varies considerably. However, many Vernal Pools exhibit similar vegetative structure. For example, Pools tend to have a semi-open to closed forest canopy around them and the degree of canopy closure generally decreases with increasing pool size. The basin substrate consists of dense mats of submerged leaf litter and scattered, coarse woody debris. Herbaceous vegetation is usually absent to sparse in and around the basin, although small mossy patches frequently occur along the basin edge. A dense shrub layer may occur along the shoreline or in small patches within the basin, especially on the Coastal Plain, but many Pools also lack a well-developed shrub layer.

County Distribution: Statewide

Places to Visit: Seth Demonstration Forest

State Rare Natural Community: Vernal Pool



Mapped Locations of Vernal Pools in Maryland. Source: MD DNR.

Spring

MD DNR

The Spring key wildlife habitat is a concentrated discharge of groundwater at a small (usually < 1 m^2), distinct site or opening in the ground. Springs are uncommon, isolated features and most occur west of the Fall Line. They provide critical habitat for highly rare aquatic snails and subterranean invertebrates, salamanders, crayfish and other invertebrates. Because some Springs discharge directly into streams or wetlands, they also play a vital role in maintaining the ecological integrity of these habitats which, in turn, may harbor species of conservation concern (e.g., pearl dace, brook trout, rare dragonflies and damselflies). Springs emit groundwater due to hydrostatic pressure resulting from gravity or artesian flow, although other physical forces may play a role (e.g., buoyant effect of dissolved gases). Several types of Spring key wildlife habitats exist in Maryland including contact, scree, and fault Springs. Perhaps the most common type is fracture or crevice springs. Here, groundwater moves downward due to gravity, flowing through fractures and crevices underneath the ground and emerging as a spring where a major fracture in a rock formation occurs at the earth's surface, usually along a ravine or swale. The flow or discharge rates of Maryland's Springs range from less than one gallon per minute to nearly 10,000 gallons per minute. Springs differ from seeps in that the latter appear on the ground surface as broad, diffuse zones of wetness or percolation rather than distinct discharge sites. Also, seeps and associated wetlands often support distinct plant communities while springs are essentially aquatic and geological features.

County Distribution: Statewide

Places to Visit: Henryton Spring, Annapolis Rock Spring

Mapped Locations of Springs in Maryland. Sources: MD DNR, Geographic Names Information System (USGS).

Coastal Plain Stream

MBSS, MD DNR

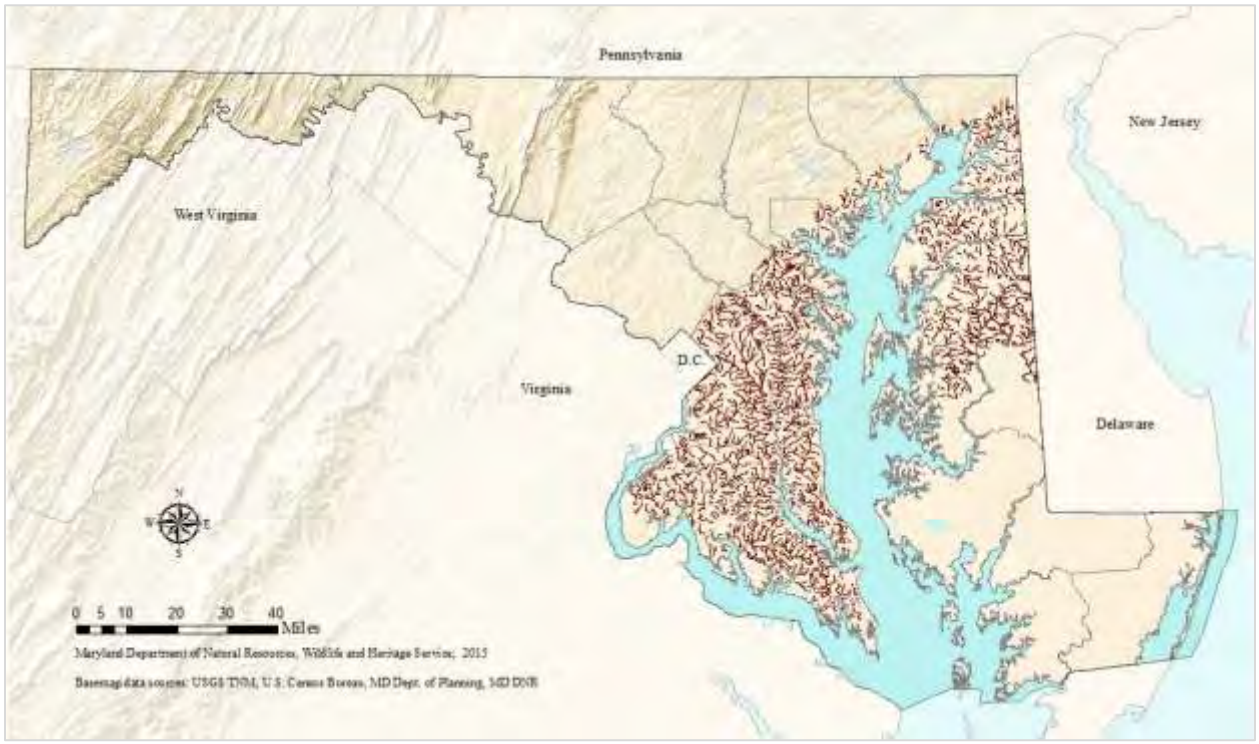
Maryland's Coastal Plain Streams extend from the Fall Line eastward toward the Atlantic Ocean. These streams are typically low in gradient (<1%) and found at elevations of less than 50 feet above sea level. They represent the lower non-tidal and upper fresh tidal (salinity < 0.5 ppt) sections of larger stream and river systems, and form transition zones between upper non-tidal reaches and increasingly larger, saline tidal sections. Silt, sand, gravel, and small cobble are the dominant substrates. Most Coastal Plain Streams contain only runs, glides and pools; however, gravel riffles are common in those streams draining the rolling hills on the western and upper eastern shore. Streams on the lower eastern shore are extremely sluggish with broad floodplains and braided channels. Since Coastal Plain Streams lack stable substrates such

as bedrock and boulders, wood and submerged aquatic vegetation are important channel features. Submerged logs and tree roots slow the flow of nutrients and sediment, provide cover for fishes and stream insects, and control stream bank erosion. Beaver activity along Coastal Plain Streams represents an important form of natural disturbance and creates habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife species of greatest conservation need. Eastern mudminnow *(Umbra pygmaea)*, bluespotted sunfish *(Enneacanthus gloriosus)*, creek chubsucker *(Erimyzon oblongus)*, and least brook lamprey *(Lampetra aepyptera)* are common Coastal Plain Stream fishes. These streams are also important habitat for the American eel *(Anguilla rostrate)* from the juvenile to adult stage. Sandy and gravel substrates of Coastal Plain Streams support a diverse community of freshwater mussels (Unionidae), many of which are listed as In Need of Conservation, Threatened, or Endangered in Maryland. Many of these riverine fish and mussel species are favorite prey items of river otter and muskrat. The Chester, Choptank, Nanticoke/Wicomico, Pocomoke, Lower Potomac, Patapsco, Gunpowder, Elk, Lower Susquehanna, Bush, Potomac Washington Metro, West Chesapeake, and Patuxent River basins all contain Coastal Plain Streams, comprising approximately 2,500 stream miles.

Based on fish and benthic macroinvertebrate community assessments (MBSS 2007-2009), the average condition of Coastal Plain Streams in Maryland is fair, meaning that many of these streams are at least partially degraded. Approximately 38% of Coastal Plain Streams are considered severely degraded. Thirty-four percent of Coastal Plain Streams are considered to be minimally impaired and 6% of the 2,500 miles of Coastal Plain Streams are designated as “high quality waters” by Maryland’s Anti-degradation regulation (COMAR 26.08.02.04-1).

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Harford, Howard, Kent, Prince George’s, Queen Anne’s, St. Mary’s, Talbot

Places to Visit: Tuckahoe State Park, Millington Wildlife Management Area, Myrtle Grove Wildlife Management Area



Mapped Locations of Coastal Plain Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Blackwater Stream

Blackwater Streams are sluggish, low gradient (<1%) systems located within the Pocomoke and Nanticoke/Wicomico basins and a few other scattered areas of Maryland's Coastal Plain physiographic province. They are characterized by low acidity, generally with pH levels less than 6, and dissolved organic carbon greater than 8 mg/L. In contrast to other streams, dissolved oxygen levels are low (< 5mg/L) due to increased bacterial respiration from the decomposition of organic matter. Substrate consists primarily of silt, sand, and organic matter, with minor and isolated amounts of small gravel. Because of the lack of larger, more stable substrate, instream wood is of critical importance in defining hydrologic features and providing cover for the aquatic biota. Biodiversity in Blackwater Streams is typically low, and limited to only those organisms

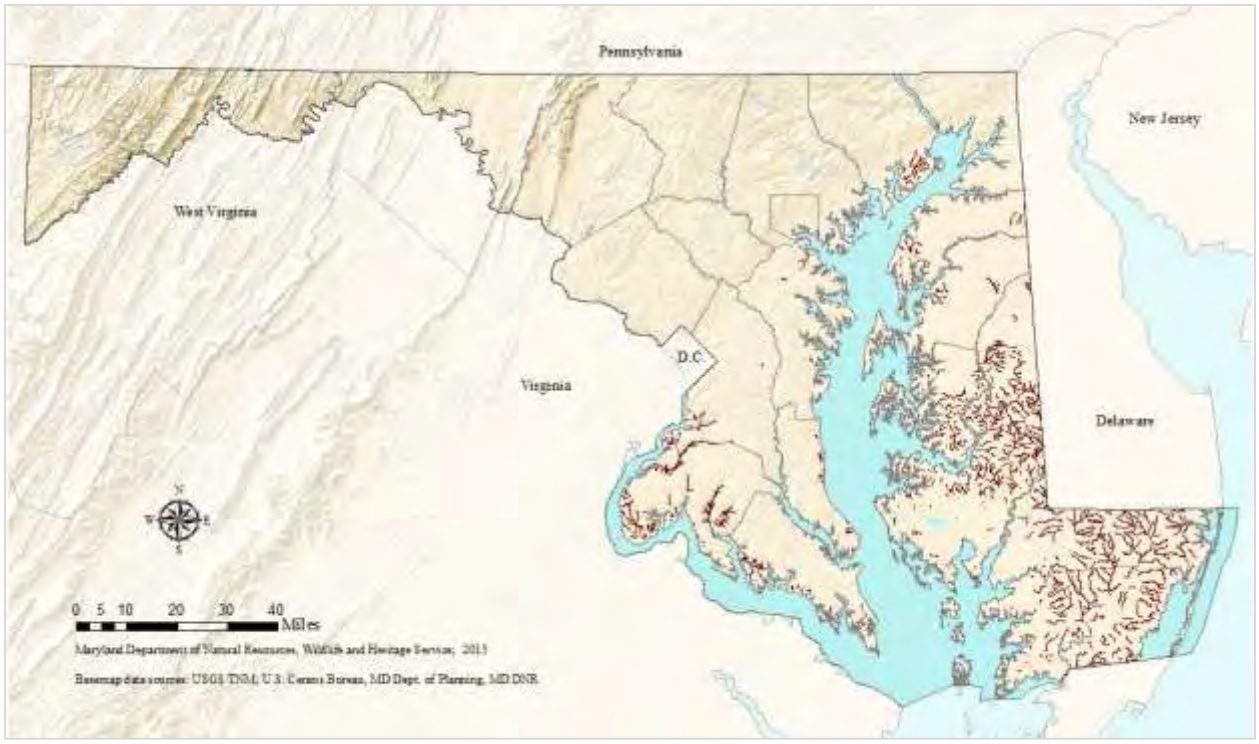
that are tolerant of the naturally acidic conditions. Beaver activity along Blackwater Streams represents an important form of natural disturbance and creates habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife species of greatest conservation need. Common fishes include eastern mudminnow *(Umbra pygmaea)*, pirate perch *(Aphredoderus sayanus)*, golden shiner *(Notemigonus crysoleucas)*, creek chubsucker *(Erimyzon oblongus)*, tadpole madtom *(Noturus gyrinus)*, and redfin pickerel *(Esox americanus)*. The benthic macroinvertebrate community is dominated by dragonfly, amphipod, and isopod taxa. There are approximately 1,275 miles of Blackwater Streams in Maryland.

Jay Kilian, MD DNR

Based on fish and benthic macroinvertebrate community assessments (MBSS 2007-2009), 30 percent of Blackwater Streams remain in good biological condition. Approximately, 64 miles of Blackwater Streams are considered "high quality waters" as designated by Maryland's Anti-degradation regulation (COMAR 26.08.02.04-1). However, approximately half of all Blackwater Streams in Maryland are considered degraded, largely due to intensive agricultural practices, removal of forests, stream channelization, and other stressors.

County Distribution: Anne Arundel, Calvert, Caroline, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Pocomoke State Park, Zekiah Swamp Natural Environmental Area



Mapped Locations of Blackwater Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Coastal Plain River

Jason Harrison, MD DNR

Coastal Plain Rivers are low gradient, slow flowing rivers (typically 5th order and larger) in the Lower and Upper Coastal Plain physiographic provinces. They represent the lower non-tidal and upper fresh tidal (salinity < 0.5 ppt) sections of larger river systems, and form transition zones between upper non-tidal river reaches and increasingly larger, saline tidal sections that eventually flow into and form part of the Chesapeake Bay proper. Coastal Plain Rivers consist of predominantly pool/glide habitat with sand and silt substrates. Large woody debris is an important element in structuring pool habitat and serves as an important source of coarse organic matter to riverine food webs. Open tree canopies allow for the growth of periphyton, phytoplankton, and aquatic macrophytes. These primary producers also form the base of energy flow within these systems. Connectivity between river channels and the adjacent

floodplain is important for the movement and exchange of organic matter in Coastal Plain River systems. Floodplains provide refugia for aquatic species during periods of high flows and for prey species from main channel fish predators. Extensive pool habitat common in Coastal Plain Rivers is home to many large predator fish species typically uncommon in headwater Coastal Plain Streams. Fish species common to Coastal Plain Rivers include American eel *(Anguilla rostrate)*, pumpkinseed *(Lepomis gibbosus)*, redbreast sunfish *(Lepomis auritus),* bluegill *(Lepomis macrochirus)*, shorthead redhorse *(Moxostoma macrolepidotum),* quillback *(Carpiodes cyprinus)*, longnose gar *(Lepisosteus osseus)*, and warmouth *(Lepomis gulosus)*. Popular game fishes in these rivers include largemouth bass *(Micropterus salmoides)*, chain pickerel *(Esox niger)*, and black crappie *(Pomoxis nigromaculatus)*. Coastal Plain Rivers also provide spawning habitat to many migratory fish species of Chesapeake Bay such as blueback herring *(Alosa aestivalis)*, alewife *(Alosa pseudoharengus)*, white perch *(Morone americana),* yellow perch *(Perca flavescens)*, American shad, and hickory shad. Sandy and gravel substrates of Coastal Plain Rivers support a diverse community of freshwater mussels (Unionidae), many of which are listed as In Need of Conservation, Threatened, or Endangered in Maryland. Many of these riverine fish and mussel species are favorite prey items of river otter and muskrat. Coastal Plain Rivers also serve as wintering habitats for migratory waterfowl. Coastal Plain River habitats can be found in portions of the Chester, Choptank, Nanticoke, Lower Potomac, Patapsco, Patuxent, Pocomoke, Potomac Washington Metro, and Wicomico river basins. Coastal Plain River habitat comprises approximately 115 stream miles within these basins.

Degradation and loss of species associated with Coastal Plain and Blackwater Stream tributaries have ultimately affected the downstream conditions of Maryland's Coastal Plain River habitats. Maryland Coastal Plain Rivers are located in predominately agriculturally-focused watersheds. Nutrient enrichment and sedimentation associated with agricultural land use practices have reduced habitat quality and quantity available to many fish and mussel SGCN. Stream blockages have also reduced upstream access to spawning habitats for migratory fishes.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Tuckahoe State Park, Idylwild Wildlife Management Area, Pocomoke State Park

Appendix B

Conservation Actions for Key Wildlife Habitats

(selected sections)

Full document available at
https://dnr.maryland.gov/wildlife/Documents/SWAP/SWAP_AppendicesChapter7.pdf

Chapter 7

Conservation Actions

APPENDICES

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Chapter 7 Appendices

7a. Conservation Action Prioritization Criteria

Key Wildlife Habitat Conservation Actions

7b. Conservation Actions for Upland Habitats

7c. Conservation Actions for Wetland Habitats

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Species of Greatest Conservation Need Conservation Actions

7g. Conservation Actions for Mammal Species of Greatest Conservation Need

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7k. Conservation Actions for Insect Species of Greatest Conservation Need

7l. Conservation Actions for Crayfish Species of Greatest Conservation Need

7m. Conservation Actions for Mussel Species of Greatest Conservation Need

Appendix 7a. Conservation Action Prioritization Criteria

The process of prioritizing conservation actions for the Maryland SWAP revision focused on identifying priorities for implementation. Table 1 summarizes how each of these criteria was ranked for every conservation action to determine that action's overall prioritization status. More information about these seven criteria, as well as factors the SWAP Development Team considered while prioritizing conservation actions, can be found in Table 2.

Table 1 Summary of criteria used to prioritize conservation actions.

Conservation Action Prioritization Criteria	High	Medium	Low
Urgency	Initiate immediately, within 2 years	Initiate within 2-5 years (2017-2020)	Initiate within 5-10 years (2020-2025) or can wait 10 years to initiate
Cost	Relatively expensive (>$500,000)	Moderately costly ($50,000-$500,000)	Relatively inexpensive (<$50,000)
Chance of Success	Achievable/Certain or Very Likely: 90-100% (demonstrated by other projects)	Somewhat likely or uncertain: 30-90% (e.g., BMP or sufficient information available)	Highly uncertain/Unlikely/Unknown: <30% (not tested/implemented anywhere)
Benefit	Highly beneficial	Moderately beneficial	Unclear benefits
Collateral Benefit (to other species/habitat)	Highly beneficial to other species/habitat	Moderately beneficial to other species/habitat	Unclear benefits to other species/habitat
Feasibility/Likelihood of Implementation	Feasible/Certain/Very Likely: 90-100%	Moderately Difficult/Likely:30-90%	Difficult/Unlikely/Unknown: <30%
Public Support	Very important/well supported	Moderately important/somewhat supported	Less important, much outreach

Table 2. Additional information about the criteria used to prioritize conservation actions.

Terms	Explanation/Content	Factors to Consider	Priority Ranking
Urgency	The urgency of the action should estimate the ideal timeframe for completing the action. How quickly does the action need to be taken? This is a relative estimate of the urgency of the action given the severity, immediacy, or extent of the threats and the priority of the species or habitat.	Extinction risk Potential for loss of opportunity if delayed Threat to the species/habitat, including: • Immediacy: this characteristic assesses the time scale over which impacts of the threat will be observable. • Severity of threat • Spatial extent: how much of species' population or habitat is negatively effected	(Mark High) **Urgent:** Initiate immediately, within two years (Mark Medium) **Moderately Urgent:** Initiate within 5 years (2017-2020) (Mark Low) **Less Urgent:** Initiate within 5-10 years (2020-2025) or can wait 10 years to initiate
Cost/Value	Cost estimates, even very rough ones, are helpful for prioritization. This should include total future costs in current dollar values, but not include any past expenses for infrastructure that will be used by proposed action. Avoid using the unknown category if possible.	Cost evaluations are for life of the project (as opposed to per year) Direct and indirect costs of the project Cost/acre treated or cost/species	(Mark High) **Expensive:** >$500,000 (Mark Medium) **Moderately costly:** $50,000-$500,000 (Mark Low) **Relatively Inexpensive:** <$50,000 **Unknown**

Terms	Explanation/Content	Factors to Consider	Priority Ranking
Likelihood/ chance of success	To what degree will the action address the threat or improve species' populations or habitats? An assessment of whether or not the project will work	Will it meet its specified objectives? Will the project work/be successful?	(Mark High) **Achievable/Certain or Very Likely:** 90-100% (demonstrated by other projects) (Mark Medium) **Somewhat likely or uncertain:** 30-90% (e.g., BMP or sufficient information available) (Mark Low) **Highly uncertain/Unlikely/Unknown:** <30% (not tested/implemented anywhere)
Benefits	A measure of how much good will result from the project. These answers will likely be suggested by defining what the action is and why it is being taken. However, efforts to prioritize actions will probably require specific benefits to be considered. Answering this question clearly may also help define the measures of project success. Consider the direct benefits and contrast them with the indirect benefits.	Depending on the action, benefits (direct or indirect) may be habitat improvements, species' responses, reductions in threat risk, or public or stakeholder benefits. Reduction in extinction risk Increase in population size and/or range Responsibility – how much of the species' status depends on this project? Fundamental contribution	(Mark High) **Highly beneficial** (Mark Medium) **Moderately beneficial** (Mark Low) **Unclear benefits**

Terms	Explanation/Content	Factors to Consider	Priority Ranking
Collateral Benefits	Defining the ecological/biological benefits to other species, habitats, or processes. Is the species considered a keystone species, umbrella species, indicator species, or other species that has management practices that will provide collateral benefits to other species or habitats?	Keystone species have a disproportionate effect on their ecosystem, due to their size or activity, and any change in their population will have correspondingly large effects on their ecosystem Umbrella species have such demanding habitat requirements that, if we can conserve enough land to ensure their viability, the viability of smaller and more abundant species is almost guaranteed Indicator species are intended either to represent community composition or to reflect environmental change. Indicator species must respond to the particular environmental change of concern and demonstrate that change when monitored.	(Mark High) **Highly beneficial to other species/habitat** (Mark Medium) **Moderately beneficial to other species/habitat** (Mark Low) **Unclear benefits to other species/habitat**
Likelihood of Implementation/ Feasibility	How easy is this action to achieve? An assessment of the difficulty associated with this project Can the action be implemented?	Logistical and political factors Source of funds Community attitudes Biological factors	(Mark High) **Feasible/Certain/Very Likely:** 90-100% (Mark Medium) **Moderately Difficult/Likely:**30-90% (Mark Low) **Difficult/Unlikely/Unknown:** <30%

Terms	Explanation/Content	Factors to Consider	Priority Ranking
Public Support	A measure of the amount of support there is likely to be and how important the species or habitat is perceived; weighing the cultural/social values. Does anyone care? Would there be enough public support or might there be a need for additional outreach efforts?	Social and cultural importance Local community attitudes, as well as broader regional or statewide attitudes Education factor Flagship species are chosen to raise public awareness or financial support for conservation action	(Mark High) **Very Important or well supported** (Mark Medium) **Moderately Important or somewhat supported** (Mark Low) **Unimportant, might be a liability, or might need intensive outreach efforts**

Appendix 7c. Conservation Actions for Wetland Habitats

Appendices 7b – 7f list conservation actions recommended for key wildlife habitats in a format intended to allow readers to efficiently find specific threats and conservation actions cross-referenced to habitats. This appendix lists conservation actions specific to **Wetland Habitats**. Individual habitats classified as **Wetland Habitats** are marked **P** if the listed action is a **priority action** for implementation in that habitat and **X** if the action is a **non-priority action** for implementation in that habitat. Urgency, cost, chance of success, benefit, collateral benefit to other species/habitat, feasibility/likelihood of implementation, and public support were considered in the selection of priority actions for implementation. Further details regarding prioritization are presented in Chapter 7 and Appendix 7a. Complete IUCN threat codes are defined in Appendix 5a.

This Appendix (7c) includes three separate Wetland key wildlife habitat sections: 1) Floodplain Wetlands, 2) Groundwater Wetlands, and 3) Tidal Wetlands.

Conservation Actions for Floodplain Wetlands

IUCN Threat Code	IUCN Threat Description	Conservation Actions for Floodplain Wetland Habitats	Montane - Piedmont Floodplain	Coastal Plain Floodplain
IUCN 1-4: Urbanization/Development				
1-4	Habitat loss (from various causes)	Conserve and protect habitat and appropriate corridors for movement and dispersal of SGCN.	P	P
1-4	Habitat loss (from various causes)	Establish and maintain landscape-scale network of protected floodplain habitat as species dispersal and movement corridors.	P	P
1-4	Habitat loss (from various causes)	Focus land preservation efforts on protecting large tracts of contiguous habitat to minimize fragmentation and edge effects for area-dependent species.	P	P
1-4	Habitat loss (from various causes)	Establish and maintain appropriate buffers to wetlands through landowner incentive programs, acquisition, easements, regulatory means and implementation of BMPs. Expand buffers provided by regulation to afford adequate protection.	P	P
1-4	Habitat loss (from various causes)	Protect high priority wetlands (e.g., WSSC, ESA, BioNet Tier 1-3 sites) through land acquisition and conservation easements; where appropriate, extend protection to the surrounding forest matrix and watershed with adequate landscape connectivity between wetland systems.	P	P
1-4	Habitat loss (from various causes)	Maintain wetland breeding habitat and adjacent upland non-breeding habitats (life zones) of SGCN.	P	P
1-4	Habitat loss (from various causes)	Protect rare natural communities associated with floodplain wetland systems (e.g., riverside prairies, Atlantic white cedar swamps, bald cypress swamps).	P	P
1-4	Habitat loss (from various causes)	Restore floodplain forests including reestablishment of old growth, natural hydrology, and improved water quality.	P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions for Floodplain Wetland Habitats	Montane - Piedmont Floodplain	Coastal Plain Floodplain
IUCN 2: Agriculture and Aquaculture				
2	Agriculture and aquaculture	Work with landowners, farming community, and MD Department of Agriculture (MDA) to develop and encourage the implementation of BMPs for agricultural practices and to conserve, restore, and protect wetlands through Farm Bill programs (e.g. Conservation Reserve Program) and other landowner incentives for the maintenance of habitats of SGCN.	P	P
IUCN 3: Energy Production and Mining				
3.1.2	Hydraulic fracturing	Ensure that sufficient regulatory protection is in place to prevent or minimize hydraulic fracturing impacts on wetlands and the surrounding forest matrix and watershed.	P	
3.2.2	Surface mining - rock quarry	Prevent/minimize rock and sand quarrying impacts to wetland areas and surrounding watersheds, including appropriate buffers.	X	X
IUCN 4: Transportation and Service Corridors				
4.1.1	Roads and railroads: land conversion from natural habitat to roads and railroads	Work with MDOT to improve transportation planning for new roads to minimize loss and fragmentation of habitat and negative impacts to SGCN; explore options for off-site mitigation.	P	P
4.1.1	Roads and railroads; land conversion from natural habitat to roads and railroads	Work with MDOT to construct roads in such a way that minimizes effects on movement patterns of SGCN, especially for amphibians and reptiles that use these wetlands year-round or seasonally as breeding habitat.	P	P
4.2.1	Utility and service lines	Coordinate with utility companies to improve habitat management in wetlands and wetland buffers.	X	X
IUCN 5: Biological Resource Use				
5.3	Logging and wood harvesting	Establish and maintain adequate forest buffers along streams and rivers using strategies such as working with watershed groups to encourage forest conservation.	P	P
5.3	Logging and wood harvesting	Restore forest cover to deforested watersheds/catchment basins/buffers by developing wetland habitat protection, restoration and management guidelines for public land managers and foresters.	P	P
5.3	Logging and wood harvesting	Work with forestry community to improve and enforce timber harvest BMPs for private landowners that protect wetlands and, where appropriate, the surrounding forest matrix with adequate connectivity between wetlands.	P	P
5.3.2	Logging and wood harvesting; intentional use - large scale	Utilize appropriate silvicultural treatments to ensure adequate structural diversity, especially regarding canopy and understory components (shrubs, treefalls, downed wood, dense thickets, snags).	X	X

IUCN Threat Code	IUCN Threat Description	Conservation Actions for Floodplain Wetland Habitats	Montane - Piedmont Floodplain	Coastal Plain Floodplain
IUCN 6: Human Intrusions and Disturbance				
6.1	Recreational activities	Coordinate with public land managers to protect wetlands from impacts of active recreational use.	P	P
6.1.1	Recreational activities: off-road vehicles (motorized and non-motorized)	Reduce and, wherever possible, eliminate ORV use in wetlands and other fragile habitats; work with ORV industry to better inform riders of ecological impacts and responsibility; limit access when necessary.	P	P
IUCN 7: Natural Systems Modifications				
7	Natural systems modifications	Restore prior converted and other degraded wetlands to naturally functioning systems.	X	X
7.2	Dams and water management/use	Protect wetlands from drainage, ditching, filling, water withdrawal, and other damaging practices that alter hydrology (includes beaver dams in wetland areas, which can be beneficial in small quantities, harmful when there are too many).	P	P
7.2	Dams and water management/use	Restore hydrology through ditch plugging, water control structures, and other appropriate practices.	P	P
7.3.3	Removal of coarse woody debris	Establish and maintain effective natural buffers adjacent to wetlands by restoring natural communities.	P	P
7.2.5 - 7.2.7	Dams and water management/use: groundwater withdrawal	Ensure that groundwater and surface water withdrawal for development and agriculture is adequately monitored and regulated such that these activities do not negatively impact SGCN and their habitats.	P	P
7.2.9	Dams and water management/use: small dams	Work with landowners to encourage retention of emergent wetlands (e.g. DO NOT impound).	X	X
7.2.14	Dams and water management/use: impervious surfaces	Improve storm water management practices and sediment erosion control measures to avoid/minimize development impacts to wetland areas.	P	P
7.3.4	Lack of natural disturbance patterns or ecosystem functions due to species loss	Allow natural reestablishment of beaver and manage populations to approximate natural conditions.	X	X
7.3.4	Lack of natural disturbance patterns or ecosystem functions due to species loss	Restore the Atlantic white-cedar component in Coastal Plain wetland systems.		X
IUCN 8: Invasive and Other Problematic Species, Genes, and Diseases				
8	Invasive and other problematic species, genes, and diseases	Develop and implement protocols to control invasive species and prevent their establishment that is compatible with SGCN.	P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions for Floodplain Wetland Habitats	Montane - Piedmont Floodplain	Coastal Plain Floodplain
8.1.2	Invasive and other problematic species, genes, and diseases	Limit or prohibit the use of non-native fish as BMPs for mosquito control and vegetation management in wetlands.	X	X
8.1.2	Aquatic animals	Determine the ranges/current distribution of *Gambusia*.	X	X
8.1.4	Terrestrial/ wetland animals	Work with partners to control or eradicate populations of invasive, non-native terrestrial / wetland animals, such as nutria and emerald ash borer, using appropriate BMPs and effective education campaigns.	P	P
8.2.2	Problematic native species / diseases: white-tailed deer	Develop and implement measures to maintain deer populations at or below carrying capacity to control populations and reduce browsing levels.	P	P
8.5.2	Viral/prion-induced diseases: *Ranavirus*	Promote disinfection protocols to minimize spread of *Ranavirus*.	P	P
IUCN 9: Pollution				
9.1.1	Domestic and urban waste water: sewage	Implement nitrogen and phosphorus reduction strategies for septic and stormwater runoff to improve water quality within wetlands.	X	X
9.1.2	Domestic and urban waste water: run-off	Protect wetlands from contamination, siltation, and eutrophication by improving stormwater management practices and erosion control measures.	P	P
9.1.2	Domestic and urban waste water: run-off	Work with MDOT and local and county governments to reduce impacts from road salt, silt, pesticides and other runoff contaminants on wetlands.	X	X
9.2.1	Industrial and military effluents: oil spills	Implement all procedures to minimize risk of oil and gas spills and respond immediately to contain spills when they occur; maintain chemical spill response readiness.	X	X
9.2.2	Industrial and military effluents: seepage from Mining	Restore wetlands affected by coal mining and acid mine drainage.	X	X
9.2.2	Industrial and military effluents: seepage from Mining	Work with mining industry and regulators to improve regulations and implementation in order to eliminate detrimental impacts to hydrology and water quality of wetlands.	P	P
9.2.3	Agricultural and forestry effluents: hydraulic fracturing	Establish baseline and follow-up monitoring of streams and wetlands that may be impacted by hydraulic fracturing.	X	
9.3	Agricultural and forestry effluents	Restore, protect, and maintain riparian and wetland buffers to block siltation, pesticide, and fertilizer runoff to wetlands, streams, and rivers.	P	P
9.3.1	Agriculture and forestry effluents: nutrient loads	Reduce sources of groundwater contamination by implementing BMPs for nutrients on agricultural lands.	P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions for Floodplain Wetland Habitats	Montane - Piedmont Floodplain	Coastal Plain Floodplain
9.5.5	Air-borne pollutants: pesticides and herbicides	Promote use of only highly selective pesticides to control pest insect species.	X	X
9.5.5	Air-borne pollutants: pesticides and herbicides	Prevent/minimize mosquito control impacts on wetlands; develop a statewide inter-agency (MDA, MDE, DNR) mosquito control policy that protects public health while avoiding and minimizing impacts on ecosystems and SGCN.	X	X
IUCN 12: Resource Management Needs				
12.1.1	Lack of initial baseline inventory	Improve understanding (via surveys, remote sensing data, etc.) of the historical and current distribution, characteristics and condition of wetland habitats.	X	X
12.2.2	Need to conduct environmental reviews	Incorporate habitat conservation actions and BMPs into project reviews and land use change decisions by local, state, and federal agencies.	P	P
12.2.3	Need for fish, wildlife and/or habitat planning	Include habitat conservation needs and actions into local, state, and federal land use planning efforts and land management plans; where appropriate, extend protection to the surrounding forest matrix and watershed with adequate landscape connectivity between wetland systems.	P	P
12.2.3	Need for fish, wildlife and/or habitat planning	Protect and restore wetlands on public lands and incorporate these measures in public land management plans, including forest stewardship plans; where appropriate, extend protection to the surrounding forest matrix and watershed with adequate landscape connectivity between wetland systems.	P	P
IUCN 14: Education/Outreach Needs				
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Update information on rare wetland types by working with certified wetland delineators and agency regulators to more easily recognize these significant wetlands.	X	X
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Educate the public regarding necessary conservation of wildlife habitats and their SGCN.	X	X
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Encourage landowners to reduce the use of fertilizers, such as through the Bay Wise Program.	X	X
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Increase public awareness of sensitivity of wetlands to encroachment of introduced plants, including native species.	X	X
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Promote guidelines for restoration of wetlands that incorporate natural processes and native natural communities.	X	X
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Work with forestry professionals, UME service professionals, and other resource professionals to help educated private landowners on the value of wetlands and buffers and provide management guidance (BMPs) on how to best conserve important habitats.	P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions for Floodplain Wetland Habitats	Montane - Piedmont Floodplain	Coastal Plain Floodplain
IUCN 15: Administrative Needs				
15.1.2	Need to maintain or improve information management systems	Regularly update GIS layers that identify forest interior habitats, Wetlands of Special State Concern, and other significant resources for use in local, state, and federal land planning and management.	P	P
15.3.2	Need for coordination for effective management	Work with watershed groups, watershed-based initiatives, landowners, and federal programs to expand and coordinate wetland conservation efforts.	X	X
15.3.3	Need for updates to existing laws/regulations and enacting new laws/regulations	Modify the loblolly pine seed tree law to so that forestry practices can more easily encourage the establishment of mixed deciduous-pine stands and more natural forest communities.		X
15.3.3	Need for increased legal protection	Modify, as needed, nontidal wetland protection regulations, especially as they relate to Nontidal Wetlands of Special State Concern, to better protect wetlands and surrounding wetlands.	P	P
15.3.4	Need for increased enforcement of laws	Increase enforcement of wetland protection regulations, especially as they relate to Nontidal Wetlands of Special State Concern.	P	P
15.3.5	Need for changes in government policies	Work with public and private entities to improve SGCN habitat in areas that are managed for waterfowl.	X	X

Conservation Actions for Groundwater Wetlands

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Montane Bog and Fen	Montane - Piedmont Acidic Seepage Swamp	Montane - Piedmont Basic Seepage Swamp	Piedmont Seepage Wetland	Piedmont Upland Depression Swamp	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Delmarva Bay	Maritime Swamp	Vernal Pool	Spring
IUCN 1-4: Urbanization/Development														
1-4	Habitat loss (from various causes)	Conserve and protect habitat and appropriate corridors for movement and dispersal of SGCN.	P	P	P	P	P	P	P	P	P	P	P	P
1-4	Habitat loss (from various causes)	Focus land preservation efforts on protecting large tracts of contiguous habitat to minimize fragmentation and edge effects for area-dependent species.	P	P	P	P	P	P	P	P	P	P	P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Montane Bog and Fen	Montane - Piedmont Acidic Seepage Swamp	Montane - Piedmont Basic Seepage Swamp	Piedmont Seepage Wetland	Piedmont Upland Depression Swamp	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Delmarva Bay	Maritime Swamp	Vernal Pool	Spring
1-4	Habitat loss (from various causes)	Establish and maintain appropriate buffers to wetlands through landowner incentive programs, acquisition, easements, regulatory means and implementation of BMPs. Expand buffers provided by regulation to afford adequate protection.	P	P	P	P	P	P	P	P	P	P	P	P
1-4	Habitat loss (from various causes)	Protect high priority wetlands (e.g., WSSC, ESA, BioNet Tier 1-3 sites) through land acquisition and conservation easements; where appropriate, extend protection to the surrounding forest matrix and watershed with adequate landscape connectivity between wetland systems.	P	P	P	P	P	P	P	P	P	P	P	P
1-4	Habitat loss (from various causes)	Maintain wetland breeding habitat and adjacent upland non-breeding habitats (life zones) of SGCN.	P	P	P	P	P	P	P	P	P		P	P
IUCN 2: Agriculture and Aquaculture														
2	Agriculture and aquaculture	Work with landowners, farming community, and MD Department of Agriculture (MDA) to develop and encourage the implementation of BMPs for agricultural practices and to conserve, restore, and protect wetlands through Farm Bill programs (e.g. Conservation Reserve Program) and other landowner incentives for the maintenance of habitats of SGCN.	P	P	P	P	P	P	P	P	P	P	P	P
IUCN 3: Energy Production and Mining														
3.1.1	Oil and gas drilling/pipelines: drilling and distribution of petroleum and other liquid hydrocarbons	Avoid or minimize gas and petroleum pipelines within sensitive wetland areas and their buffers.	P	P	P	P	P	P	P	P	P		P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Montane Bog and Fen	Montane - Piedmont Acidic Seepage Swamp	Montane - Piedmont Basic Seepage Swamp	Piedmont Seepage Wetland	Piedmont Upland Depression Swamp	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Delmarva Bay	Maritime Swamp	Vernal Pool	Spring
3.1.2	Hydraulic fracturing	Ensure that sufficient regulatory protection is in place to prevent or minimize hydraulic fracturing impacts on wetlands and the surrounding forest matrix and watershed.	P	P	P								P	
3.2.2	Surface mining - rock quarry	Prevent/minimize rock and sand quarrying impacts to wetland areas and surrounding watersheds, including appropriate buffers.	X	X	X	X	X	X	X	X	X		X	X
3.3.1	Wind power	Site industrial wind development (including roads) in a manner that avoids or minimizes impacts to SGCN and habitat.						X						
IUCN 4: Transportation and Service Corridors														
4.1.1	Roads and railroads: land conversion from natural habitat to roads and railroads	Work with MDOT to improve transportation planning for new roads to minimize loss and fragmentation of habitat and negative impacts to SGCN; explore options for off-site mitigation.	P	P	P	P	P	P	P	P	P	X	P	P
4.1.1	Roads and railroads: land conversion from natural habitat to roads and railroads	Work with MDOT to construct roads in such a way that minimizes effects on movement patterns of SGCN, especially for amphibians and reptiles that use these wetlands year-round or seasonally as breeding habitat.	P	P	P	P	P	P	P	P	P	X	P	P
4.2.1	Utility service lines	Coordinate with utility companies to improve habitat management in wetlands and wetland buffers.	X	X	X	X	X	X	X	X	X	X	X	X
IUCN 5: Biological Resource Use														
5.3	Logging and wood harvesting	Restore forest cover to deforested watersheds/catchment basins/buffers by developing wetland habitat protection, restoration, and management guidelines for public land managers and foresters.	P	P	P	P	X	X	P	P	X	X	X	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Montane Bog and Fen	Montane - Piedmont Acidic Seepage Swamp	Montane - Piedmont Basic Seepage Swamp	Piedmont Seepage Wetland	Piedmont Upland Depression Swamp	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Delmarva Bay	Maritime Swamp	Vernal Pool	Spring
5.3	Logging and wood harvesting	Work with forestry community to improve and enforce timber harvest BMPs for private landowners that protect wetlands and, where appropriate, the surrounding forest matrix with adequate connectivity between wetlands.	P	P	P	P	P	P	P	P	P	P	P	P
5.3.2	Logging and wood harvesting; intentional use – large scale	Utilize appropriate silvicultural treatments to ensure adequate structural diversity, especially regarding canopy and understory components (shrubs, treefalls, downed wood, dense thickets, snags).		X	X		X	X	X			X		
5.3.2	Logging and wood harvesting; intentional use – large scale	Protect, and where possible, restore old growth forest (including adequate no-cut buffers) on public and private lands, and where possible, expand these areas and promote the establishment of additional extensive tracts of old growth forest.		P	P		P	P	P			P		
IUCN 6: Human Intrusions and Disturbance														
6.1	Recreational activities	Limit public access to the most sensitive wetlands to avoid trampling and compaction.	X							X				
6.1.1	Recreational activities: off-road vehicles (motorized and non-motorized)	Reduce and, wherever possible, eliminate ORV use in wetlands and other fragile habitats; work with ORV industry to better inform riders of ecological impacts and responsibility; limit access when necessary.	P	P	P	P	X	X	P	P	X	X	X	P
6.1	Recreational activities	Coordinate with public land managers to protect wetlands from impacts of active recreational use.	P	P	P	P	P	P	P	P	P	P	P	P
IUCN 7: Natural Systems Modifications														
7	Natural systems modifications	Restore prior converted and other degraded wetlands to naturally functioning systems.	P	P	P	P			P	P				P
7.1.2	Fire and fire suppression: suppression of fire frequency / intensity	Implement prescribed burn programs, where appropriate as a restoration measure, to help control woody vegetation in wetlands and their buffers.								X	X			

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Montane Bog and Fen	Montane - Piedmont Acidic Seepage Swamp	Montane - Piedmont Basic Seepage Swamp	Piedmont Seepage Wetland	Piedmont Upland Depression Swamp	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Delmarva Bay	Maritime Swamp	Vernal Pool	Spring
7.1.2	Fire and fire suppression: suppression of fire frequency / intensity	Re-establish natural fire regimes to restore and maintain habitats.										X		
7.2	Dams and water management/ use	Protect wetlands from drainage, ditching, filling, water withdrawal, and other damaging practices that alter hydrology (includes beaver dams in wetland areas, which can be beneficial in small quantities, harmful when there are too many).	P	P	P	P	P	P	P	P	P	P	P	P
7.2	Dams and water management/ use	Restore hydrology through ditch plugging, water control structures, and other appropriate practices.	P	P	P	P	P	P	P	P	P	P	P	P
7.2.5-7.2.7	Dams and water management/ use: groundwater withdrawal	Ensure that groundwater and surface water withdrawal for development and agriculture is adequately monitored and regulated such that these activities do not negatively impact SGCN and their habitats.	P	P	P	P	P	P	P	P	P	P	P	P
7.2.5-7.2.7	Dams and water management/ use: groundwater withdrawal	Protect the immediate catchment basin and groundwater supply feeding springs that support SGCN.												P
7.2.14	Dams and water management/ use: impervious Surfaces	Improve storm water management practices and sediment erosion control measures to avoid/minimize development impacts to wetland areas.				X	X	X			X		X	
7.3.3	Removal of coarse woody debris (streams, forests)	Establish and maintain effective natural buffers adjacent to wetlands by restoring natural communities.	P	P	P	P	P	P	P	P	P	P	P	P
7.3.4	Lack of natural disturbance patterns or ecosystem functions due to species loss	Allow natural reestablishment of beaver and manage populations to approximate natural conditions.		X	X				X					

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7.3.4	Lack of natural disturbance patterns or ecosystem functions due to species loss	Promote the establishment and growth of floating-leaved and submerged vegetation.									X			
7.3.4	Lack of natural disturbance patterns or ecosystem functions due to species loss	Restore the Atlantic white-cedar component in Coastal Plain wetland systems.						X	X					
7.3.4	Lack of natural disturbance patterns or ecosystem functions due to species loss	Restore the northern conifer component (e.g., red spruce, eastern white pine, eastern hemlock) of bog-fen wetland complexes on the Allegheny Plateau.	X	X	X								X	
7.3.4	Lack of natural disturbance patterns or ecosystem functions due to species loss	To the extent possible, manage habitats by mimicking natural disturbance patterns.									X			
IUCN 8: Invasive and Other Problematic Species, Genes, and Diseases														
8	Invasive and other problematic species, genes, and diseases	Develop and implement protocols to control invasive species and prevent their establishment that is compatible with SGCN.	P	P	P	P	P	P	P	P	P	P	P	P
8.1.2	Invasive non-native aquatic animals	Limit or prohibit the use of non-native fish as BMPs for mosquito control and vegetation management in wetlands.									X		X	
8.2.2	Problematic native species: white-tailed deer	Develop and implement measures to maintain deer populations at or below carrying capacity to control populations and reduce browsing levels.	P	P	P	P	P	P	P	P	P	P	P	P
8.5.2	Viral/prion-induced diseases: *Ranavirus*	Promote disinfection protocols to minimize spread of *Ranavirus.*	P	P	P	P	P	P	P	P	P	P	P	P

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IUCN 9: Pollution														
9	Pollution	Initiate measures to prevent and minimize pollution by surrounding the habitat with adequate buffers of native plant communities.					X	X			X		X	
9.1.1	Domestic and urban wastewater: sewage	Implement nitrogen and phosphorus reduction strategies for septic and stormwater runoff to improve water quality within wetlands.	X	X	X	X	X	X	X	X	X	X	X	X
9.1.2	Domestic and urban wastewater: Run-off	Protect wetlands from contamination, siltation, and eutrophication by improving stormwater management practices and erosion control measures.	P	P	P	P	P	P	P	P	P	X	P	P
9.1.2	Domestic and urban wastewater: Run-off	Work with MDOT and local and county governments to reduce impacts from road salt, silt, pesticides and other runoff contaminants on wetlands.	X	X	X	X	X	X	X	X	X		X	X
9.2.1	Industrial and military effluents: oil spills	Implement all procedures to minimize risk of oil and gas spills and respond immediately to contain spills when they occur; maintain chemical spill response readiness.	X	X	X	X	X	X	X	X	X	X	X	X
9.2.2	Industrial and military effluents: seepage from mining	Restore wetlands affected by coal mining and acid mine drainage.	X	X	X								X	
9.2.2	Industrial and military effluents: seepage from mining	Work with mining industry and regulators to improve regulations and implementation in order to eliminate detrimental impacts to hydrology and water quality of wetlands.	P	P	P	P			P	P				P
9.2.3	Hydraulic fracturing	Establish baseline and follow-up monitoring of streams and wetlands that may be impacted by hydraulic fracturing.	X	X	X								X	X
9.3	Agricultural and forestry effluents	Restore, protect, and maintain riparian and wetland buffers to block siltation, pesticide, and fertilizer runoff to wetlands, streams, and rivers.	P	P	P	P	P	P	P	P	P	P	P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Montane Bog and Fen	Montane - Piedmont Acidic Seepage Swamp	Montane - Piedmont Basic Seepage Swamp	Piedmont Seepage Wetland	Piedmont Upland Depression Swamp	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Delmarva Bay	Maritime Swamp	Vernal Pool	Spring
9.3.1	Agricultural and forestry effluents: nutrient loads	Reduce sources of groundwater contamination by implementing BMPs for nutrients on agricultural lands.	X	X	X	X	P	P	X	X	P	X	P	X
9.4.1	Garbage and solid waste	Reduce wetland degradation from filling and garbage dumping by educating the public.		P										P
9.5.5	Air-Bourne Pollutants	Promote use of only highly selective pesticides to control pest insect species.	X	X	X	X	X	X	X	X	X	X	X	X
9.5.5	Air-borne pollutants: herbicides and pesticides	Prevent/minimize mosquito control impacts on wetlands; develop a statewide inter-agency (MDA, MDE, DNR) mosquito control policy that protects public health while avoiding and minimizing impacts on ecosystems and SGCN.	X	X	X	X	X	X	X	X	X	P	X	X
IUCN 11: Climate Change and Severe Weather														
11.1.1	Habitat shifting or alteration: sea-level rise	Plan for landward "migration" or shifting of habitats in coastal areas, such as increasing emphasis on conserving buffers and migration corridors.										P		
IUCN 12: Resource Management Needs														
12.1.1	Lack of initial baseline inventory	Complete a statewide inventory and ecological assessment of targeted wetlands, such as vernal pools, Delmarva bays, and intertidal flats.									P		P	X
12.1.1	Lack of initial baseline inventory	Improve understanding (via surveys, remote sensing data, etc.) of the historical and current distribution, characteristics and condition of wetland habitats.	X	X	X	X			X	X				X
12.1.2	Lack of up-to-date information	Establish and maintain long-term habitat monitoring programs, determine extent of marshes and economic value of ecosystem services.									P		P	P
12.1.3	Need to answer research question	Delineate the catchment areas for springs, seeps, and runs/headwater streams that support SGCN to improve effectiveness of conservation actions for those habitats.		X	X	X			X	X				P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Montane Bog and Fen	Montane - Piedmont Acidic Seepage Swamp	Montane - Piedmont Basic Seepage Swamp	Piedmont Seepage Wetland	Piedmont Upland Depression Swamp	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Delmarva Bay	Maritime Swamp	Vernal Pool	Spring
12.2.2	Need to conduct environmental reviews	Incorporate habitat conservation actions and BMPs into project reviews and land use change decisions by local, state, and federal agencies.	P	P	P	P	P	P	P	P	P	P	P	P
12.2.3	Need for fish, wildlife and/or habitat planning	Include habitat conservation needs and actions into local, state, and federal land use planning efforts and land management plans; where appropriate, extend protection to the surrounding forest matrix and watershed with adequate landscape connectivity between wetland systems.	P	P	P	P	P	P	P	P	P	P	P	P
12.2.3	Need for fish, wildlife and/or habitat planning	Protect and restore wetlands on public lands and incorporate these measures in public land management plans, including forest stewardship plans; where appropriate, extend protection to the surrounding forest matrix and watershed with adequate landscape connectivity between wetland systems.	P	P	P	P	P	P	P	P	P	X	P	P
IUCN 14: Education/Outreach Needs														
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Update information on rare wetland types by working with certified wetland delineators and agency regulators to more easily recognize these significant wetlands.	X	X	X	X	X	X	X	X	X	X	X	X
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Educate the public regarding necessary conservation of wildlife habitats and their SGCN.	X	X	X	X	X	X	X	X	X	X	X	X
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Encourage landowners to reduce the use of fertilizers, such as through the Bay Wise Program.	X	X	X	X	X	X	X	X	X	X	X	X

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Montane Bog and Fen	Montane - Piedmont Acidic Seepage Swamp	Montane - Piedmont Basic Seepage Swamp	Piedmont Seepage Wetland	Piedmont Upland Depression Swamp	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Delmarva Bay	Maritime Swamp	Vernal Pool	Spring
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Increase public awareness of sensitivity of wetlands to encroachment of introduced plants, including native species.	X	X	X	X	X	X	X	X	X	X	X	X
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Promote guidelines for restoration of wetlands that incorporate natural processes and native natural communities.	X	X	X	X	X	X	X	X	X	X	X	X
14.2.1	Need for improved knowledge of fish and wildlife and their habitats	Work with forestry professionals, extension service professionals, and other resource professionals to help educated private landowners on the value of wetlands and buffers and provide management guidance (BMPs) on how to best conserve important habitats.	P	P	P	P	P	P	P	P	P	P	P	P
IUCN 15: Administrative Needs														
15.1.2	Infrastructure needs: need to maintain or improve information management systems	Regularly update GIS layers that identify forest interior habitats, Wetlands of Special State Concern, and other significant resources for use in local, state, and federal land planning and management.	P	P	P	P	P	P	P	P	P	P	P	P
15.3.2	Need for coordination for effective management	Work with watershed groups, watershed-based initiatives, landowners, and federal programs to expand and coordinate wetland conservation efforts.	X	X	X	X	X	X	X	X	X	X	X	X
15.3.3	Need for updates to existing laws/regulations and enacting new laws/regulations	Modify the loblolly pine seed tree law so that forestry practices can more easily encourage the establishment of mixed deciduous-pine stands and more natural forest communities.						X	X	X	X	X	X	X
15.3.3	Need for increased legal protection	Modify, as needed, nontidal wetland protection regulations, especially as they relate to Nontidal Wetlands of Special State Concern, to better protect wetlands and surrounding wetlands	P	P	P	P	P	P	P	P	P		P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Montane Bog and Fen	Montane - Piedmont Acidic Seepage Swamp	Montane - Piedmont Basic Seepage Swamp	Piedmont Seepage Wetland	Piedmont Upland Depression Swamp	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Delmarva Bay	Maritime Swamp	Vernal Pool	Spring
15.3.4	Need for increased enforcement of laws	Increase enforcement of wetland protection regulations, especially as they relate to Nontidal Wetlands of Special State Concern.	P	P	P	P	P	P	P	P	P	P	P	P

Conservation Actions for Tidal Wetlands

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Tidal Wetland Habitats	Tidal Forest	Tidal Freshwater Marsh and Shrubland	Tidal Brackish Marsh and Shrubland	Tidal Salt Marsh and Shrubland	Intertidal Mudflat and Sand Flat
IUCN 1-4: Urbanization/Development							
1-4	Habitat loss (from various causes)	Conserve and protect habitat and appropriate corridors for movement and dispersal of SGCN.	P	P	P	P	P
1-4	Habitat loss (from various causes)	Focus land preservation efforts on protecting large tracts of contiguous habitat to minimize fragmentation and edge effects for area-dependent species.	P	P	P	P	P
1-4	Habitat loss (from various causes)	Establish and maintain appropriate buffers to wetlands through landowner incentive programs, acquisition, easements, regulatory means and implementation of BMPs. Expand buffers provided by regulation to afford adequate protection.	P	P	P	P	X
IUCN 2: Agriculture and Aquaculture							
2	Agriculture and aquaculture	Work with landowners, farming community, and MDA to develop and encourage the implementation of BMPs for agricultural practices and to conserve, restore, and protect wetlands through Farm Bill programs (e.g. Conservation Reserve Program) and other landowner incentives for the maintenance of habitats of SGCN.	P	P	P	P	P
2.4	Marine and freshwater aquaculture	Design and site aquaculture facilities in a manner that positively impacts estuarine and marine ecosystems.				X	X

Appendix 7d. Conservation Actions for Aquatic Habitats

Appendices 7b – 7f list conservation actions recommended for key wildlife habitats in a format intended to allow readers to efficiently find specific threats and conservation actions cross-referenced to habitats. This appendix lists conservation actions specific to **Aquatic Habitats**. Individual habitats classified as **Aquatic Habitats** are marked **P** if the listed action is a **priority action** for implementation in that habitat and **X** if the action is a **non-priority action** for implementation in that habitat. Urgency, cost, chance of success, benefit, collateral benefit to other species/habitat, feasibility/likelihood of implementation, and public support were considered in the selection of priority actions for implementation. Further details regarding prioritization are presented in Chapter 7 and Appendix 7a. Complete IUCN threat codes are defined in Appendix 5a.

This Appendix (7d) includes two separate Aquatic key wildlife habitat sections: 1) Streams and Rivers, and 2) Bay and Ocean.

Conservation Actions for Streams and Rivers

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Streams and Rivers	Blackwater Stream	Coastal Plain River	Coastal Plain Stream	Coldwater Stream	Limestone Stream	Highland Stream	Highland River	Piedmont Stream	Piedmont River
IUCN 1: Residential and Commercial Development											
1	Residential and Commercial Development	Conserve and restore seepage, floodplain, and tidal wetlands associated with streams and rivers.	X	X	X	X	X	X	X	X	X
1	Residential and Commercial Development	Conserve and protect habitat and appropriate corridors for movement and dispersal of SGCN.	P	P	P	P	P	P	P	P	P
1	Residential and Commercial Development	Pursue land protection/ conservation easements in stronghold watersheds and high quality aquatic habitats, and assess acquisition by evaluating SGCN and their key wildlife habitats.	P	P	P	P	P	P	P	P	P
1	Residential and Commercial Development	Use low impact development design, retrofits, and state-of-the-art storm water management and sediment erosion control practices to minimize development impacts.	P	P	P	P	P	P	P	P	P
1	Residential and Commercial Development	Preserve and enhance connectivity of critical habitats.	X	X	X	X	X	X	X	X	X

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Streams and Rivers	Blackwater Stream	Coastal Plain River	Coastal Plain Stream	Coldwater Stream	Limestone Stream	Highland Stream	Highland River	Piedmont Stream	Piedmont River
1.3.1	Land conversion from natural habitat to recreation or tourism areas (large and small)	Limit infrastructure development for recreation (such as trails, parking lots, etc.) in key areas for SGCN that are sensitive to disturbance (e.g., wood turtle, timber rattlesnake, salamanders).	X	X	X	X	X	P	X	X	X
IUCN 2: Agriculture and Aquaculture											
2	Agriculture and Aquaculture	Encourage farmers and landowners to become involved in Farm Bill programs and other landowner incentives, including the Conservation Reserve programs, for the maintenance of stream and riparian habitats and protection/conservation of wetlands, highly erodible lands, at-risk species and other wildlife on working lands.	P	P	P	X	X	X	X	X	X
2	Agriculture and Aquaculture	Work with landowners and farming community to develop and encourage BMPs for agricultural practices to conserve, restore and protect key wildlife habitats.	X	X	X	X	X	X	X	X	X
2.3	Livestock farming and ranching	Explore options to work with farmers to require stream buffers and livestock exclusion from streams.			X	X	X	X	P	X	X
IUCN 3: Energy Production and Mining											
3.1.2	Hydraulic fracturing	Site hydraulic fracturing development, gas extraction, and deep mining in a manner that avoids or minimizes impacts on SGCN and habitats.				X	X	X	X		
3.1.2	Hydraulic fracturing	Develop and implement BMPs for hydraulic fracturing that includes recommendations to address sediments and thermal pollution.				X		X	X		
3.1.2	Hydraulic fracturing	Limit groundwater and surface water withdrawals from industry, public consumption, and agriculture to maintain adequate stream flow and volume to sustain SGCN; use hydroassessments and permitting.	P	P	P	P	P	P	P	P	P
3.3.1	Wind power	Site industrial wind development (including roads) in a manner that avoids or minimizes species and habitat impacts.	X	X	X	X	X	X	X	X	X
IUCN 4: Transportation and Service Corridors											
4.1	Roads and railroads	Improve habitat connectivity in streams via blockage removal, culvert retrofit, and transportation BMPs; Prioritize these efforts into areas with the largest/best populations of SGCN and forage species supporting SGCN.	X		X	X	X	X		X	

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Streams and Rivers	Blackwater Stream	Coastal Plain River	Coastal Plain Stream	Coldwater Stream	Limestone Stream	Highland Stream	Highland River	Piedmont Stream	Piedmont River
4.1.1	Roads and railroads: land conversion from natural habitat to roads and railroads	Incorporate state-of-the-art stream crossing design in planning for new roads to minimize geomorphic and hydrologic alterations and impacts to aquatic habitat and biota.	X	X	X	X	X	X	X	X	X
IUCN 5: Biological Resource Use											
5.1.3	Hunting and collecting terrestrial animals: persecution/ control	Maintain beaver populations and encourage their re-establishment in areas where they are lacking as one means of creating SGCN habitat; do so in a manner that avoids and minimizes nuisance issues and conflicts with other SGCN, unique natural communities, etc.	X	X	X	X	X	X	X	X	X
5.3.1	Logging and wood harvesting; intentional use - small scale	Work with foresters and land managers in implementing riparian habitat management guidelines.	X	X	X	X	X	X	X	X	X
IUCN 7: Natural Systems Modifications											
7.2	Dams and water management/use	Restore channelized streams to natural meanders.	X		X						
7.2	Dams and water management/use	Restore and conserve brook trout habitat in watersheds, especially in areas where populations are declining.				X					
7.2.3	Dams and water management/use: abstraction of surface water (domestic use)	Reduce stream channelization, ditching, impoundments which reduce access to spawning areas and take away habitat.	X	X	X	X	X	X	X	X	X
7.2.9	Dams and water management/use: small dams	Promote removal of dams and implement Executive Order 13508 that prompted the adoption of the 2014 Chesapeake Bay Watershed Agreement that included an outcome for opening 1000 miles of migratory fish passage by 2025.	P	P	P	X	P	X	X	P	P
7.2.14	Dams and water management/use: impervious surfaces	Limit impervious surfaces in watersheds; utilize MD DNR-developed impervious thresholds in land use planning to minimize SGCN and their habitats.	P	P	P	P	P	P	P	P	P
7.2.14	Dams and water management/use: impervious surfaces	Maintain and increase forest cover in watersheds including land acquisition.	P	P	P	P	P	P	P	P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Streams and Rivers	Blackwater Stream	Coastal Plain River	Coastal Plain Stream	Coldwater Stream	Limestone Stream	Highland Stream	Highland River	Piedmont Stream	Piedmont River
7.2.3	Dams and water management/use: abstraction of surface water (agricultural use)	Minimize stream channelization and maintenance of ditched streams.	P		P	X	X	X		X	
7.3.4	Lack of natural disturbance patterns or ecosystem functions due to species loss	Reintroduce or augment certain SGCN in suitable habitats, when and where appropriate.	P	X	P	P	X	X	P	X	X
IUCN 8: Invasive and other Problematic Species, Genes, and Diseases											
8.1	Invasive non-native/alien species/diseases	Focus invasive species control efforts where they are most likely to be successful and have high biological return.	P	P	P	P	P	P	P	P	P
8.1.2	Invasive non-native aquatic animals	Limit stocking of non-native trout in fall in streams that support hellbenders.				P			P		
8.1.2	Invasive non-native aquatic animals	Work with partners to control populations of invasive, non-native aquatic plants and animals, such as hydrilla, zebra mussel, northern snakehead and blue/flathead catfish, using appropriate BMPs and effective education campaigns.	P	P	P	X	X	X	X	X	P
8.2.2	Problematic native species/diseases: white-tailed deer	Work with partners to reduce and control white-tailed deer populations to reverse browsing damage; advocate for more liberal doe season to control white-tailed deer populations in specific areas.	X	X	X	X	X	X	X	X	X
IUCN 9: Pollution											
9	Pollution	Reduce impacts of water pollution from boats.		X							X
9	Pollution	Direct TMDL development and implementation into watersheds that will have the greatest benefit to SGCN.	X	X	P	X	X	X	X	P	P
9.1	Domestic and urban wastewater	Enhance point source pollution control.	X	X	X				X		P
9.1, 9.2, 9.3	Domestic and urban wastewater; industrial and military effluents; agricultural and forestry effluents	Reduce pollution from urban, industrial and agricultural sources by promoting activities that effectively lower TMDL's and meet water quality standards, as agreed upon in the 2014 Chesapeake Bay Watershed Agreement.	X	X	X	X	X	X	X	X	X
9.1.1	Domestic and urban wastewater: sewage	Work with partners to reduce deleterious contaminant (e.g., endocrine disrupting compounds) concentrations and upgrade wastewater treatment plants to improve water quality.	X	P	X	X	X	X	P	X	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Streams and Rivers	Blackwater Stream	Coastal Plain River	Coastal Plain Stream	Coldwater Stream	Limestone Stream	Highland Stream	Highland River	Piedmont Stream	Piedmont River
9.1.2	Domestic and urban wastewater: run-off	Assess impacts of road salt and fly ash application to stream habitats and SGCN and develop abatement measures or alternatives for road salt and fly ash application in sensitive stream habitats. Conduct a comprehensive examination of state-to-state road salt use and policy, study trends in stream conductivity and chloride levels, identify regional SGCN most vulnerable to high chloride levels, and identify areas where rare aquatic habitats and species coincide with high levels of salt application.	P	P	P	P	P	P	P	P	P
9.1.2	Domestic and urban wastewater: run-off	Develop education and outreach efforts regarding impacts from road salt and promote possible BMPs and alternatives to use in sensitive stream habitats and propose to MDOT/SHA. Include public health in advocacy and outreach efforts.	P	P	P	P	P	P	P	P	P
9.2.1	Industrial and military effluents: oil spills	Minimize risk of oil and chemical spills and respond immediately to contain spills when they occur; improve capacity for eliminating spills.	X	X	X	X	X	X	X	X	X
9.2.2	Industrial and military effluents: seepage from mining	Minimize acid mine drainage and mitigate damages resulting from such drainage.				X		P	X		
9.3	Agricultural and forestry effluents	Restore, protect, and maintain riparian buffers to block siltation, pesticide, and fertilizer runoff to wetlands, streams, and rivers.	P	P	P	P	P	P	P	P	P
9.3.1	Agricultural and forestry effluents: nutrient loads	Implement BMPs for livestock grazing near streams.	X	X	X	P	P	P	P	P	P
9.3.1	Agricultural and forestry effluents: nutrient loads	Work with partners, such as watershed groups, to implement BMPs to reduce non-point nutrient inputs and nutrient loads to protect and restore aquatic/riparian communities.	X	X	X	X	X	X	X	X	X
9.3.2	Agricultural and forestry effluents: soil erosion and sedimentation	Improve sediment and erosion control practices.	X	X	P	X	X	X	X	X	X
9.3.3	Agricultural and forestry effluents: herbicides and pesticides	Work with landowners and farming community to implement BMPs for nutrient and pesticide application.	X	X	X	X	X	X	X	X	X
9.3.3	Agricultural and forestry effluents: herbicides and pesticides	Work with landowners and farming community to develop and encourage BMPs for agricultural practices to reduce and restrict the flow of pesticides and other toxic contaminants into aquatic systems.	X	X	X	X	X	X	X	X	X

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Streams and Rivers	Blackwater Stream	Coastal Plain River	Coastal Plain Stream	Coldwater Stream	Limestone Stream	Highland Stream	Highland River	Piedmont Stream	Piedmont River
9.4.1	Garbage and solid waste: fishing line and other trash	Reduce trash dumping and fishing line dumping by educating the public.	X	X	X	X	X	X	X	X	X
9.5.1	Air-borne pollutants: acid rain	Increase efforts to continue research and monitoring for impacts and causes of acidic atmospheric deposition into Chesapeake Bay with specific restoration goals established in the 2014 Chesapeake Bay Watershed Agreement.	X	X	X	X	X	X	X	X	X
9.6.2	Excess energy: thermal pollution	Work with power companies to address thermal pollution (e.g., warmwater discharges, hypolimnetic releases, utility rights-of-way clearings from electric power generation.		X					X		X
IUCN 11: Climate Change and Severe Weather											
11.1.1	Habitat shifting or alteration: sea-level rise	Evaluate habitat change and loss to predicted changes in sea level.	X	X	X						
11.1.1	Habitat shifting or alteration: sea-level rise	Take measures to mitigate habitat change resulting from sea-level rise.	X	X	X						
11.3	Temperature extremes	Evaluate habitat change and loss predicted due to changes in thermal regime and precipitation patterns.	P	P	P	P	P	P	P	P	P
11.3	Temperature extremes	Take measures to mitigate habitat change resulting from changes in thermal regime and precipitation patterns, including limiting impervious surfaces, surface and groundwater abstraction, damming, and buffer encroachment in streams with sensitive species.	P	P	P	P	P	P	P	P	P
IUCN 12: Resource Management Needs											
12.1.1	Lack of initial baseline inventory	Assess stream habitats and identify areas where restoration is feasible with high likelihood of success and prioritize for biological recovery.	X	X	X	X	X	X	X	X	X
12.1.2	Lack of up-to-date existing information	Establish and maintain long-term habitat monitoring programs for health and condition of stream.	P	X	P	P	P	P	X	P	X
12.1.2	Lack of up-to-date existing information	Encourage and assist with the development of citizen science groups (e.g. Trout Unlimited) to participate in stream assessments, spawning surveys, etc.	X	X	X	X	X	X	X	X	X
12.1.2	Lack of up-to-date existing information	Continue annual stream surveys for water quality and rapid assessment of habitat conditions, with special focus on brackish, tannic, and freshwater habitats.	P	P	P	X	X	X	X	X	X

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Streams and Rivers	Blackwater Stream	Coastal Plain River	Coastal Plain Stream	Coldwater Stream	Limestone Stream	Highland Stream	Highland River	Piedmont Stream	Piedmont River
12.1.2	Lack of up-to-date existing information	Assess status of Maryland Coastal Bays and Assateague aquatic communities with MD DNR Stream Waders collection opportunities.	X	X	X						
12.2.3	Need for fish, wildlife and/or habitat planning	Work with watershed management plans to conserve streams and rivers.	P	P	P	P	X	P	P	X	P
12.2.3	Need for fish, wildlife and/or habitat planning	Incorporate conservation actions and BMPs into public land management plans by local, state, and federal agencies; include habitat protection, connectivity and restoration needs in public land management plans and overall improvement of managing state lands for the promotion and conservation of SGCN and their habitats.	P	P	P	X	X	X	X	X	X
12.2.3	Need for fish, wildlife and/or habitat planning	Develop a statewide survey to assess the chemical, physical, and biological condition of large rivers and prioritize areas for conservation.		X					X		X
12.2.3	Need for fish, wildlife and/or habitat planning	Target and promote stream restoration and associated BMPs in minimally-impaired, stronghold watersheds to improve conditions in MD's best-remaining stream habitats.	P	P	P	P	P	P	P	P	P
12.2.3	Need for fish, wildlife and/or habitat planning	Develop a 'watershed champion' program on a county/watershed level and develop a model for a high quality example (e.g. Mattawoman).	X	X	X	X	X	X	X	X	X
12.2.3	Need for fish, wildlife and/or habitat planning	Conduct a partner-wide assessment of existing protection and restoration efforts to create an up-to-date record of programs.	X	X	X	X	X	X	X	X	X
IUCN 14: Education/Outreach Needs											
14.3.1	Outreach needs: need to develop or maintain a broad base of support	Develop and disseminate public educational materials and improve public outreach efforts, especially about 1) recreational impacts and ways to minimize them, 2) working with non-commercial residential landowners to implement BMPs for nutrient and pesticide application in their backyards & gardens.	X	X	X	X	X	X	X	X	X
14.3.1	Outreach needs: need to develop or maintain a broad base of support	Educate the public regarding necessary conservation of wildlife habitats and their SGCN; target behavior change outreach and education with watershed conservation through hands on, localized stewardship activities.	P	P	P	P	P	P	P	P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Streams and Rivers	Blackwater Stream	Coastal Plain River	Coastal Plain Stream	Coldwater Stream	Limestone Stream	Highland Stream	Highland River	Piedmont Stream	Piedmont River
14.3.1	Outreach needs: need to develop or maintain a broad base of support	Develop a social marketing strategy to promote awareness and conservation of high quality watersheds.	X	X	X	X	X	X	X	X	X
14.3.1	Outreach needs: need to develop or maintain a broad base of support	Provide local governments with infrastructure or information needed to protect water quality and ensure standards in watersheds.	X	X	X	X	X	X	X	X	X
IUCN 15: Administrative Needs											
15.1.2	Need to maintain or improve information management systems	Improve completeness of maps for recognized blue line streams, including intermittent streams.	X	X	X	X	X	X	X	X	X
15.3.2	Need for coordination for effective program/project management	Work with watershed groups, watershed-based initiatives, landowners, and federal programs to expand and coordinate stream conservation efforts.	P	P	P	P	P	P	P	P	P
15.3.2	Need for coordination for effective program/project management	Follow conservation implementation strategies from the North American Waterfowl Plan where/when appropriate.	X	X	X						
15.3.2	Need for coordination for effective program/project management	Coordinate efforts among agencies, counties, volunteer groups, and NGOs to conserve habitat and maintain the integrity of aquatic and wetland systems across wide geographic areas and state boundaries, including targeting the highest quality areas.	P	P	P	X	X	P	P	X	X
15.3.2	Need for coordination for effective program/project management	Utilize MCBP, USACE, MDE, and Critical Area Commission regulatory processes to protect habitat.	P	P	P						
15.3.2	Need for coordination for effective program/project management	Continue partnership with MDA to maintain a viable Conservation Reserve Enhancement Program agreement with Farm Service Agency that achieves enrollment goals. Modify 2009 amendment and make changes as necessary.	X	X	X						
15.3.2	Need for coordination for effective program/project management	Coordinate with partner organizations to develop a citizen science symposium statewide.	X	X	X	X	X	X	X	X	X
15.3.2	Need for coordination for effective program/project management	Support and promote local watershed groups for policy change and outreach. Continue the development and sustainability of these groups through grant writing, funding sources, and outreach.	P	P	P	P	P	P	P	P	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions For Streams and Rivers	Blackwater Stream	Coastal Plain River	Coastal Plain Stream	Coldwater Stream	Limestone Stream	Highland Stream	Highland River	Piedmont Stream	Piedmont River
15.3.2	Need for coordination for effective program/project management	Develop Conservation Innovation Grants (CIG) with NRCS to stimulate development and adoption of innovative conservation approaches and technologies in conjunction with agricultural and forestry practices.	X	X	X						
15.3.2	Need for coordination for effective program/project management	Develop Regional Conservation Partnership Program to leverage federal Farm Bill dollars with State and private funding to maximize effectiveness of conservation efforts.	X	X	X						
15.3.2	Need for coordination for effective program/project management	Work closely with USDA and Congressional representatives to develop and implement subsequent Farm Bills.	P	P	P						
15.3.2	Need for coordination for effective program/project management	Further encourage the development and implementation of Tier III CWA Anti-Degradation policy within DNR and MDE.	X	X	P	X	X	X	X	X	X
15.3.2	Need for coordination for effective program/project management	Coordinate and communicate with local Chesapeake Bay advisory groups. Support these groups with up to date, sound science data and assist in interpreting the data.	X	X	X	X	X	X	X	X	X
15.3.2	Need for coordination for effective program/project management	Partner with National Association of Conservation Districts, National Association of State Conservation Agencies, National Association of Resource Conservation and Development Councils, National Conservation District Employees Association, and NRCS in developing the National Conservation Planning Partnership, a multi-year commitment to conservation planning.	X	X	X						
15.3.3	Need for increased legal protection	Improve regulatory protection for intermittent streams.	P	P	P	P	P	P	P	P	P
15.3.3	Need for increased legal protection	Advocate for the adoption of revised water quality criteria standards for ammonia, chloride, and other pollutants that impact SGCN. Implement these guidelines and ensure adherence to legal standards.	P	P	P	P	P	P	P	P	P

Appendix 7e. Conservation Actions for Subterranean Habitats

Conservation Actions for Cave and Karst

Appendices 7b – 7f list conservation actions recommended for key wildlife habitats in a format intended to allow readers to efficiently find specific threats and conservation actions cross-referenced to habitats. This appendix lists conservation actions specific to **Subterranean Habitats**. Individual habitats classified as **Subterranean Habitats** are marked **P** if the listed action is a **priority action** for implementation in that habitat and **X** if the action is a **non-priority action** for implementation in that habitat. Urgency, cost, chance of success, benefit, collateral benefit to other species/habitat, feasibility/likelihood of implementation, and public support were considered in the selection of priority actions for implementation. Further details regarding prioritization are presented in Chapter 7 and Appendix 7a. Complete IUCN threat codes are defined in Appendix 5a.

This Appendix (7e) includes one Subterranean key wildlife habitat: 1) Cave and Karst.

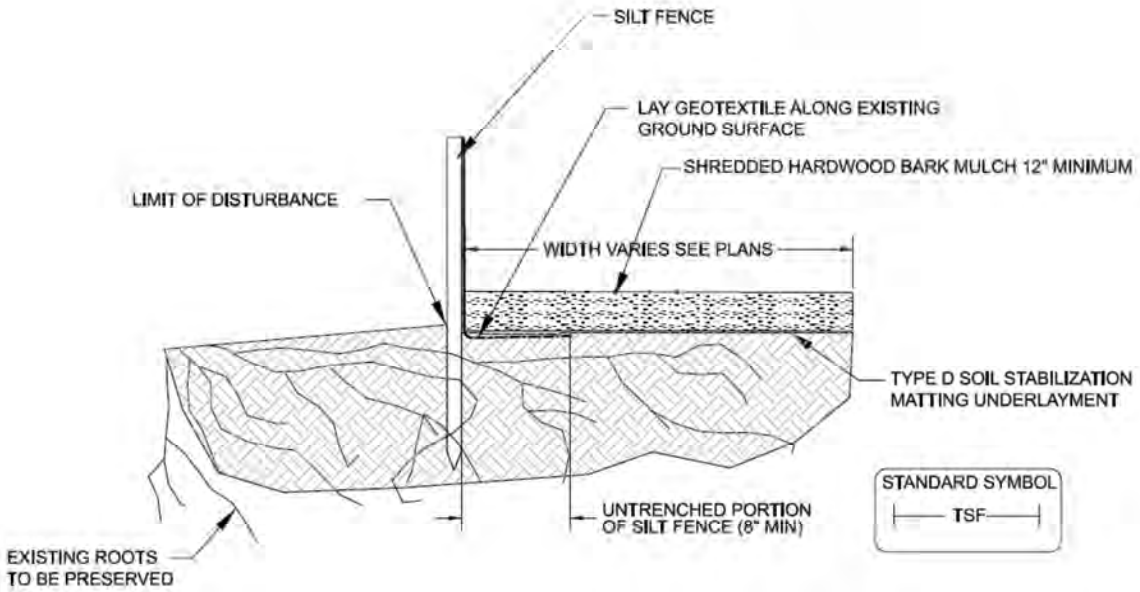
IUCN Threat Code	IUCN Threat Description	Conservation Actions for Cave and Karst Habitats	Action Priority Type
IUCN 1-4: Urbanization/Development			
1- 4	Habitat loss (from various causes)	Protect high priority cave ecosystems (e.g., Ecologically Significant Areas, BioNet Tier 1-3 sites) through land acquisition and conservation easements; where appropriate, extend protection to the surrounding forest matrix and groundwater aquifers.	P
1-4	Habitat loss (from various causes)	Restore and protect natural sinkholes as vital components of karst groundwater and cave ecosystems.	X
1-4	Habitat loss (from various causes)	Work with industry and regulators to improve regulations and implementation in order to avoid or minimize detrimental impacts to hydrology from drainage, ditching, filling, water withdrawal, mining, and other damaging practices resulting from land-use changes.	P
IUCN 3: Energy Production and Mining			
3.2	Mining and quarrying	Protect cave ecosystems and surrounding forested buffers from future mining by siting and configuring mining operations in a manner that avoids or minimizes impacts to priority habitats harboring SGCN.	P
IUCN 5: Biological Resource Use			
5.3	Logging and wood harvesting	Protect water quality within catchment basins of SGCN inhabited caves, sinkholes, and subterranean springs by maximizing forest cover and implementing appropriate forestry BMPs.	X
IUCN 6: Human Intrusions and Disturbance			
6.1.4	Recreational activities: exploration of caves/mines	Educate both the general public and spelunkers about the value of these habitats and the impacts of disturbance to caves and mines supporting SGCN.	P
6.1.4	Recreational activities: exploration of caves/mines	Install and maintain appropriate cave and mine entrance gates to protect cave fauna, especially SGCN.	P
6.1.4	Recreational activities: exploration of caves/mines	Limit access to minimize human disturbance in sensitive cave/mine/tunnel habitats harboring SGCN.	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions for Cave and Karst Habitats	Action Priority Type
IUCN 7: Natural Systems Modifications			
7.2	Dams and water management/use	Protect groundwater supply feeding subterranean springs inhabited by SGCN.	P
7.2.14	Dams and water management/use: impervious surfaces	Improve stormwater management practices and sediment erosion control measures to avoid or minimize development impacts to groundwater aquifers.	P
IUCN 8: Invasive and Other Problematic Species, Genes, and Diseases			
8	Invasive and Other Problematic Species, Genes, and Diseases	Develop and implement protocols to control invasive species in a manner compatible with SGCN.	X
8.1.2	Invasive non-native aquatic animals: white-nose syndrome	Rigorously perform protocols for decontamination of equipment and clothing to avoid the spread of fungal spores by humans.	P
IUCN 9: Pollution			
9.1, 9.3	Domestic and urban wastewater; agricultural and forestry effluents	Initiate measures to prevent pollution of sinking or losing streams associated with subterranean habitats through retention or development of adequate vegetated buffers.	P
9.3.1	Agricultural and forestry effluents: nutrient loads	Protect water quality of cave ecosystems and surrounding buffer habitats by restricting livestock access to vital groundwater components, particularly sinkholes, springs, sinking streams and cave entrance areas.	X
9.3.2	Agricultural and forestry effluents: soil erosion and sedimentation	Minimize or eliminate soil disturbance in estimated catchment basins; restore forest cover to deforested catchment basins.	X
9.3.3	Agricultural and forestry effluents: herbicides and pesticides	Limit the use of pesticides such that SGCN and this habitat are not adversely affected.	X
IUCN 12: Resource Management Needs			
12.1.1	Lack of Initial Baseline Inventory	Determine the extent of groundwater aquifers for highest priority cave systems harboring SGCN.	P
12.1.2	Lack of up-to-date information	Continue research into the composition, distribution, and abundance of groundwater and cave obligate fauna in Maryland.	X
12.1.3	Need to answer research question	Determine reasons for bat survival in tunnels and extend knowledge to restore bat populations in caves.	P
12.2.1	Need to provide technical assistance	Work with MDE Mining Program to protect deep mines supporting SGCN.	P

IUCN Threat Code	IUCN Threat Description	Conservation Actions for Cave and Karst Habitats	Action Priority Type
12.2.3	Need for fish, wildlife and/or habitat planning	Incorporate habitat conservation actions and protection needs into land planning efforts and public land management plans by local, state, and federal agencies.	P

Appendix C

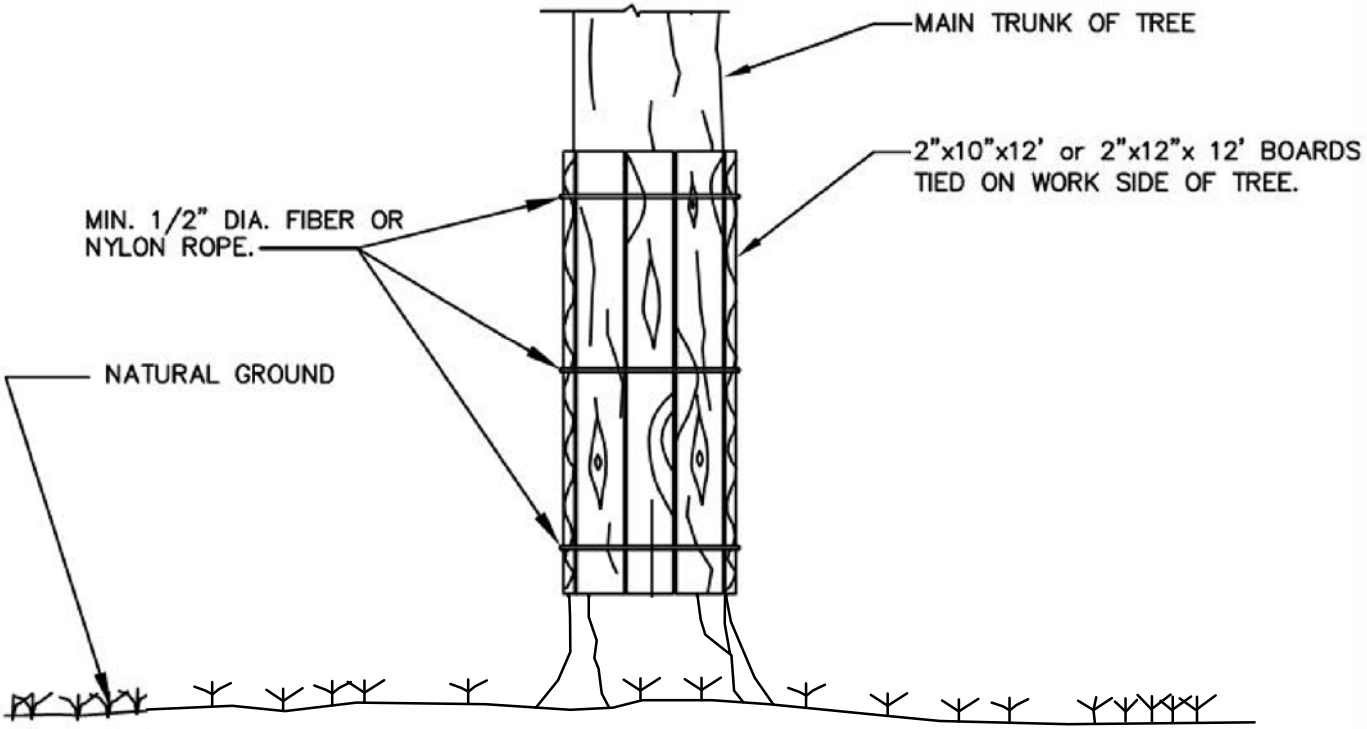
Sample Details and Guidance



NOTES:
1. GEOTEXTILE FABRIC SHALL BE LAID ALONG THE EXISTING GROUND SURFACE AND NOT TRENCHED.
2. GEOTEXTILE FABRIC SHALL OVERLAP TYPE D SOIL STABILIZATION MATTING BY A MINIMUM OF 8".

TRENCHLESS SILT FENCE
CROSS SECTION-TYPICAL

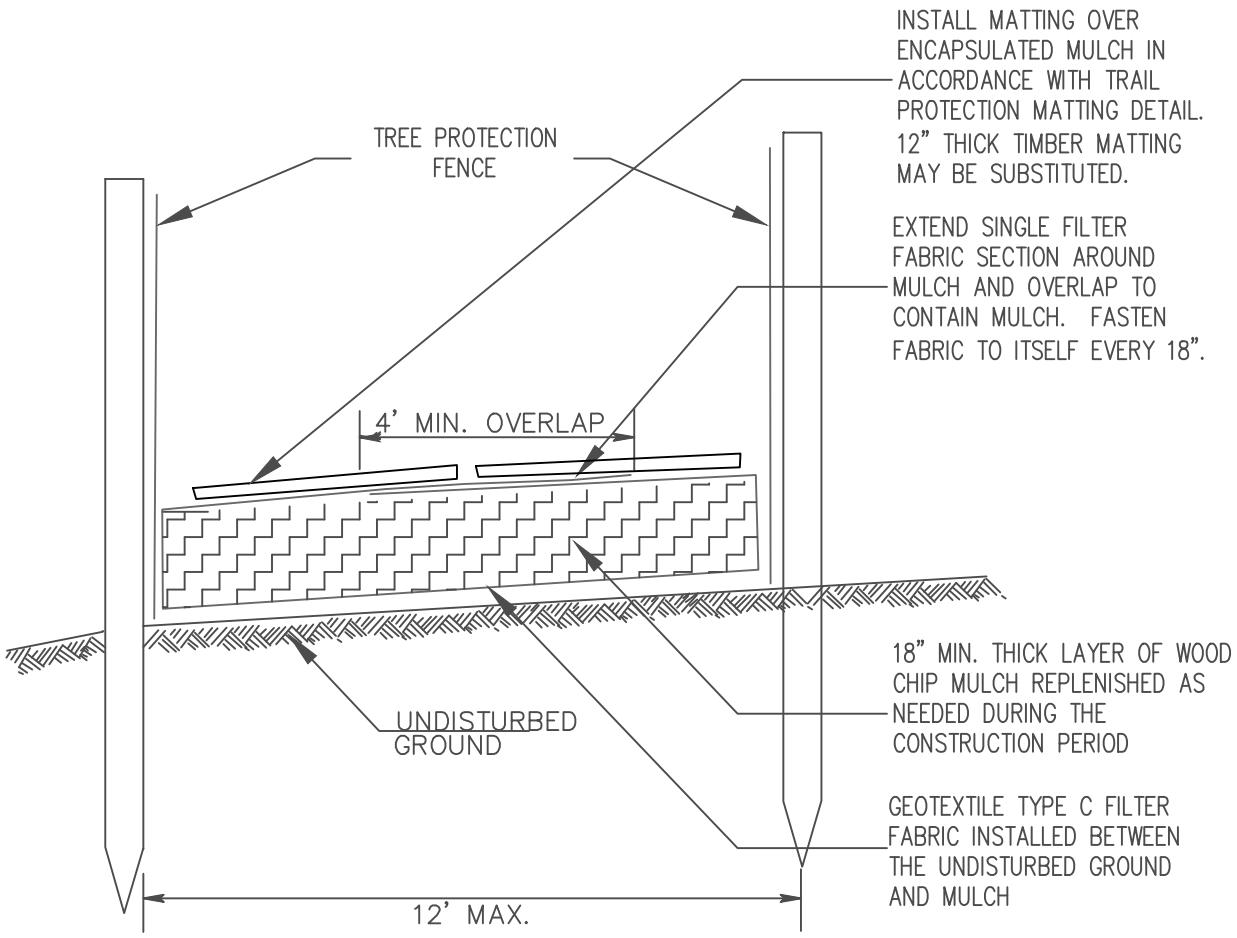
NOT TO SCALE



SPECIAL TREE PROTECTION DETAIL

NOTES:

1. TIE WITH 1/2" DIAMETER ROPE (FIBER OR NYLON), SUFFICIENT 2"x10"x12' OR 2"x12"x12' BOARDS AROUND MAIN TRUNK OR TREE TO PROTECT ALL AREAS EXPOSED TO CONSTRUCTION.



NOTES:

1. ACCESS ROUTES TO BE FIELD LOCATED WITH M-NCPPC AND MCDPS AT PRE-CONSTRUCTION MEETING.
2. FILTER FABRIC SHALL BE A SINGLE PIECE ACROSS WIDTH. OVERLAP FABRIC BY 24" MIN. ALONG LENGTH OF ROUTE.
3. FILTER FABRIC MAY ONLY BE ELIMINATED AT DIRECTION OF M-NCPPC ARBORIST.
4. CONTRACTOR SHALL MAINTAIN MULCH MAT THROUGHOUT CONSTRUCTION PERIOD. MULCH SHALL BE DISPOSED OF OFF-SITE UNLESS OTHERWISE APPROVED BY M-NCPPC.
5. FOLLOWING CONSTRUCTION, CONTRACTOR SHALL DECONSOLIDATE SOILS AS DIRECTED BY M-NCPPC ARBORIST.

HEAVY DUTY MULCH MAT DETAIL

NOT TO SCALE

POCOMOKE RIVER RESTORATION

WITTMYER, TULL, PATEY, TOWN OF BERLIN

AREA L (51 AC) & AREA M (105 AC)

WETLAND RESTORATION - 657 (106 AC) JC 4

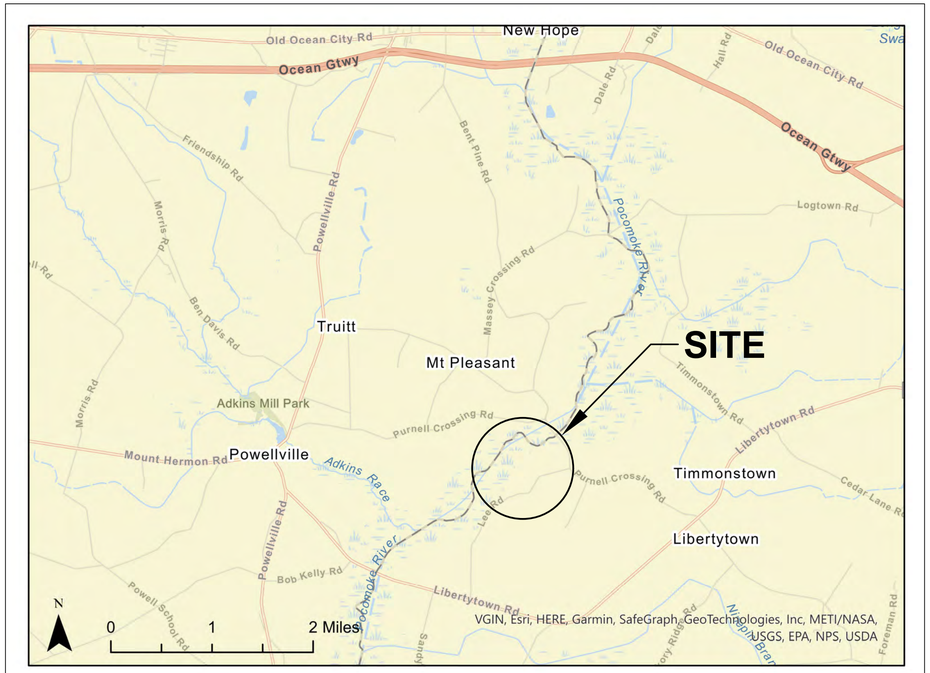
STREAMBANK PROTECTION - 580 (1250 LF) JC 3

CONSTRUCTION SEQUENCING

1. EMPLOY ALL SEDIMENT AND EROSION CONTROL MEASURES BEFORE BEGINNING WORK.
2. AT THE END OF EACH DAY, ALL COMPLETED CONSTRUCTION SHALL BE SEEDED AND FILL AREAS MULCHED WITH STRAW AND THE BREACHES COVERED WITH JUTE MATTING. BEGIN WORKING ON THE BREACH FURTHEST AWAY FROM THE ROAD ACCESS, COMPLETE EACH BREACH IN THE FOLLOWING SEQUENCE:
   A. CLEAR TREES IN THE BREACH FOOTPRINT, AND PLACE ON THE SPOIL PILES OUTSIDE OF THE BREACH AREA AND FILL AREAS. PLACEMENT OF TREES WILL BE DIRECTED BY THE ON-SITE CONSTRUCTION MANAGER.
   B. GRADE BREACH LOCATIONS TO PROPER ELEVATION AND PLACE SPOIL IN THE DESIGNATED SPOIL DISPOSAL AREAS.
   C. PLACE THE TREES THAT WERE TEMPORARILY STORED IN FLOODPLAIN ON FILL AREAS.
   D. REMOVE ANY SOIL FILL FROM THE FLOODPLAIN THAT MAY HAVE FALLEN OFF THE ROOTBALLS OF THE CLEARED TREES.
   E. SEED AND STRAW FILL AREAS THAT ARE NOT COVERED BY TREES
   F. SEED AND PLACE JUTE MATTING IN THE BREACHES
3. CONSTRUCT BREACHES ACCORDING TO DRAWING. USFWS OR TNC WILL VERIFY FLOODPLAIN ELEVATION AND SET GRADE STAKES AT EACH BREACH. PLACE SPOIL FROM BREACHES IN THE DESIGNATED DISPOSAL AREAS SHOWN ON THE MAP OR IDENTIFIED BY USFWS/TNC.
4. ALL SPOIL DISPOSAL AREAS SHALL BE SEEDED IMMEDIATELY FOLLOWING FINAL GRADING USING MIX 2, AND STABILIZED WITH STRAW MULCH APPLIED AT 2 TONS/ACRE AT 1-2" DEPTH. BREACHES SHALL BE SEEDED IMMEDIATELY USING MIX 1. ALL SEEDING AND PLANTING MIXES ARE FOUND ON PAGE 4 OF THESE PLANS.
5. AFTER SEEDING THE BREACHES, INSTALL JUTE MATTING ACCORDING TO PRODUCT SPECIFICATIONS.

CONSTRUCTION NOTES

1. CONTACT US FISH AND WILDLIFE SERVICE CHESAPEAKE BAY FIELD OFFICE OR THE NATURE CONSERVANCY (TNC) FOR CONSTRUCTION LAYOUT AND PRECONSTRUCTION MEETING.
2. CONSTRUCTION MUST BE SUPERVISED BY A MEMBER OF THE US FISH AND WILDLIFE SERVICE OR TNC.
3. THREE WORKING DAYS BEFORE CONSTRUCTION BEGINS CONTACT MISS UTILITY AT 1-800-441-8355.
4. THERE WILL NOT BE A CONSTRUCTION ROAD. ACCESS WILL VARY BASED ON THE METHOD THAT REMOVES THE LEAST NUMBER OF LARGE TREES. TO BE DETERMINED ON SITE BY CONSTRUCTION MANAGER. USE LOGGING MATS ON ACCESS ROAD IN ORDER TO MINIMIZE DAMAGE TO FLOODPLAIN DURING CONSTRUCTION.
5. NO SPOIL SHALL BE PLACED WITHIN 10' OF THE CHANNELIZED RIVER. SPOIL ELEVATIONS SHOULD NOT BE GREATER THAN 1.5' ABOVE EXISTING SPOIL HEIGHT. ALL SPOIL PLACEMENT SHALL BE GRADED TO A MINIMUM OF 2:1 SLOPE OR FLATTER.
6. BREACHES WILL BE CLOSELY MONITORED TO ADDRESS ANY POTENTIAL EROSION PROBLEMS THAT MIGHT OCCUR. ANY ISSUES WILL BE FIXED IMMEDIATELY.
7. NO CHANGES SHALL BE MADE TO THE PLANS WITHOUT PRIOR APPROVAL FROM THE PERSON RESPONSIBLE FOR THE DESIGN.



Estimated Construction Quantities		
Amount	**Units**	**Item**
10639	cu yd	Total Amount of Material to be Moved
2.5	acres	Critical Area Seeding on Breaches
3.5	acres	Critical Area Seeding on Spoil Disposal Areas
6	acres	Total Critical Area Seeding
2.5	acres	Total Jute Matting Area
1250	linear feet	Total Linear Feet of Live Stakes Planting

AS-BUILT STATEMENT

THE CONSERVATION PRACTICE(S) MEETS OR EXCEEDS DESIGN STANDARDS AND SPECIFICATIONS

INSPECTED BY _____ SIGNATURE _____ DATE

CONSTRUCTION APPROVAL _____ SIGNATURE _____ DATE

VERIFIED DISTRICT CONSERVATIONIST _____ SIGNATURE _____ DATE

811 Know what's below. Call before you dig.

"The Soil Conservation District makes no representation as to the existence or Non-existence of any utilities at the construction site. Shown on these construction drawings are those utilities which have been identified. It is the responsibility of the landowners or operators and contractors to assure themselves that no hazard exists or damage will occur to utilities"

LANDOWNER/CONTRACTOR STATEMENT

I CERTIFY THAT THIS DESIGN HAS BEEN EXPLAINED TO ME BY _____, A REPRESENTATIVE OF _____, AND I UNDERSTAND THE CONTENTS. ALL CONSTRUCTION WILL BE DONE ACCORDING TO THESE PLANS AND SPECIFICATIONS. I FURTHER UNDERSTAND THAT ALL CONSTRUCTION WILL BE UNDER THE INSPECTION OF ONE OF THESE ORGANIZATIONS.

_____ OWNER'S SIGNATURE DATE

_____ OWNER'S SIGNATURE DATE

_____ OWNER'S SIGNATURE DATE

_____ OWNER'S SIGNATURE DATE

_____ CONTRACTOR'S SIGNATURE DATE

CONSTRUCTION NOTIFICATION

The Contractor/Owner is to notify the project point of contract at least 72 hours prior to construction to facilitate any scheduling, layout, or preliminary mobilization necessary to ensure proper construction inspection to enable appropriate certification of this project.

PROJECT POINT OF CONTACT NAME AND PHONE:

Mike Dryden, The Nature Conservancy

ALTERNATIVE POC NAME AND PHONE:

Prepared June 2022 as a Partnership Between:

The Nature Conservancy
Maryland/DC Chapter

U.S. FISH & WILDLIFE SERVICE
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
Habitat Restoration and Conservation Program
177 Admiral Cochrane Drive
Annapolis, MD 21401
Tel. (703) 501-0593

Designed LF 05-22
Drawn LF 06-22
Checked

WITTMYER, TULL, PATEY, TOWN OF BERLIN
WETLAND RESTORATION (657)
Berlin, Maryland

Approved Date
Title Job Class

Maryland Department of Agriculture
Worcester Co. Soil Conservation District

USDA United States Department of Agriculture
Natural Resources Conservation Service

REVISIONS

Date	Description	Approved

File No. *.DWG

Sheet 1 of 5

PRESTON & DIANE SMITH

DAVID PATEY

MAYOR & COUNCIL OF BERLIN

JOHN C JR & BARBARA WITTMYER

TULL BROTHERS LLC

DAVID PATEY

MAYOR & COUNCIL OF BERLIN

MAYOR & COUNCIL OF BERLIN

MATCH LINE

MATCH LINE

L1 L2 L3 L4

M1 M2 M3 M4 M5 M6 M7 M8

0 250 500 Feet

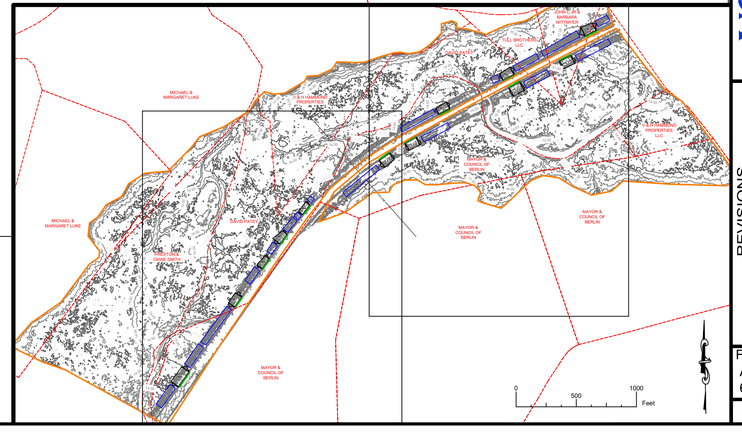
Contours - 1 ft

Tax Parcels

Breaches

Spoil Placement

Live Stakes Planting



0 500 1000 Feet

Designed	LF	05-22
Drawn	LF	06-22
Checked		

WITTMYER, TULL, PATEY, TOWN OF BERLIN

WETLAND RESTORATION (657)

Berlin, Maryland

Approved ____ Date ____

Title ____ Job Class ____

Maryland Department of Agriculture

Worcester Co. Soil Conservation District

USDA United States Department of Agriculture

Natural Resources Conservation Service

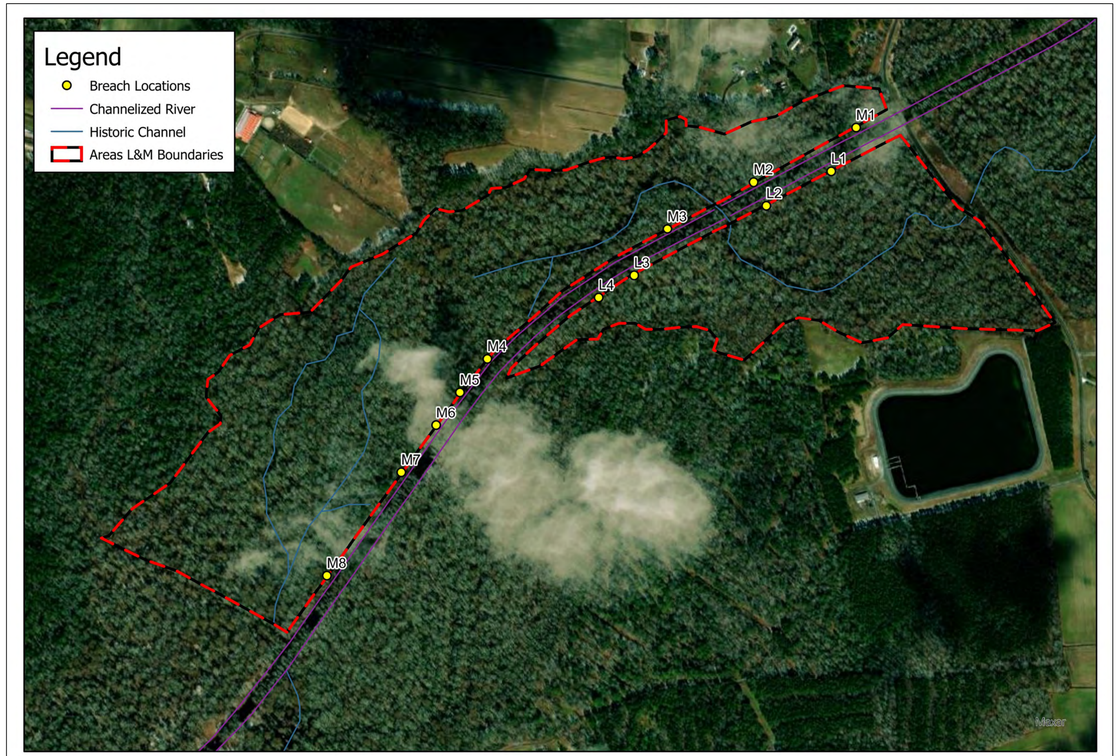
REVISIONS

Date	Description	Approved

File No. AreaML_design_ 6-1-22.DWG

Sheet 2 of 5

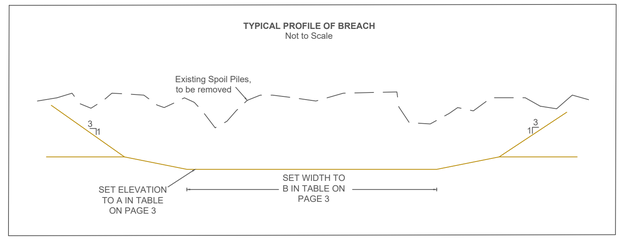
BREACH LOCATIONS

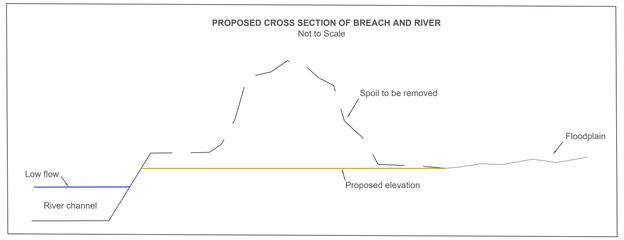


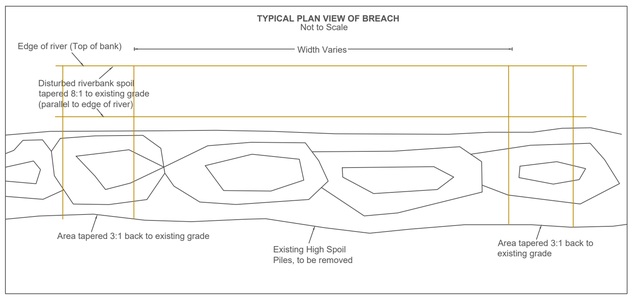
Estimated Breach Dimensions			
Breach Number	Breach Bottom Elevation, A	Breach Bottom Width, B	Estimated Breach Area (sq ft)
L1	16.00	100	8951
L2	15.50	100	9256
L3	15.00	100	8453
L4	15.00	100	8551
M1	17.50	100	9960
M2	15.50	100	7965
M3	15.50	100	7037
M4	15.50	100	4657
M5	15.50	100	7098
M6	15.50	100	5566
M7	15.50	100	7949
M8	15.00	150	12948

Estimated Construction Quantities		
Amount	Units	Item
900	cu yds	Spoil Removal From Breach L1
701	cu yds	Spoil Removal From Breach L2
687	cu yds	Spoil Removal From Breach L3
929	cu yds	Spoil Removal From Breach L4
1472	cu yds	Spoil Removal From Breach M1
783	cu yds	Spoil Removal From Breach M2
755	cu yds	Spoil Removal From Breach M3
212	cu yds	Spoil Removal From Breach M4
584	cu yds	Spoil Removal From Breach M5
425	cu yds	Spoil Removal From Breach M6
993	cu yds	Spoil Removal From Breach M7
1238	cu yds	Spoil Removal From Breach M8

TYPICAL DETAILS







Designed LF 05-22
Drawn LF 06-22
Checked

WITTMYER, TULL, PATEY, TOWN OF BERLIN
WETLAND RESTORATION (657)
Berlin, Maryland

Approved Date
Title Job Class

Maryland Department of Agriculture
Worcester Co. Soil Conservation District

United States Department of Agriculture
Natural Resources Conservation Service

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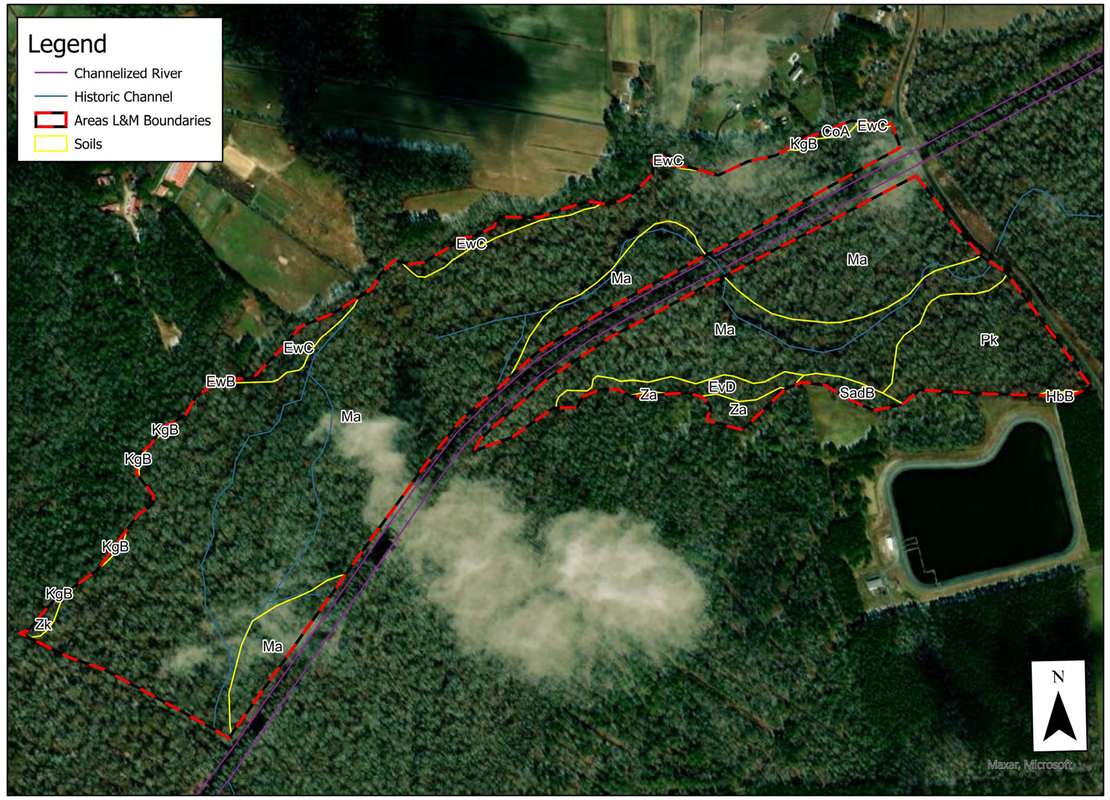
SOIL MAP



Map Unit Symbol	Map Unit Name
CoA	Corsica mucky loam, 0 to 2 percent slopes
EvD	Evesboro loamy sand, 5 to 15 percent slopes
EwB	Evesboro sand, 2 to 5 percent slopes
EwC	Evesboro sand, 5 to 10 percent slopes
HbB	Hambrook sandy loam, 2 to 5 percent slopes
KgB	Klej-Galloway complex, 0 to 5 percent slopes
Ma	Manahawkin muck, frequently flooded
Ma	Manahawkin muck, 0 to 1 percent slopes, frequently flooded
Pk	Puckum muck, frequently flooded
SadB	Sassafras sandy loam, 2 to 5 percent slopes, Northern Tidewater Area
Za	Zekiah sandy loam, frequently flooded
Zk	Zekiah silt loam, frequently flooded

CONSTRUCTION SPECS

USDA NRCS — Western Maryland RC&D Resource Conservation and Development Council, Inc.

CONSTRUCTION SPECIFICATIONS

SITE PREPARATION

Areas designated for borrow areas, earth fill, shallow water areas, and structural works shall be cleared, grubbed and stripped of topsoil. All trees, vegetation, roots and other objectionable material shall be removed.

All cleared and grubbed material shall be disposed of outside of limits of wetlands in locations approved by the project POC or designee. When specified, a sufficient quantity of topsoil will be stockpiled in a suitable location for use on the shallow water areas and other designated areas.

VEGETATIVE STABILIZATION

The work consists of preparing the area for treatment; furnishing and placing seed, mulch, fertilizer, lime, and other soil amendments as specified.

Seed - All seed shall conform to the current rules and regulations of the state where it is being used and shall be from the latest crop available.

Seed shall be labeled in accordance with the state laws and the U.S. Department of Agriculture rules and regulations under the Federal Seed Act in effect on the date of invitations for bids. Bag tag figures are evidence of purity and germination. No seed will be accepted with a test date of more than 9 months before the delivery date to the site.

Seed that has become wet, moldy, or otherwise damaged in transit or storage will not be accepted. The percent of noxious weed seed allowable shall be as defined in the current State laws relating to agricultural seeds. Each type of seed shall be delivered in separate sealed containers and fully tagged unless exception is granted in writing by the contracting officer.

The application rate per acre for seed mixtures and date of seeding or planting shall be as shown on the plans.

Fertilizer - Unless otherwise specified, the fertilizer shall be a commercial grade fertilizer. It shall meet the standard for grade and quality specified by State law. Where fertilizer is furnished from bulk storage, the contractor shall furnish a supplier's certification of analysis and weight. When required by the contract, a representative sample of the fertilizer shall be furnished to the contracting officer for chemical analysis.

Lime and other soil amendments - Lime shall consist of standard ground agriculture limestone, or approved equivalent. Standard ground agriculture limestone is defined as ground limestone meeting current requirements of the State Department of Agriculture.

Seedbed preparation and treatment - Areas to be treated shall be dressed to a smooth, firm surface. On sites where equipment can operate on slopes safely, the seedbed shall be adequately loosened (4 to 6 inches deep) and smoothed. Depending on soil and moisture conditions, disking or cultipacking, or both, may be necessary to properly prepare a seedbed. Where equipment cannot operate safely, the seedbed shall be prepared by hand methods by scarifying to provide a roughened soil surface so that broadcast seed will remain in place.

If seeding is to be accomplished immediately following construction operations, seedbed preparation may not be required except on a compacted, polished, or freshly cut soil surface.

Rocks larger than 6 inches in diameter, trash, weeds, and other debris that will interfere with seeding or maintenance operations, shall be removed.

Seedbed preparation shall be discontinued when soil moisture conditions are not suitable for the preparation of a satisfactory seedbed.

Seeding, spriqging, fertilizing, mulching, and stabilizing – All seeding operations shall be performed in such a manner that the seed are applied in the specified quantities uniformly in the designated areas. Unless otherwise specified, seeding shall be accomplished within 2 days after final grading is completed and approved.

Fertilizer, lime, and other soil amendments shall be applied as specified on the plans. When specified, the fertilizer and soil amendments shall be thoroughly incorporated into the soil immediately following surface application.

The rate, amount, and kind of mulching shall be as specified on the plans. Mulches shall be applied uniformly to the designated areas. They shall be applied to areas seeded not later than 2 working days after seeding has been performed. Straw mulch material shall be stabilized within 24 hours of application using a mulch crimper or equivalent anchoring tool or by a suitable tackifier. When the mulch crimper or equivalent anchoring tool is used, it shall have straight blades and be the type manufactured expressly for and capable of firmly punching the mulch into the soil. Where the equipment can be safely operated, it shall be operated on the contour. Hand methods shall be used where equipment cannot safely operate to perform the work required.

Mulching

Straw mulch material - straw mulch shall consist of wheat, barley, oat or rye straw, hay, grass cut from native grasses. The mulch material shall be air-dry, reasonably light in color, and shall not be musty, moldy, caked, or otherwise of low quality. The use of mulch that contains noxious weeds is not permitted. The contractor shall provide a method satisfactory to the contracting officer for determining weight of mulch furnished.

Applying mulch - mulches shall be applied uniformly to the designated areas. Mulch shall be applied to all disturbed areas immediately after seeding.

1. If grading is completed outside of the seeding season, mulch alone shall be applied as prescribed in this section and maintained until the seeding season returns and seeding can be performed in accordance with these specifications.
2. When straw mulch is used, it shall be spread over all seeded areas at the rate of 2 tons/acre. Mulch shall be applied to a uniform loose depth of between 1" and 2". Mulch applied shall achieve a uniform distribution and depth so that the soil surface is not exposed. If a mulch anchoring tool is to be used, the rate should be increased to 2.5 tons/acre.
3. Wood cellulose fiber used as a mulch shall be applied at a net dry weight of 1,500 lbs. per acre. The wood cellulose fiber shall be mixed with water, and the mixture shall contain a maximum of 50 lbs. Of wood cellulose fiber per 100 gallons of water.

Securing straw mulch - mulch anchoring shall be performed immediately following mulch application to minimize loss by wind or water. Straw mulch material shall be stabilized within 24 hours of application using one of the following methods (listed by preference), depending upon size of area and erosion hazard:

1. A mulch anchoring tool is a tractor drawn implement designed to punch and anchor mulch into the soil surface a minimum of two (2) inches. This practice is most effective on large areas, but is limited to flatter slopes where equipment can operate safely. If used on sloping land, this practice should be used on the contour if possible. Hand methods shall be used where equipment cannot safely operate to perform the work required.
2. Wood cellulose fiber may be used for anchoring straw. The fiber binder shall be applied at a net dry weight of 750 pounds/acre. The wood cellulose fiber shall be mixed with water and the mixture shall contain a maximum of 50 pounds of wood cellulose fiber per 100 gallons of water.

3. Application of liquid binders should be heavier at the edges where wind catches mulch, such as in valleys and on crests of banks. The remainder of area should be appear uniform after binder application. Synthetic binders - such as acrylic dlr (agro-tack), dca-70, petroset, terra tax ii, terra tack or other approved equal may be used at rates recommended by the manufacturer to anchor mulch.

MOBILIZATION AND DEMOBILIZATION

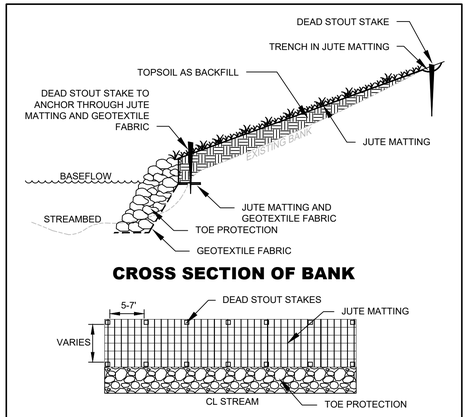
The work consists of the mobilization and demobilization of the contractor's forces and equipment necessary for performing the work required under the contract. Mobilization will not be considered as work in fulfilling the contract requirements for commencement of work.

Mobilization shall include all activities and associated costs for transportation of contractor's personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary general facilities for the contractor's operations at the site; premiums paid for performance and payment bonds including coinsurance and reinsurance agreements as applicable.

One of the primary purposes of this project is to provide high quality habitat for wildlife, which includes a diverse community of native plants. **To prevent contamination of the site with noxious and invasive plants, equipment (including buckets, tracks, and tires) shall be reasonably clean and free of soil and plant materials prior to mobilization.**

Demobilization shall include all activities and costs for transportation of personnel, equipment, and supplies not required or included in the contract from the site; including the disassembly, removal, and site cleanup of offices, buildings, and other facilities assembled on the site specifically for this contract.

This work includes mobilization and demobilization required by the contract at the time of award. If additional mobilization and demobilization activities and costs are required during the performance of the contract as a result of changed, deleted, or added items of work for which the contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.



NOTES:
- EROSION CONTROL FABRIC SHOULD BE PLACED ON SLOPES ADJACENT TO EROSIVE INUNDATION
- MATERIALS SHALL BE INSTALLED THE SAME DAY THAT THEY ARE PREPARED
- DEAD STOUT STAKES SHALL BE PLACED ON THE TOP EDGE OF JUTE MATTING AND WHERE JUTE MATTING MEETS THE TOE PROTECTION (USE 5-7' SPACINGS)

NRCS — Natural Resources Conservation Service, United States Department of Agriculture

JUTE MATTING DETAIL

Designed — Date
Drawn
Checked
Approved
File No.
Drawing No.
Sheet of

Designed LF 05-22
Drawn LF 06-22
Checked

WITTMYER, TULL, PATEY, TOWN OF BERLIN
WETLAND RESTORATION (657)
Berlin, Maryland

Approved — Date
Title — Job Class

Maryland Department of Agriculture
Worcester Co. Soil Conservation District

United States Department of Agriculture
Natural Resources Conservation Service

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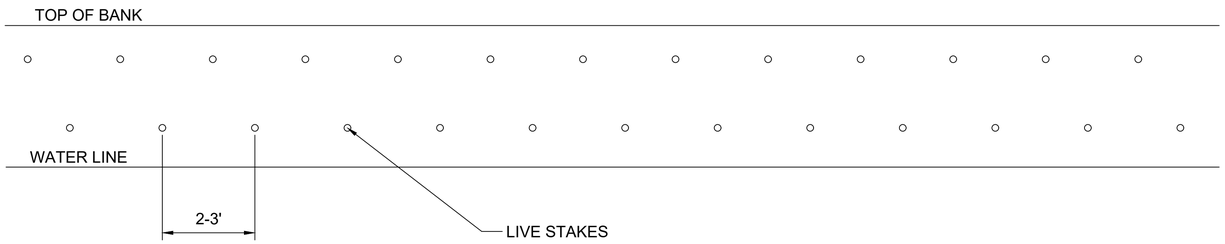
PLANTING PLAN

LIVE STAKES PLANTING

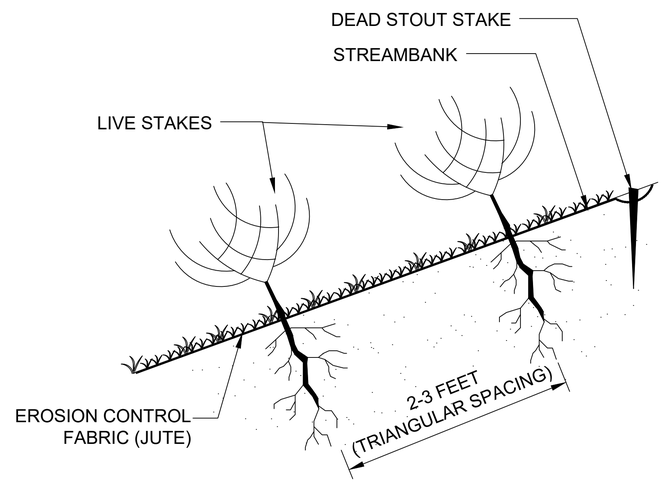
Live Stakes Planting				
Species	Item	Units	Spacing	Length
Silky Dogwood (*Cornus amomum*)	Live Stake	Each	3' O.C.	2' Min.
Southern Arrow-wood (*Viburnum dentatum)*	Live Stake	Each	3' O.C.	2' Min.
Elderberry (*Sambucus nigra*)	Live Stake	Each	3' O.C.	2' Min.

*Live stakes planting will occur on the banks adjacent to breaches. Refer to the design for planting locations.
Planting Dates for Live Stakes: Feb 15 - Apr 30, Nov 15 - Nov 30.

TYPICAL PLAN VIEW



TYPICAL PROFILE



NOTES:
- MATERIALS SHALL BE INSTALLED THE SAME DAY THAT THEY ARE PREPARED
- DEAD STOUT STAKES SHALL BE PLACED ON THE TOP EDGE OF JUTE MATTING AND WHERE JUTE MATTING MEETS THE TOE PROTECTION (USE 5-7' SPACINGS)

PLANTING CALCULATIONS
TOTAL LENGTH OF STREAMBANK TO BE PLANTED: 1250 FEET
AVERAGE SPACING: 2.5 FT
OF PLANTS/ROW: 1250/2.5 ≈ 500
OF ROWS: 2
OF STAKES: 1000

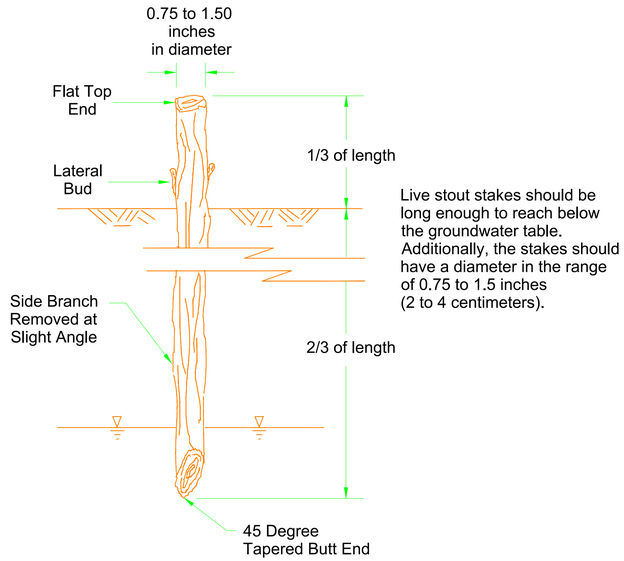
CRITICAL AREA SEEDING

Seed Mix 1 - Breaches			
Species	Recommended Cultivar	Rate LB/AC	Rate LB/1,000 SF
Riverbank Wildrye (*Elymus riparius*)	Common	10	0.23
Virginia Wildrye (*Elymus virginicus*)	Common	10	0.23
Redtop Panicgrass (*Panicum rigidulum*)	Common	2	0.05
Rough Bentrgrass (*Agrostis scabra*)	Common	1	0.02
Fox Sedge (*Carex vulpinoidea*)	Common	2	0.05

Substitutions may be allowed upon review and approval by the designer.

Seed Mix 2 - Spoil Areas			
Species	Recommended Cultivar	Rate (LB/AC)	Rate (LB/1000 SF)
Deertounge (*Dichanthelium clandestinum)*	Tioga	15	0.34
Virginia Wildrye (*Elymus virginicus)*	Common	5	0.11
Creeping Red Fescue (*Festuca rubra)*	Dawson, Jasper, Navigator II	20	0.46

STAKE DETAIL



Live stout stakes should be long enough to reach below the groundwater table. Additionally, the stakes should have a diameter in the range of 0.75 to 1.5 inches (2 to 4 centimeters).

Designed LF 05-22
Drawn LF 06-22
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STREAMBANK PROTECTION (580)
Berlin, Maryland

Approved Date
Title Job Class

Maryland Department of Agriculture
Worcester Co. Soil Conservation District

United States Department of Agriculture
Natural Resources Conservation Service

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Description
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Appendix D

Monitoring Protocol

ECOLOGICAL PERFORMANCE STANDARDS AND MONITORING PROTOCOL FOR NONTIDAL WETLAND MITIGATION SITES IN MARYLAND

September 14, 2023

Nontidal wetland mitigation banks, in-lieu fee sites, and permittee-responsible mitigation ('Site') shall conform to the following interim-based and final performance standards (Section I below) by the end of the monitoring period, unless otherwise determined by the U.S. Army Corps of Engineers ('USACE') and the Maryland Department of the Environment ('MDE'). In the case of permittee-responsible mitigation, the agencies requiring the mitigation (USACE and/or MDE) will make the determination on site success. For mitigation banks and in-lieu fee sites, coordination with the Interagency Review Team (IRT) may also be required. Monitoring timeframes, monitoring reports, monitoring report measurements, and adaptive management for mitigation sites must be consistent with the requirements in Sections II-V below. In addition, please see, "Standard Methods for Monitoring Vegetation, Hydrology, and Soils in Wetland Mitigation Sites in Maryland" below (pages 13-19) for the recommended techniques for monitoring wetland mitigation sites. Any decision whether or not a project meets the approved performance standards is within the sole discretion of the USACE and MDE and shall not be subject to appeal.

These performance standards and monitoring protocols are intended to provide a predictable and consistent approach to monitoring mitigation sites and to demonstrate that a site is trending towards meeting overall goals and objectives of the mitigation plan. All final performance standards, including any deviation in these standard performance standards, must be approved by the USACE and MDE prior to implementing the mitigation site. Alternative performance standards and monitoring protocols may be considered by the IRT when site-specific objectives critical to the establishment of the desired aquatic resource would not be met through use of the following general performance standards and monitoring protocols. If any of the performance standards or monitoring protocols listed below are not proposed for use or alternative standards or protocols are proposed for any given project, the rationale based on scientific literature, reference data, or data from prior professional experiences must be explained in the mitigation banking instrument or mitigation plan. If alternate performance standards or monitoring protocol are proposed, the Bank Sponsor, Permittee, or Authorized Person ('Sponsor') of the Site must clearly specify through track changes the proposed differences as part of their Performance Standards and Monitoring Protocol ('PS-M Protocol') submitted with the mitigation proposal for review and approval. These alternate standards cannot just be shown on the design plans. **If these alternate standards are not clearly stated in the PS-M Protocol approved for the Site, the below standards shall apply.** The USACE and MDE retain approval authority for any performance standards proposed that are different from those contained in this document.

Potential consequences of unmet performance standards and/or monitoring requirements:
If performance standards or monitoring requirements are not met, the Sponsor must notify the USACE and MDE. The USACE and MDE (in the case of permittee-responsible mitigation) or the USACE and MDE, in consultation with the IRT (in the case of mitigation banks) ('Agencies'), will evaluate measures to address the project deficiencies. In consultation with the Sponsor, the USACE and MDE will determine appropriate measures, which may include site modifications, design changes, and revisions to maintenance or monitoring requirements. Appropriate measures must be designed to ensure that the modified project provides ecological functions and benefits comparable or superior to those described in the plan objectives (33 CFR 332.7(c)(3). In addition, the USACE and MDE may determine that an extension of the monitoring period is appropriate, and/or keeping financial assurances in place until ecological performance standards approved as part of the PS-M Protocol are achieved. This may also result in a requirement to provide additional mitigation equivalent to the portion of the project that failed to meet the performance standards (in consideration of replacement of any additional temporal functional

lag), or as a last resort, suspending or revoking permits, levying administrative penalties, or even pursuing litigation. For mitigation banks and in-lieu fee sites, this may also include reducing the total amount of credits available, delaying or reducing the interim credit releases, and/or suspending credit sales or terminating the mitigation banking instrument. Note: For projects proposing overlapping credit types (i.e., stream buffer and wetland), the overlapping area must meet performance standards for both credit types. In accordance with 33 CFR 332.3(j)(1)(ii), the overlapping credits may be used to offset a wetland-only impact or stream-only impact, and the linked (i.e., overlapping) credit must be retired.

I. Performance Standards: The Agencies will use visual observations during site visits and submitted monitoring reports to evaluate attainment of performance standards and performance-based milestones and in determining whether part of or the entire site is successful or whether corrective actions are warranted. Except for standards for "Non-Native and Invasive Species" and "Wetland Species Richness" (except related to Loblolly pines) which will be determined by cell, success for each of the following standards will be determined at each sampling plot and/or well location. **Presenting averages or means of plot data across a site is not satisfactory to demonstrate success.** All the following standards and milestones will be used to assess project success and must be achieved each monitoring year.

A. Reporting: To ensure the compensatory mitigation project successfully meets its goals and objectives, the Sponsor must submit all required documentation, including recorded approved site protection instruments, proof of financial assurance and long-term monitoring deposits and withdrawals, pre-and post-construction completion notifications, as-built surveys/construction completion reports, monitoring and financial reports, long-term management reports, and annual proof of financial assurance renewal.

B. Wetland Area(s):

1. **Wetland Vegetation Dominance:** Wetland vegetation dominance[1], defined as a vegetation community where more than 50% of all dominant plant species across all strata are rated obligate ("OBL"), facultative wet ("FACW"), or facultative ("FAC"), using the vegetation sampling procedures as described in the appropriate regional supplement to the Corps of Engineers Wetland Delineation Manual, must be achieved; and

2. **Absolute Cover[2] Vegetative Standards:**
   a) For sites that require monitoring in year one, the mitigation site shall have a minimum of 50% native (FAC or wetter) species cover.
   b) By the end of year two, the mitigation site shall have a minimum of 60% native (FAC or wetter) species cover.
   c) By the end of year three, the mitigation site shall have a minimum of 70% native (FAC or wetter) species cover.
   d) By the end of year five and each monitoring year thereafter, the mitigation site shall have a minimum of 85% native (FAC or wetter) species cover. Volunteer species should support functions consistent with the project design goals; and

[1] Using the Dominance Test from the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual, dominant species comprise up to 50% of the total cover in each stratum, plus any other species that, by itself, is at least 20% total. A stratum requires $\geq$5% total plant cover unless it is the only strata present.
[2] This is actual cover, so sites with open ground may have a total less than 100% and sites with overlapping species cover may have a total greater than 100%.

3. **Non-Native and Invasive Species:** The goal of any mitigation site is to have no non-native or invasive species. Proper site selection is very important in meeting this goal. However, if non-native or invasive species are present, no more than 10% of relative plant cover[3] over the entire site shall be made up by non-native or invasive species, with no individual colony greater than or equal to 5% of relative plant cover. No more than 5% of relative plant cover over the entire site shall be made up of *Phragmites australis*[4], *Persicaria perfoliata, Pueraria montana*, or *Lythrum salicaria*. The presence, location, and percent cover of invasive and/or non-native species must be noted on the mitigation plan. Invasive species are identified on the 2010 National Park Service/U.S. Fish and Wildlife Service document *Plant Invaders of Mid Atlantic Natural Areas*[5] and the Maryland Invasive Species Council Invasive Species of Concern in Maryland[6]. Native status will be based on the Natural Resources Conservation Service Plants Database[7]. *Phalaris arundinacea* and *Typha* spp. may also be considered as invasive species by the Agencies. If the Sponsor determines they are unable to meet the performance standards and the Agencies recommend alternate standards, the Sponsor may provide justification for alternate standards based on the likelihood of successfully controlling those species. The documentation for these alternate standards must be reviewed and approved by the Agencies prior to implementation. In this approach, consideration should be given to the adverse effects of the species presence and of continuous treatment with herbicide. Non-chemical treatments are favored over chemical treatments in Maryland. For example, alternate standards may be proposed for invasive and/or non-native species that are not easily controlled without extensive and chronic herbicide use, and when their relative plant cover value will not adversely affect ecological functions related to community properties or hinder long-term success of the project (e.g., tree survival, plant diversity, etc.). In addition, the Sponsor must demonstrate that they are following the Adaptive Management Plan approved as part of their mitigation plan. If the Agencies allow alternate standards, while the project may not be considered a failure, delays in credit release and/or reduction in credit will likely occur; and

4. **Wetland Species Richness:**
   a) For scrub/shrub wetlands, establish a minimum of three species of native wetland shrubs (FAC or wetter) with no more than 50% relative cover of the tree/shrub species being one species, over the entire site. Loblolly pine cannot be more than 35% relative cover of the native wetland tree/shrub species in any plot.
   b) For forested wetlands, establish a minimum of three species of native wetland trees and two species of native wetland shrubs (FAC or wetter) with no more than 50% relative cover of the tree/shrub species being one species, over the entire site. Loblolly pine cannot be more than 35% relative cover of the native wetland tree/shrub species in any plot; and

5. **Wetland Vegetation Density for Scrub-Shrub and Forested Wetlands:** For scrub-shrub or forested wetlands, native wetland (FAC or wetter) plant density of at least 435 living trees/shrubs per acre with a minimum height of 10 inches shall be achieved by the end of the first year a monitoring report is required and maintained each monitoring year thereafter

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[3] "Relative plant cover" is defined as the cover of a particular species as a percentage of total plant cover. Thus, relative cover will always total 100%, even when total absolute cover is quite low.

[4] American Common Reed, *Phragmites australis* subsp. *americanus*, while uncommon, is not considered to be an invasive plant.

[5] https://www.invasive.org/alien/pubs/midatlantic/midatlantic.pdf

[6] http://mdinvasives.org/species-of-concern/

[7] https://plants.sc.egov.usda.gov/

through the end of the monitoring period; and

6. **Wetland Vegetation Cover for Forested Wetlands:** For forested wetlands, average tree height of tallest five native wetland (FAC or wetter) trees within each sample plot shall be at least three feet in height at year three and at least five feet in height at year five and each monitoring year thereafter. Canopy cover[8] of native wetland (FAC or wetter) trees and shrubs must be at least 30% by the end of the monitoring period; and

7. **Wetland Hydrology:**
   a) At a minimum, the site must be inundated (flooded or ponded) or the water table is 12 inches or less below the soil surface for at least 14 or more consecutive days during the growing season in most years (greater than or equal to 50 percent probability). Short-term monitoring (less than 10 years) must consider the normality of rainfall occurring prior to and during the monitoring period when addressing the frequency requirement. For the purpose of this determination, the growing season should be based on median dates (i.e., 50 percent probability) of 28ºF air temperatures in spring and fall, based on the long-term data for the nearest appropriate weather station, as recorded in the WETS tables available from the NRCS National Water and Climate Center (https://www.wcc.nrcs.usda.gov/climate/navigate_wets.html), or as specified in the appropriate regional supplement to the Corps of Engineers Wetland Delineation Manual; and
   b) The overall seasonal hydroperiod (depth, degree, duration, and periodicity) shall be similar to that of an IRT-approved reference wetland or targeted wetland type, with the acceptable range of the seasonal hydroperiod specified in the approved mitigation plan.

8. **Anaerobic Soil Conditions:** The entire wetland restoration or creation area must meet the Hydric Soil Technical Standard (Technical Note 11) developed by the National Technical Committee for Hydric Soils for saturated conditions and anaerobic conditions at a minimum frequency of 3 years out of the 5 monitoring years (50 percent or higher probability):
   a) Free water must exist within 10 inches (25 cm) of the ground surface for at least 14 consecutive days; and
   b) Anaerobic conditions must exist within 10 inches (25 cm) of the ground surface for at least 14 consecutive days. Anaerobic conditions may be determined by one of the following methods[9], as detailed in the Hydric Soil Technical Standard:
      (1) Positive reaction to alpha-alpha dipyridyl, determined as least weekly.
      (2) Reduction of iron determined with IRIS devices (tubes or films) installed for 30 days.
      (3) Measurement of redox potential (Eh) using platinum electrodes, determined at least weekly.

[8] "Canopy cover" is defined as the percentage of ground covered by tree and shrub leaves, when the edges of the leaves are mentally projected down to the ground surface.
[9] In order for results to be valid, methods must follow the "Recommended Methods for Monitoring Vegetation, Hydrology, and Soils in Wetland Mitigation Sites in Maryland" located at the end of this document.

9. **Topsoil:** For areas where grading occurred or topsoil has been removed, the entire wetland restoration, creation or enhancement area must have a depth of at least 6 inches topsoil, or other depth as approved in the mitigation plan. Imported topsoil must be a loam, sandy loam, clay loam, silt loam, sandy clay loam, or loamy sand, unless previously approved by the Agencies. Imported topsoil must contain less than 5 percent by volume of cinders, stones, slag, coarse fragments, gravel, sticks, roots, trash, or other materials larger than 1½ inches in diameter. If the soil surface has a Munsell value or chroma >3, then soil organic matter (using the Walkley-Black method), must show the site has at least 2% organic matter. *<If the site was designed to have similar soils as an Agency-approved reference wetland soil, the Sponsor may propose an organic matter content that is within a range specified in the approved mitigation plan, which must also be specified here.>*

10. **Bulk Density:** The subsoil shall have a bulk-density of less than 85 lbs/cubic foot (1.35 g/cc) for loamy and finer textured soils and less than 107 lbs/cubic foot (1.70 g/cc) in sands (prior to adding topsoil or organic matter). *<If the site is designed to be precipitation driven the Sponsor may propose an alternate bulk density requirement in the approved mitigation plan, which must also be specified here.>*

11. **Microtopography:** Microtopographic variations range from 3 to 6 inches from design elevation, with no more than 25 percent of each wetland cell remaining at the design elevation. *<If microtopography was designed to mimic an Agency-approved reference wetland, the Sponsor may propose alternate elevation variations in the approved mitigation plan, which must also be specified here.>*

12. **Woody Debris**: Multiple types of coarse woody debris (e.g., logs at least six inches in diameter and six feet long, brush piles, root wads, overturned stumps, standing snags, etc.) are present throughout the mitigation site. *<If the Sponsor determines that alternate densities, types, and/or locations of coarse woody debris should be utilized at the site due to the unique design/objectives, the Sponsor may propose alternate requirements in the approved mitigation plan, which must also be specified here.>*

13. **Delineation of Aquatic Resources:** At the mid-term monitoring year (year 3 for a 5-year monitoring period and year 5 for a 10-year monitoring period) and at the final year of the monitoring period, the wetland boundary area (established/ re-established/ restored/ enhanced/ preserved) as shown on the approved mitigation plan, shall be delineated using the wetland criteria outlined in the Corps of Engineers Wetlands Delineation Manual (1987) and appropriate regional supplement(s). Delineated wetlands shall be broken into projected vegetative type (e.g., emergent, scrub-shrub, forested) based on species present and density. In addition, all special aquatic sites, other waters, such as lakes and ponds, and all streams, within the approved mitigation site shall be identified and delineated. The delineated aquatic resource mitigation areas as verified by the Agencies shall be consistent with the approved mitigation plan and contain at least as much wetland acreage and waterway linear feet as required in the mitigation plan. Deep water habitats and unvegetated areas that do not meet wetland criteria shall not be included in area measurements.

14. **Wetland function assessment:** The mitigation site should meet the intended goals and objectives of the project, as specified in the approved mitigation plan. An assessment of the specific wetland functions and values being provided should be conducted.

C. **Buffer Area(s):** The Buffer Area Performance Standards are required to be met if the buffer is getting mitigation credit. If upland or wetland areas were cleared to provide access for construction, but will not be getting mitigation credit, they will still be required to meet the following Performance Standards:

1. **Absolute Cover[2] Vegetative Standards:**
   a) For sites that require monitoring in year one, the mitigation site shall be vegetated with a minimum of 50% native species cover.
   b) By the end of year two, the mitigation site shall be vegetated with a minimum of 60% native species cover.
   c) By the end of year three, the mitigation site shall be vegetated with a minimum of 70% native species cover.
   d) By the end of year five and each monitoring year thereafter, the mitigation site shall be vegetated with a minimum of 85% native species cover.
   e) Volunteer species should support functions consistent with the project design goals; and

2. **Non-Native and Invasive Species:** The goal of any site is to have no non-native or invasive species. Proper site selection is very important in meeting this goal. However, if non-native or invasive species are present, no more than 10% of relative plant cover[3] over the entire site shall be made up by non-native or invasive species, with no individual colony greater than or equal to 5% of relative plant cover. No more than 5% of relative plant cover over the entire site shall be made up of *Phragmites australis*[2], *Persicaria perfoliata*, or *Pueraria montana*. The presence, location, and percent cover of invasive and/or non-native species must be noted on the mitigation plan. Invasive species are identified on the 2010 National Park Service/U.S. Fish and Wildlife Service document *Plant Invaders of Mid Atlantic Natural Areas*[10] and the Maryland Invasive Species Council Invasive Species of Concern in Maryland[11]. Native status will be based on the Natural Resources Conservation Service Plants Database[12]. If the Sponsor determines they are unable to meet these performance standards and the Agencies recommend alternate standards, the Sponsor may provide justification for alternate standards based on the likelihood of successfully controlling those species. The documentation for these alternate standards must be reviewed and approved by the Agencies prior to implementation. In this approach, consideration should be given to the adverse effect of the species presence and of continuous treatment with herbicide. Non-chemical treatments are favored over chemical treatments in Maryland. For example, alternate standards may be proposed for invasive and/or non-native species that are not easily controlled without extensive and chronic herbicide use, and when their relative plant cover value will not adversely affect ecological functions related to community properties or hinder long-term success of the project (e.g., tree survival, plant diversity, etc.). In addition, the Sponsor must demonstrate that they are following the Adaptive Management Plan approved as part of their mitigation plan. If the Agencies allow alternate standards, while the project may not be considered a failure, delays in credit release and/or reduction in credit will likely occur;

3. **Vegetation Density for Forested Buffers:** For forested buffers, native plant density of at least 435 living trees/shrubs per acre with a minimum height of 10 inches shall be achieved by the end of the first year a monitoring report is required and maintained each monitoring year thereafter through the end of the monitoring period; and

[10] https://www.invasive.org/alien/pubs/midatlantic/midatlantic.pdf
[11] http://mdinvasives.org/species-of-concern/
[12] https://plants.sc.egov.usda.gov/

4. **Vegetation Cover for Forested Buffers:** For forested buffers, average tree height of tallest five native trees within each sample plot shall be at least three feet in height at year three and at least five feet in height at year five and each monitoring year thereafter. Canopy cover[8] of native trees and shrubs must be at least 30% by the end of the monitoring period.

II. Monitoring Timeframe:

A. The Sponsor will be responsible for monitoring the site for a period specified in the approved mitigation plan. The USACE 2008 Mitigation Rule requires the monitoring period to be sufficient to demonstrate that the compensatory mitigation project has met performance standards and be a minimum period of five years (33 CFR 332.6(b)). However, longer monitoring periods of more than 5 years are warranted for aquatic resources with slow development rates (e.g., vernal pools, riparian forest, forested wetlands, and coastal salt marsh). In accordance with federal requirements, all monitoring of mitigation sites regulated by the USACE must adhere to the minimum standards provided in Regulatory Guidance Letter 08-03, *Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Restoration, Establishment, and/or Enhancement of Aquatic Resources,* (https://www.nab.usace.army.mil/Missions/Regulatory/Mitigation/).

B. The monitoring period begins the year the mitigation planting occurs, unless planting occurs after April 15, in which case the monitoring period will not begin until the following year. For each monitoring report, vegetative monitoring shall be conducted between May 1 and September 30 for forested/scrub-shrub systems and between June 15 and September 30 for emergent systems. Site visits should preferably be during a period with normal precipitation and groundwater levels.

C. Monitoring must be conducted a minimum of once per year during the years that monitoring reports are required. Certain sites may require more frequent monitoring (e.g., twice a year during spring and fall) and reporting during the early stages of development to quickly identify and address problems and/or concerns. The extent of monitoring may be reduced or waived no earlier than the end of the fifth monitoring year over part or the entire site upon a determination by the Agencies, that the site has achieved all performance-based milestones each monitoring year and all final performance standards for two consecutive monitoring events[13]. Remediation measures[14] (e.g., invasive species management, replanting, controlling encroachment, etc.), if required, should not have occurred during the last two full growing seasons prior to requesting reduction or waiver of remaining monitoring requirements to ensure the site is self-sustaining. If the Agencies conclude that the mitigation site has met its performance standards after a minimum 5 monitoring years and that the full monitoring requirements are not necessary to ensure that the site will meet its objectives, the Agencies will typically require a full Year-10 monitoring report in order to provide a baseline for long-term management. In no case shall a reduction of monitoring requirements be interpreted to preclude the Agencies from requiring this Year-10 report. Conversely, the Agencies, may extend the original monitoring period upon a determination that performance standards have not been met, the site is not on track to meet them (e.g., remediation or adaptive management required), or in consideration of the amount and distribution of precipitation prior to and during the growing season compared with analyses of normal precipitation ranges and other climatic variables at or near the project location. If a natural disaster

[13] Performance standards for wetland hydrology and anaerobic soil conditions must be met at least 3 years or 50% or monitoring years, whichever is greater, for the Agencies to consider reducing or waiving monitoring early.
[14] An exception may include treatment for small amounts of invasive species that are not likely to persist.

occurs during the monitoring period, remediation or adaptive management may be required and the monitoring period may be extended. On-site conditions, the complexity of the approved mitigation plan, and unforeseen circumstances will ultimately determine whether the monitoring period should be extended beyond the specified monitoring time frame, or the extent of monitoring terminated/reduced for a particular project.

III. Monitoring Reports: Monitoring reports should be concise and effectively provide the information necessary to assess the status of the site. Reports should provide information necessary, including supporting data such as plans, maps, and photographs, to illustrate site conditions and whether the site is meeting its objectives and performance standards.

A. Monitoring reports, a paper copy, and an electronic version, must be submitted by the Sponsor to the Agencies by December 31 of each monitoring year. For mitigation banks, the Sponsor must concurrently upload a copy of the monitoring report to RIBITS for access by the Agencies. For all Sites, if five years of monitoring is required, monitoring reports shall be submitted annually. If ten years of monitoring is required, monitoring reports shall be submitted for years 2, 3, 5, 7, and 10 ("monitoring years") following completion of construction and planting of the mitigation site or phase thereof. Failure to submit monitoring reports will result in non-compliance of permit conditions and delay of approval of any remaining credits and formal release from future monitoring requirements until reports are submitted and approved by the Agencies.

B. Contents of Monitoring Reports: Mitigation monitoring reports must be submitted consistent with the current Agency-approved monitoring report templates.

1. **Monitoring reports shall be provided using the attached "Mitigation Monitoring Report Template". This template provides guidance and format for the minimum content for compensatory mitigation monitoring reports consistent with the USACE Regulatory Guidance Letter 08-03, *Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Restoration, Establishment, and/or Enhancement of Aquatic Resources.***
2. **The additional information below must be submitted in a narrative format which also includes the detailed plot summary data in "Appendix A – Mitigation Monitoring and Performance Standards Summary Table Template."** This information must be included for the monitoring report to be considered complete.

IV. Narrative report requirements. The following information must be included in the narrative portion of the monitoring report:

A. Background information and discussion:

1. Specify any requested action (e.g., credit release, Agency review).
2. A brief paragraph describing the goals and objectives of the site, including the proposed mitigation acreage and aquatic resource type approved as part of the mitigation plan.
3. A brief narrative description of the site addressing its position in the landscape, adjacent waterbodies, and adjacent land use.
4. Describe methods used to evaluate performance standards. Plot locations should be clearly identified on attached maps.
5. A narrative description of existing mitigation site conditions and functions and how the site has or has not achieved the goals, objectives and performance standards established for the project.
6. If monitoring or site inspections were conducted between years of required monitoring (e.g., year four in a 10-year monitoring period), this data should also be included.

7. Estimate the percent of the site that is establishing into wetland and the type of wetland system (ex: forested, scrub-shrub, emergent). If this differs from what was planned, show the boundaries of the actual wetland area/types on the plans or maps.
8. Estimate the percent of the site buffer that is establishing into forested buffer. If this differs from what was planned, show the boundaries of the actual forested buffer area on the plans or maps.
9. Discussion of growing season and how it was determined for the site.

B. Conclusions: A general statement must be included that describes the conditions of the site. If performance standards are not being met, a brief explanation of the difficulties and potential remedial actions proposed by the Sponsor, including a timetable, must be provided. The Agencies will ultimately determine if the mitigation site is successful for a given monitoring period.

C. Monitoring Report Measurements. Monitoring reports should include all the following information for the overall site, and each plot, well or cell. While this information is required as part of the monitoring report narrative, the summary data for each plot should be included in Appendix A:

1. Wetland Area(s):

a) Vegetation:

i. Estimate the absolute and relative percent cover by plant species, in order of dominance, across all strata for each plot. <u>This information must be included in a separate table for each plot</u> to allow verification of calculations and a better understanding of detailed species composition. For each species listed in the table include 1) native/non-native status, 2) wetland indicator status, and 3) if it is a dominant species. Summarize the data by plot, cell, and overall site. An example table is located at the end of this document. The presence, location, and percent cover of colonies of invasive and/or non-native species shall be mapped on the mitigation plan.

ii. For scrub-shrub or forested wetlands, estimate the percent survival of planted trees and number of native wetland (FAC or wetter) trees/shrubs per acre (including volunteer woody species) at least ten inches. Data should be summarized for each plot and by cell and overall site. Please note that projects where the vegetation is inconsistent throughout the site may not meet the performance standards (e.g., a site where some portions have high densities of woody species, but other portions have low densities).

iii. For scrub-shrub or forested wetlands, measure the height of the tallest five trees within each sample plot in each monitoring year. In the final year of monitoring, measure canopy cover of native wetland (FAC or wetter) trees and shrubs.

iv. Summarize the results from the vegetation plot study, including how the vegetation meets/does not meet performance standards. Data should be summarized for each plot, by cell, and for the entire site. Do not include the raw plot data in your monitoring report.

b) Hydrology:

i. Estimate percent of site that is inundated or saturated to the surface on the dates of the site visits.

ii. Monitoring data for surface water and groundwater, including hydrograph of

measured depth to water table, after calibrating for above-ground height of well. Data should be included for each well separately.

iii. Discuss analyses of how precipitation, drought, and other climatic factors during this monitoring year compared with the normal range of those factors that would be expected, based on data collected at or near the project location over a rolling 30-year period. Climatic and precipitation normal ranges are informed through the use of multiple tools and site-specific data such as, but not limited to, the antecedent precipitation tool (APT[15]), WETS tables[16] , Standard Precipitation Index[17] , NOAA/National Weather Service Meteorological Stations, National Weather Service – MidAtlantic River Forecast Center – Precipitation Departures[18] , USDA National Water and Climate Center[19] , aerial photography, soil mapping, LIDAR, topographic mapping, NWI maps, site-specific physical and biological field indicators, etc. It is important to recognize that APT and other tools inform normal conditions at the surface, and groundwater levels are not necessarily reflected. Precipitation data taken ≥ 3 months before the observation should be evaluated to determine if preceding dry conditions have potentially impacted current groundwater tables (e.g., lag times in the recovery of groundwater tables and discharge)

iv. Provide hydrograph showing well data (see example at end of document). *This should include ground elevation on the Y axis, with the ground surface and 12 inches below ground surface clearly marked. The X axis should be time.* The data should include well water levels and precipitation over that period. The hydrograph should also clearly mark the beginning and end of the growing season and should highlight the periods of time where the hydrology criteria was met.

v. Summarize results of the hydrology monitoring for each well, by cell, and for the entire site, including if each meets/does not meet the performance standards. Estimate percent of site that has wetland hydrology. Include a discussion of water movement into and through the site.

c) Soils:

i. Monitoring data to determine if hydric soils are actively developing. *This should be included for each monitoring report.* Data should be included for each sample location, including percentage of reduction and depth of reduction (e.g., 6-inch section for IRIS technology and 4-inch section for alpha alpha dipyridyl). This must include evidence that saturated and anaerobic soil conditions are being met, as measured by alpha-alpha dipyridyl, IRIS devices (tubes or films), or platinum electrodes. Include photos of all removed IRIS tubes/films or alpha alpha dipyridyl strips.

ii. For the first monitoring report, include monitoring data to determine if at least 2% organic matter is present in the entire depth of topsoil. Data should be included for each sample location.

iii. For the first monitoring report, include monitoring data to determine the bulk density of the subsoil. Data should be included for each sample location.

iv. Provide a soil profile description with accompanying soil photos for each soil

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15 https://github.com/jDeters-USACE/Antecedent-Precipitation-Tool/releases/latest

16 https://www.wcc.nrcs.usda.gov/climate/wets_doc.html

17 https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/indices

18 https://www.weather.gov/marfc/Precipitation_Departures#

19 https://www.wcc.nrcs.usda.gov/

location tested above.

v. Summarize results of the soil monitoring for each sample location, by cell, and for the entire site, including if each meets/does not meet the performance standards.

d) Physical Structure:

i. Estimate percentage of site with microtography and compare with approved mitigation plan.

ii. Estimate density and type of coarse woody debris (e.g., logs, brush piles, root wads, overturned stumps, standing snags, etc.) and compare with approved mitigation plan.

e) Wetland functional/conditional assessment: Provide an assessment of the specific wetland functions and values being provided at the mitigation site. When using a detailed functional/conditional assessment (e.g., MDWAM), please provide results.

2. Buffer Area(s):

a) Vegetation:

i. Estimate the absolute and relative percent cover by plant species across all strata for each plot. Include this information in a table. For each species listed in the table, include native/non-native status. Summarize the data by plot, cell, and overall site. The presence, location, and percent cover of colonies of invasive and/or non-native species shall be mapped on the mitigation plan.

ii. For scrub-shrub or forested buffers, estimate the percent survival of trees and the number of native trees/shrubs per acre (including planted or volunteer woody species at least ten inches). Data should be summarized for each plot and by cell and overall site. Please note that projects where the vegetation is inconsistent throughout the site may not meet the performance standards (e.g., a site where some portions have high densities of woody species, but other portions have low densities).

iii. For scrub-shrub or forested buffers, measure the height of the tallest five trees within each sample plot in each monitoring year. In the final year of monitoring, measure canopy cover of native trees and shrubs.

iv. Measurements of vegetation based upon performance standard and methods used to evaluate the vegetative success of the mitigation site. **Do not include the raw plot data in your monitoring report.**

D. Remediation:

1. Describe any problems observed within the wetland or buffer, such as: excessive inundation, insufficient hydrology, seasonal drought conditions, invasion by undesirable species of plants or wildlife, disease condition for plants, poor plant establishment, human encroachment, adverse water quality impacts (e.g., excessive sediment loading, water pollution, etc.) and slope failures or erosion problems.
2. Describe the proposed remedial measures to address the problems noted above. Note: even if some performance standards are met when summarizing across a cell (e.g., tree density), if some plots are not meeting the performance standards, remediation should be proposed for the area represented by the failing plot. Additionally, a site walk may help to identify other issues not captured in the plot data, which should still be remediated.
3. Remedial measures proposed by the Sponsor are subject to review and approval by the Agencies prior to implementation. Remediation should be completed within a year of identifying the deficiency. In the event that remedial measures are implemented, the monitoring period may be extended on a case-by-case basis. The treatment of non-native invasive plant species does not need the approval of the Agencies but should be completed at the correct time of year by someone with a current pesticide applicator certification and the required MDE toxic materials permit.

V. Adaptive Management Review

A. The Sponsor assumes all liability for performing approved measures through adaptive management strategies or alternative mitigation should Agencies or the Sponsor determine the site is not meeting performance standards or satisfying the objectives of the approved mitigation plan or instrument. The approved adaptive management plan will guide decisions for revising mitigation plans and implementing measures to address circumstances (foreseeable and unforeseen) that adversely affect mitigation site success. Any deviations from the approved mitigation plan requires approval from the Agencies.

B. The Sponsor must include appropriate information in the monitoring reports about performance issues and implementation of approved adaptive management measures to allow the Agencies to assess how the project is progressing. The Sponsor must notify the Agencies as soon as possible if the site is not achieving its performance standards as anticipated. The Agencies and Sponsor will evaluate any deficiencies and determine if proposed measures will address those deficiencies and/or require modification of the approved mitigation plan(s). The proposed measures must be designed to ensure that the modified mitigation project provides aquatic resource functions comparable to those described in the mitigation plan objectives. The Sponsor shall implement the strategies in the adaptive management plan until the site has been determined by the Agencies to have met its goals, objectives, and performance standards and the long-term management plan is initiated.

STANDARD METHODS FOR MONITORING VEGETATION, HYDROLOGY, AND SOILS IN WETLAND MITIGATION SITES IN MARYLAND

Below are the recommended techniques for monitoring mitigation sites. Alternate techniques may be considered but must be approved in writing by the Agencies prior to the commencement of the monitoring period.

Recommended Wetland Vegetation Density Measurement Technique

a. The following method for measuring the success of the vegetative colonization should be conducted once between May 1 and September 30 for forested/shrub-shrub systems and between June 15 and September 30 for emergent systems during each year requiring submittal of a monitoring report, unless an alternate schedule is agreed upon by the Agencies.
b. Vegetation sample plots shall be located on a stratified random basis over the site to sample all areas of wetlands at locations adjacent to each photo location marker. Plots should be located within each planned and actual vegetative type and hydrologic regime. Plot locations should be determined prior to construction and shown on the mitigation plan. Once the sample plots are approved as part of the mitigation plan, they should be stationary, unless the Sponsor recommends, and the Agencies agree to moving the permanent plot location. In conjunction with the permanent plots established within the rehabilitated, enhanced, reestablished, and/or established wetlands, additional wetland vegetative monitoring plots will be randomly selected every monitoring year during the maintenance and monitoring phase of the mitigation site. A minimum of half the plot locations will be permanent and the remaining half will be randomly selected every monitoring year. Alternatively, the Agencies may also recommend the relocation of some or all the sample plots to better reflect the plant communities. Potential justification for moving sample plots may include that the plot location is an outlier, or the actual vegetative type/hydrologic regime differs from what was planned, resulting in some representative areas not being monitored. The following minimum numbers of samples will be required:
    i. If the site is < 5 acres, then a minimum of 3 plots/acre is necessary.
    ii. If the site is > 5 acres but less than 20 acres, then a minimum of 3 plots/acre is required for the first 5 acres, then 2 plots/acre is required for the remaining acreage.
    iii. If the site is > 20 acres, then a minimum of 2 plots/acre is required for the first 20 acres, then 1 plot/acre is required for the remaining acreage.
    iv. All cells shall be sampled. A targeted vegetation monitoring approach that correlates monitoring stations with vegetative signatures on aerial photography may be useful for larger mitigation sites.
c. Consistent with the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual, plot sizes shall be 5’ radius for the herbaceous stratum, 15’ radius for the sapling/shrub stratum, 30’ radius for the tree stratum, and 30’ radius for the woody vine stratum. Note: to better determine if the trees/shrubs are meeting performance standards, the Sponsor should use a 15’ radius plot size to sample the trees/shrubs, even if they are less than 1 meter tall. If larger trees are present (≥3-inch diameter at breast height), they should be sampled using the 30’ radius size for the tree stratum. At least one representative plot needs to be in each plant community. The Sponsor may request alternate plot sizes consistent with the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual. For example, if the Sponsor proposes a smaller sample size, additional plots will be required to ensure sampling provides a good representation of the vegetation present. The vegetation data shall be collected in the field during the growing season and shall include:
    i. Percent absolute cover of each plant species in each stratum of the community.
    ii. Number of native wetland (FAC or wetter) woody plant stems greater than 10 inches in height.
    iii. Percent survival by planted species.

iv. Height of tallest five native wetland (FAC or wetter) trees/shrubs.
v. Evaluate and map colonies of non-native/invasive species cover across the entire site.

Recommended Buffer Vegetation Density Measurement Technique

a. The following method for measuring the success of the vegetative colonization should be conducted once between May 1 and September 30 of each year requiring submittal of a monitoring report, unless an alternate schedule is agreed upon by the Agencies.
b. Vegetation sample plots shall be located on a stratified random basis over the site to sample all areas of wetland buffer at locations adjacent to each photo location marker. Plots should be located within each planned and actual vegetative type and hydrologic regime. Plot locations should be determined prior to construction and shown on the mitigation plan. Once the sample plots are approved as part of the mitigation plan, they should be stationary, unless the Sponsor recommends, and the Agencies agree to moving the permanent sample plots. In conjunction with the permanent plots established within the rehabilitated, reestablished, and/or established wetlands, additional wetland vegetative monitoring plots will be randomly selected every monitoring year during the maintenance and monitoring phase of the mitigation site. A minimum of half the plot locations will be permanent and the remaining half will be randomly selected every monitoring year. Alternatively, the Agencies may also recommend the relocation of some or all the sample plots to better reflect the plant communities. Potential justification for moving sample plots may include that the plot location is an outlier, or the actual vegetative type differs from what was planned, resulting in some representative areas not being monitored. The following minimum numbers of samples will be required:
    i. If the site is < 5 acres, then a minimum of 3 plots/acre is necessary.
    ii. If the site is > 5 acres but less than 20 acres, then a minimum of 3 plots/acre is required for the first 5 acres, then 2 plots/acre is required for the remaining acreage.
    iii. If the site is > 20 acres, then a minimum of 2 plots/acre is required for the first 20 acres, then 1 plot/acre is required for the remaining acreage.
    iv. All cells shall be sampled. A targeted vegetation monitoring approach that correlates monitoring stations with vegetative signatures on aerial photography may be useful for larger mitigation sites.
c. Consistent with the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual, plot sizes shall be 5' radius for the herbaceous stratum, 15' radius for the sapling/shrub stratum, 30' radius for the tree stratum, and 30' radius for the woody vine stratum. Note: to better determine if the trees/shrubs are meeting performance standards, the Sponsor should use a 15' radius plot size to sample the trees/shrubs, even if they are less than 1 meter tall. If larger trees are present (≥3-inch diameter at breast height), they should be sampled using the 30' radius size for the tree stratum. At least one representative plot needs to be in each plant community. The Sponsor may request alternate plot sizes consistent with the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual. For example, if the Sponsor proposes a smaller sample size, additional plots will be required to ensure sampling provides a good representation of the vegetation present. At least one representative plot needs to be in each plant community. The Sponsor may request alternate plot sizes consistent with the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual. For example, if the Sponsor proposes a smaller sample size, additional plots will be required to ensure sampling provides a good representation of the vegetation present. The vegetation data shall be collected in the field during the growing season and shall include:
    i. Percent absolute cover of each plant species.
    ii. Number of native woody plant stems greater than 10 inches in height.
    iii. Percent survival by planted species.
    iv. Height of tallest five native trees/shrubs.
    v. Evaluate and map colonies of non-native/invasive species cover across the entire site.

Recommended Groundwater Well Placement and Data Collection

a. Determine if this wetland is groundwater fed or has a perched water table. Soil profile descriptions must be assessed prior to well installation to identify any restrictive layers to downward water movement. Wells should be installed following the techniques described in the 2005 USACE document entitled *Technical Standard for Water-Table Monitoring of Potential Wetland Sites ERDC TN-WRAP-05-02*. They should not penetrate the restrictive layer but should instead be no deeper than the top of the restrictive layer. In most cases, a standard monitoring well installed to 15 inches below the soil surface should be used. Shallower installation depths should be utilized if restrictive soil depths are located within 15 inches of the soil surface. Well design and installation shall be consistent with current USACE guidance.
b. Specific details on the groundwater monitoring wells and locations shall be provided in the mitigation plan and must be approved by the Agencies.
c. The following minimum numbers of groundwater wells will generally be required. The Sponsor may propose alternate well requirements as part of the mitigation plan, based on justification from the proposed mitigation design:
    i. If the site is < 10 acres, then a minimum of 1 well/acre is necessary.
    ii. If the site is 10 to 20 acres, then a minimum of 1 well/acre is necessary for the first 10 acres, then 1 well/2 acres is necessary for the remaining acreage.
    iii. If the site is > 20 acres, then a minimum of 1 well/acre is necessary for the first 10 acres, 1 well/2 acres is necessary for the next 10 acres, and 1 well/5 acres is necessary for the remaining acreage.
    iv. Hydrologic zones differentiated by a 1-foot change in elevation should have a minimum of one groundwater monitoring well installed.
    v. For sites with multiple cells, each cell should have at least one well.
d. Begin the collection of groundwater well data within fourteen days of the start of the growing season. Take groundwater well readings once every 7 days for the first two months of the growing season and every 30 days for the remainder of the growing season. Data loggers are highly recommended, as they provide a continuous recording of water levels. Record to the nearest inch. Well data should be collected every year during the monitoring period in included in the monitoring report. If well data confirms the presence of wetland hydrology during multiple years of monitoring, the Sponsor may request that well data not be required every year. The Agencies will consider the evidence of hydrology, based on the monitoring reports, site visits, and local precipitation, to approve or deny this request.
e. The growing season should be based on median dates (i.e., 50 percent probability) of 28ºF air temperatures in spring and fall, based on the long-term data for the nearest appropriate weather station, as recorded in the WETS tables available from the NRCS National Water and Climate Center (https://www.wcc.nrcs.usda.gov/climate/navigate_wets.html), or as specified in the appropriate regional supplement to the Corps of Engineers Wetland Delineation Manual.
f. Measure and record any surface water present at the monitoring wells.
g. Include a copy of the plan showing the location of the wells and surface elevation beside each well. Summarize the information regarding groundwater and surface water elevations and provide monthly rainfall data for the areas.

Indicator of Saturated and Anaerobic Conditions to Demonstrate the Presence of Active Hydric Soil Conditions

a. The Hydric Soil Technical Standard (HSTS) developed by the National Technical Committee for Hydric Soils (Technical Note 11) requires documentation of anaerobic conditions and saturated conditions for a soil to be considered hydric:
    i. For a soil to meet the Saturated Conditions part of the HSTS, free water must exist within 10 inches (25 cm) of the ground surface for at least 14 consecutive days; and
    ii. Anaerobic conditions must exist within 10 inches (25 cm) of the ground surface for at least 14 consecutive days. Anaerobic conditions may be determined by one of the following methods, as detailed in the HSTS:
        (1) Positive reaction to alpha-alpha-dipyridyl, determined at least weekly.
        (2) Reduction of iron determined with IRIS devices (tubes or films) installed for 30 days.
        (3) Measurement of redox potential (Eh) using platinum electrodes, determined at least weekly.

    Methods to demonstrate the presence of anaerobic conditions are outlined at (https://nrcs.app.box.com/s/6bd9555mxicaofpudib31etctkxmwlu6/file/1049327000311?sb=/details).
b. If using alpha-alpha dipyridyl to show soil reduction, soils should be measured at least weekly during the growing season, at a depth of six inches. Note that alpha-alpha dipyridyl is also available as paper strips for easier measurement.
c. Soil testing should be conducted during the time of the growing season anticipated to have the highest amount of soil reduction (often in the early growing season).
d. Samples should be taken in a representative portion of the mitigation site with similar micro topography, vegetative community, etc., rather than in the lowest/wettest areas. Some samples should also include the areas with higher elevations. Additional tests should be taken for larger sites and sites with higher changes in elevation.
e. Plot locations shall be determined after baseline hydrology data are collected for at least one growing season to select areas that represent various hydroperiods. At least one soil sample plot location should be established for each hydroperiod present at the mitigation site. Soil sample plots shall be located within five feet of the monitoring well and shall be performed during each monitoring year. Additional soil monitoring plots may need to be established where saturation occurs between 5% and 12.5% of the growing season to provide corroborative evidence that wetland hydrology is present. Additional soil monitoring may also be required if soil monitoring occurs during extremely wet or dry years.
f. Include a copy of the plan showing the location of the soil data collection, summarize the information, and provide monthly rainfall data for the area.
g. If soil testing confirms the presence of actively reducing soil conditions during at least three years or 50% of monitoring, whichever is greater, the Sponsor may request that soil testing not be required every year. The Agencies will consider the evidence of anaerobic soil conditions, based on the monitoring reports, site visits, and local precipitation, to approve or deny this request.

<u>Recommended Method of Indicator of Reduction in Soils (IRIS) Film Placement and Data Collection</u>.

a. Label Fe-coated films.
b. Roll one Fe-coated film into 1" clear polycarbonate delivery tube, with Fe-coating facing out.
c. Create a pilot hole in the soil using a 1" push probe. The hole should be slightly deeper (1-2") than final depth of film.
d. Insert rod into the delivery tube, being sure to hook the rod into the hole at the bottom of the film.
e. Insert the "loaded" delivery tube into the hole until the mark on the tube is at the soil surface (50 cm).
f. Holding the rod to ensure the film stays in the soil, pull out the delivery tube.
g. Pull out the rod, being careful not to pull out the film.
h. Insert foam plug into the top of the film, using two O-rings to secure the film around the plug.
i. If the films are installed to shallower depths (e.g., gravel layer inhibits full depth for pilot hole), mark

the depth of the soil surface on the films with a permanent marker.

j. Install five replicates, up to a meter apart, within the study area.

k. Films should be left in place for two to four weeks and then should be removed and replacement films can be installed in the same holes for an additional two to four weeks. **Films left in for longer than four weeks cannot be used to meet required performance standards.**

l. Gently wash off any adhering soil from the films.

m. Take photos of all removed films, with labels clearly visible.

n. Estimate the amount of paint removed from each film by overlaying with a mylar grid and marking and counting the grid[20], or by using some other IRT-approved procedure.

o. Find a six-inch area on the film, entirely within the upper 12 inches, with the most paint removed. Estimate the percentage of paint removed from this six-inch area and document the depth of this six-inch area.

p. To meet the Technical Standard for reducing soil conditions as currently specified in the National Technical Committee on Hydric Soils, 30% or more of paint within this six-inch section must be removed.

q. At least three of the five replicates must show this paint removal for the soil to demonstrate that it is reducing.

<u>Recommended Method of Indicator of Reduction in Soils (IRIS) Tube Placement and Data Collection</u>
(summarized from the 2008 document entitled *Protocol for Using and Interpreting IRIS Tubes*).

a. Create a pilot hole in the soil using a 7/8" push probe. The hole should be slightly deeper (1-2") than final depth of tube.

b. Be sure tubes are labeled.

c. Insert the IRIS tube into the hole until the mark on the tube is at the soil surface (50 cm). If they are installed to shallower depths, mark the depth of the soil surface with a permanent marker.

d. Install five replicates, up to a meter apart, within the study area.

e. Tubes should be left in place for two to four weeks and then should be removed and replacement tubes can be installed in the same holes for an additional two to four weeks. **Tubes left in for longer than four weeks cannot be used to meet required performance standards**.

f. Gently wash off any adhering soil from the tubes.

g. Take photos of all removed films, with labels clearly visible.

h. Estimate the amount of paint removed from each tube by wrapping a mylar grid around tube and by marking and counting the grid, or by using some other IRT-accepted procedure.

i. If visual estimations are used, to improve accuracy, have two (or more) people estimate the amount of paint removed, then average the two sets of data.

j. Find a six-inch area on the tube, entirely within the upper 12 inches, with the most paint removed. Estimate the percentage of paint removed from this six-inch area and document the depth of this six-inch area.

k. To meet the Technical Standard for reducing soil conditions as currently specified in the National Technical Committee on Hydric Soils, 30% or more of paint within this six-inch section must be removed.

l. At least three of the five replicates must show this paint removal for the soil to demonstrate that it is reducing.

[20] Rabenhorst, M.C. 2012. Simple and Reliable Approach for Quantifying IRIS Tube Data. Soil Sci. Soc. Am. J. 76: 307-308.

Recommended Method of Application of the Alpha-Alpha Dipyridyl Paper Test Strips

a. To meet the anaerobic condition requirement using alpha-alpha dipyridyl test strips, tests should show positive reaction to alpha-alpha dipyridyl at least three times in a row (e.g., sample on Day 1, sample a week later, sample another week later).
b. Excavate a soil pit to a depth of at least 14-16 inches*. A fresh slice of the profile should be cut from the side of the pit and laid out for observation and characterization. Apply the test strips to the targeted layer(s) at several locations within the representative area to ensure that the majority of the layer is reduced. Document at what depth the positive reaction(s) to the test occurred. The procedure for problematic soils (Step 4d) discussed in Chapter 5 of the Regional Supplements requires that **at least 60% of a layer 4 inches or more thick and located within 12 inches of the surface**, react positively from liquid alpha-alpha dipyridyl solution. **Note: The depth of soil excavations for profile characterization can be much deeper depending upon the required depth and thickness requirements of some hydric soil indicators.*
c. It is important that the test strips are applied only to a fresh, broken face of the desired layer(s). Do not add moisture to soil samples or rub soil against or on to the paper, simply press the paper against a fresh, broken ped face on the soil sample(s). Be sure not to test soil samples that have been exposed to digging equipment to prevent false positive reactions. Record all observations of soil moisture, limit of saturation and the depth to water table on a data form and or in your notes.
d. A positive reaction on the paper (turning pink or red) should occur in a few moments but can take longer especially during colder periods. The manufacturer indicates that the reaction normally takes place within about 30 seconds.
e. To increase the validity of your findings, test the targeted layers at several different locations within the same representative area and any other layers which meet an indicator.
f. Testing multiple samples can exhaust your supply quickly but you can double your reserves by cutting the strips in half. Be careful not to use cutting instruments that could contaminate a sample.
g. The test should be performed as soon as you remove the sample and all information (depths, layers, etc.) recorded in the appropriate fields of the data form (i.e., hydrology remarks, soil layer comments, soil remarks, etc.). Your soil profile description should also be performed as soon as possible using one of the representative pits. In addition to photo documenting your soil profile, document the application of the strips before and after any potential reaction.
h. If the soil is allowed to dry before implementing the test strips or characterization of the profile, dig another representative pit and start over.

Recommended Method for Evaluating Organic Matter in the Topsoil

a. Topsoil organic matter should be evaluated at multiple representative locations through the mitigation site after construction is complete or during the first monitoring year. A sample should be taken near each monitoring well. Locations of topsoil organic matter samples should be shown on the monitoring plans.
b. Data should be included for each sample location. Data should include a soil profile description to a depth of at least 12 inches for each sample location with all information in the Soil Profile Description table of the Wetland Determination Data Form.
c. If the entire top 6 inches (or depth of topsoil required in the approved mitigation plans if different than 6 inches) has a Munsell value and chroma $\leq$3, then soil organic matter does not need to be tested in the laboratory. If it has a Munsell value or chroma >3, then the soil organic matter must be tested using the Walkley-Black or Loss on Ignition method.
d. Soil tests must be completed at a soil testing laboratory listed on the University of Maryland Extension website. Soil samples must follow instructions from the soil testing lab.

e. Remove leaves or debris from the top of the soil. Collect a core soil sample that is a depth of 6 inches (sampling the top 0-6 inches). Put this sample in a clean bucket and mix well. Fill the soil sample bag with the amount specified by the soil testing lab. Soil samples from different locations on the site should not be mixed together but should be clearly labeled.
f. To convert total organic carbon to organic matter, use this formula: total organic C (%) * 1.72 = OM (%).

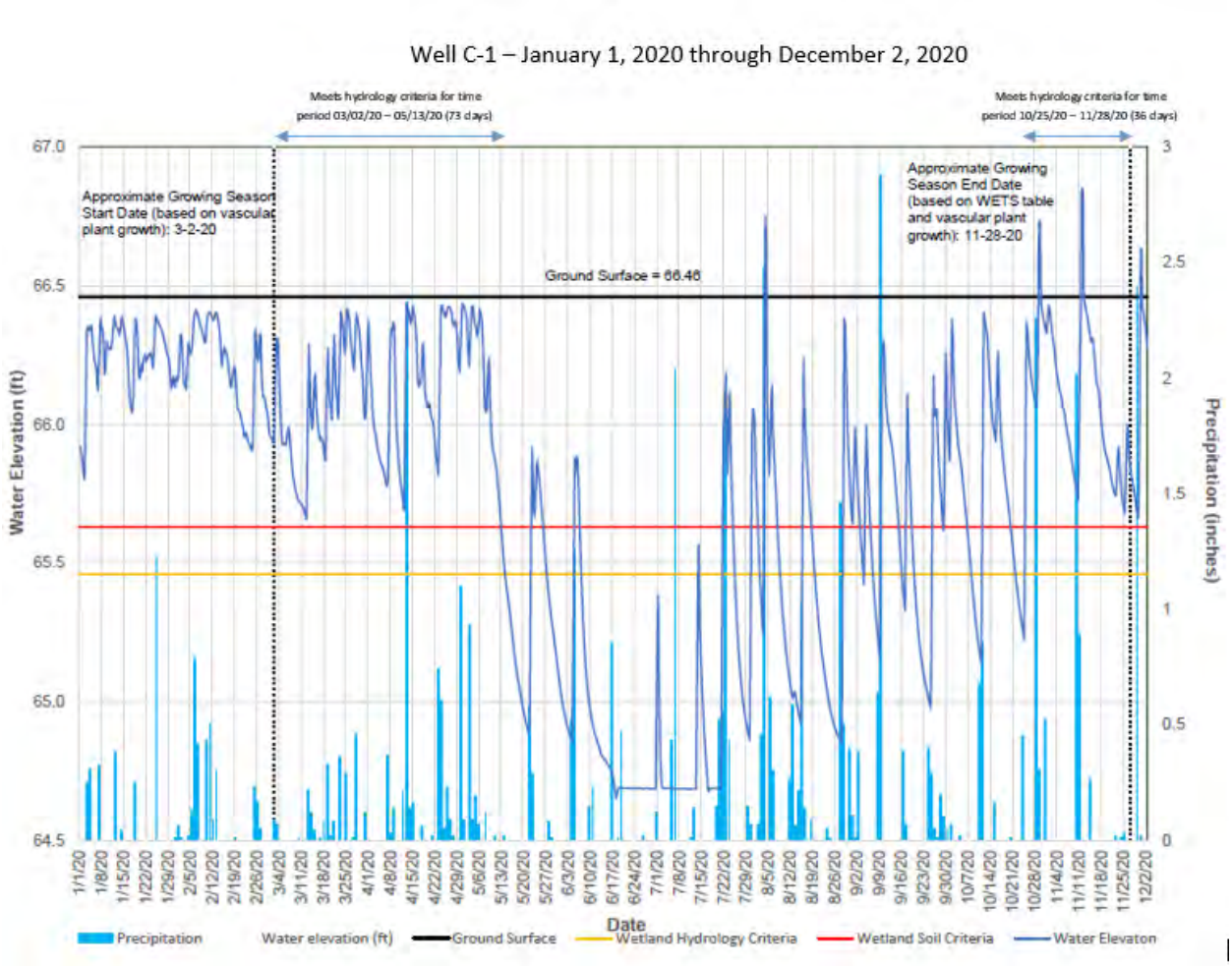
Recommended Method for Testing Subsoil Bulk Density

a. Bulk density should be tested at multiple representative locations through the mitigation site after construction is complete or during the first monitoring year. A sample should be taken near each monitoring well. Locations of bulk density samples should be shown on the monitoring plans.
b. The bulk density sample should be extracted soon after the topsoil has been replaced.
c. Topsoil should be carefully removed. Samples should be taken immediately below the topsoil. The sample should represent only one soil horizon and be a minimum thickness of four inches.
d. Extract a known volume of soil. This can be done by driving in an open-ended can or ring (e.g., 3-inch diameter) into the soil to extract a set volume. The thickness should be a minimum of 4 inches. The volume of the ring must be calculated. Using a mallet or similar tool, drive the ring into the subsoil to the depth of the ring. Make sure the top surface of the ring is level with the subsoil surface. Dig around the ring. With a trowel underneath, carefully extract the ring to prevent soil loss. Remove any excess soil from the sides, top, and bottom of the sample with a flat-bladed knife. The bottom and top of the sample should be flat with the edges of the ring.
e. Using a flat-bladed knife, push out the soil sample into a plastic sealable bag. Place the entire soil sample into the sealed bag. Soil samples from different locations on the site should not be mixed together but should be clearly labeled.
f. Dry the sample in a microwave at full power for two or more four-minute periods, allowing venting between cycles.
g. Weigh the sample. To verify that the soil is totally dry, heat the sample in the microwave again and reweigh. Continue until the sample weight does not change.
h. Weigh an empty plastic bag and remove this weight from the sample weight.
i. Calculate the bulk density as follows:

$$\text{Soil bulk density (g/cc)} = \frac{\text{oven dry weight of soil}}{\text{volume of soil}}$$

Note: for more details on this method or if the soil is gravelly or rocky, please follow the Cylindrical Core Method described in the July 2001 U.S. Department of Agriculture Service's document Soil Quality Test Kit Guide, Section I, Chapter 4, pp. 9-13.

Example Hydrograph



Example Vegetative Data for an Individual Plot

Happy Hills Mitigation Project 2023 Vegetation Monitoring							
Plot 1	Common Name	Botanical Name	Absolute Cover %	Relative Cover %	Non-native/ Invasive	Indicator Status	Dominant
Herbaceous	Soft Rush	Juncus effusus	35	41		FACW	Y
	Jointhead Arthaxon	Arthraxon hispidus	15	17	Y	FAC	Y
	Fowl Bluegrass	Poa palustris	8	9		FACW	
	Lurid Sedge	Carex lurida	5	6		OBL	
	Squarestem Monkeyflower	Mimulus ringens	3	3		OBL	
	Woolgrass	Scirpus cyperinus	3	3		FACW	
	White Clover	Trifolium repens	2	2	Y	FACU	
Trees/Shrubs	Loblolly Pine	Pinus taeda	5	6		FAC	
	Sycamore	Plantanus cccidentalis	5	6		FACW	
	Black Willow	Salix nigra	3	3		OBL	
	Multiflora Rose	Rosa multiflora	2	2	Y	FACU	
Total			86	100			
Plot size					5' radius herbs, 15' radius trees/shrubs		
Dominance test (% of absolute total)					50%=43; 20%=17.2		
Absolute canopy cover native FAC or wetter					13%		
Relative cover of Loblolly pine versus total native wetland tree/shrub canopy					38%		
Survival of planted trees/shrubs					95%		
# native trees/shrubs ≥10" tall FAC or wetter (total and #/acre)					12 individuals; 741/acre		
Height of tallest 5 trees (each tree and average)					25", 30", 25", 14", 31"; 25"=ave		

Appendix E

Karst Landscapes, Springs, and Buried Soils

Special Considerations for Areas of Karst Topography

Portions of the Piedmont physiographic region covered by this guidance include areas with karst topography. Sherwood (2004) describes karst as "terrain that's characterized by sinkholes, caves,
underground streams, and other features that are formed by the slow dissolution of calcium and magnesium oxides in limestone, dolomite, or marble bedrock."

http://www.mgs.md.gov/publications/maps.html

FIGURE E-1. Map showing the distribution of carbonate rocks in Maryland. Those most associated with collapse sinkholes are the Hagerstown Valley (HV), the Frederick Valley (FV), and the Wakefield Valley (WV). To a lesser degree, collapse sinkholes are found in Green Spring Valley (gs), Worthington Valley (wo), and Long Green Valley (lg). FR: Maryland Geological Survey. Sinkholes in Western Maryland. http://www.mgs.md.gov/geology/geohazards/sinkholes_in_maryland.html. Retrieved 11/2/2023.

The Maryland Geological Survey notes " Karst regions can be prone to unpredictable or easily contaminated groundwater supplies or unusual surface water drainage. Karst landscapes are also among the most susceptible to environmental impact, including ground subsidence. Following storms, droughts, and changes in land use, sudden subsidence features known as sinkholes, can cause damage to buildings, roads, parking lots, and farmed land." Active sinkholes are also associated with stream lowlands (Brezinski, 2018), particularly ephemeral streams, so stream restoration activities must be accomplished without increasing sinkhole formation and increased groundwater contamination.

It may be necessary to conduct a field analysis to verify the sinkhole potential. Consultation with local agencies or soil conservation districts is recommended.

Baltimore County Department of Environmental Protection and Resource Management
410-887-7428

Natural Resource Conservation District Resources:

Baltimore County
Agricultural Building
9831 Van Buren Lane
Cockeysville, MD 21030
Voice: 410-666-1188

Carroll County
1004 Littlestown Pike
Suite B-2
Westminster, MD 21157-300
Voice: 410-848-6696

Frederick County
92 Thomas Johnson Dr.
Suite 230
Frederick, MD 21702-4300
Voice: 301-695-2803

The potential to form sinkholes and transmit pollution into groundwater areas, create safety hazards, or damage to infrastructure results in needs for special limitations on earth disturbance when planning construction projects in karst areas Table E-1 shows the potential to form sinkholes based on soil type.

Brezinski (2018) discussed formation of sinkholes related to new stormwater impoundments. Soil which plugged gaps between bedrock was removed during construction, allowing stormwater to enter newly exposed gaps between rocks, and contaminate groundwater., as soil overlaying bedrock was removed, allowing the stormwater to enter groundwater and result in new or previously active sinkholes.

Excavations should not occur on soils with moderate or high potential to form sinkholes. It is particularly important to maintain vegetation on adjacent steep slopes.

Design the project so that polluted water will not enter any active sinkhole. This should be a minimum of 100 feet or greater per local requirements.

Check with local governments for other requirements related to earth disturbances in karst areas.

The Western Maryland RC&D (2004) lists a number of practices, including these which may be especially applicable to stream restoration projects in karst areas:

i) Leave a wide natural buffer of trees and under-story vegetation around sinkholes and caves when clearing land, harvesting timber, or disturbing ground in the drainage area.

Divert the flow of run-off away from sinkholes.

Sinkhole Potential by Soil Type (Frederick County) Source: NRCS

SOIL SERIES	RATING	GEOLOGIC FORMATION
Adamstown	Low	Frederick Formation (Rocky Springs Station Member)
	Moderate	Frederick Formation (Adamstown Member)
	High	Frederick Formation (Lime Klin Member)
	High	Grove Formation
Athol	Moderate	Triassic Conglomerates
Athol, Rocky Phase	High	Triassic Conglomerates
Benevola	Moderate	Sams Creek Formation (Wakefield Marble)
Blackthorn		
Buckeystown	High	Grove Formation
Buckeystown, rocky phase	Very High	Grove Formation
Conestoga	Low	Marburg Formation (Silver Run Limestone)
	Low	Sams Creek Formation
	Moderate	Sams Creek Formation (Wakefield Marble)
Dry Run	Low	Frederick Formation (Rocky Springs Station Member)
	Moderate	Frederick Formation (Adamstown Member)
	High	Frederick Formation (Lime Klin Member)
Duffield	Low	Frederick Formation (Rocky Springs Station Member)
	Moderate	Frederick Formation (Adamstown Member)
	High	Frederick Formation (Lime Klin Member)
Downsville	Moderate	Frederick Formation (Adamstown Member)
Funkstown	Low	Frederick Formation (Rocky Springs Station Member)
	Moderate	Frederick Formation (Adamstown Member)
	High	Frederick Formation (Lime kiln Member)
	Low	Sams Creek Formation
	Moderate	Sams Creek Formation (Wakefield Marble)
Hagerstown	High	Frederick Formation (Lime kiln Member)
Hagerstown, rocky phase	Very High	Frederick Formation (Rocky Springs Station Member)
	Very High	Frederick Formation (Adamstown Member)
	Very High	Frederick Formation (Lime kiln Member
	Very High	Grove Formation
Knollville		

SOIL SERIES	RATING	GEOLOGIC FORMATION
Letort	Low	Sams Creek Formation
	Moderate	Sams Creek Formation (Wakefield Marble)
	Low	Marburg Formation (Silver Run Limestone)
Morven	Low	Triassic Conglomerate
Murrill	Low	Frederick Formation (Rocky Springs Station Member)
	Moderate	Frederick Formation (Adamstown Member)
	High	Frederick Formation (Lim Klin Member)
	High	Grove Formation
Opequon	High	Frederick Formation (Rocky Springs Station Member)
	High	Frederick Formation (Adamstown Member)
	High	Frederick Formation (Lim Klin Member)
	High	Grove Formation
Ryder	Low	Frederick Formation (Rocky Springs Station Member)
	Moderate	Frederick Formation (Adamstown Member)
	High	Frederick Formation (Lime klin Member)
	High	Grove Formation
Pectonville		
Springwood	Moderate	Triassic Conglomerate
Springwood, rocky phase	High	Triassic Conglomerate
Walkersville	Low	Frederick Formation (Rocky Springs Station Member)
	Moderate	Frederick Formation (Adamstown Member)
	High	Frederick Formation (Lime klin Member)
	High	Grove Formation
Wiltshire	Moderate	Sams Creek Formation (Wakefield Marble)

Soils associated with springs (Frederick County) Source: NRCS

Springs provide valuable flow to streams and are critical to helping to maintain cooler temperatures of stream channel water. The following soils associated with springs and buried floodplains were provided by the Natural Resource Conservation Service to MDE. MDE recommends restoration designs which support continued spring flow. Restoration to remove depositions over buried floodplain/hydric soils may be suitable candidates for legacy sediment removal where the buried soil is brough the surface.

Dunning
Melvin
Lindside
Huntington
Lappans
Fairplay
Dryrun
Deposit
Funkstown*
Adamstown*

*Floodplain map units associated with floodplains that are now underground.