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

May 4, 2024

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.** With the exception of Wetland Vegetation Dominance, non-native or invasive species will not count towards success of performance standards. 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. **Vegetative Cover Standards:**
   a) For sites that require monitoring in year one, the mitigation site shall have a minimum of 50% absolute[2] and relative[3] cover of native wetland (FAC or wetter) species.
   b) By the end of year two, the mitigation site shall have a minimum of 60% absolute and relative cover of native wetland (FAC or wetter) species.
   c) By the end of year three, the mitigation site shall have a minimum of 70% absolute and relative cover of native wetland (FAC or wetter) species.
   d) By the end of year five and each monitoring year thereafter, the mitigation site shall have a minimum of 85% absolute and relative cover of native wetland (FAC or wetter)

[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 ≥5% total plant cover unless it is the only strata present.
[2] Absolute plant cover is the actual plant 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] Relative plant cover is defined as the cover of a particular species as a percentage of total plant actual cover. Thus, relative cover will always total 100%, even when total absolute cover is quite low.

species. Volunteer species should support functions consistent with the project design goals; and

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[4] 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*[5], *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*[6] and the Maryland Invasive Species Council Invasive Species of Concern in Maryland[7]. Native status will be based on the Natural Resources Conservation Service Plants Database[8]. *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 25% 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 25% relative cover of the native wetland tree/shrub species in any plot.

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[4] "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.

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

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

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

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

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 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[9] of native wetland (FAC or wetter) trees 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[10] of rainfall occurring prior to and during the monitoring period when addressing the frequency requirement. For the purpose of this determination, as based on the appropriate regional supplement to the USACE Wetland Delineation Manual, 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 by documented evidence of above-ground growth and development of vascular plants and the use of soil temperature as an indicator of microbial activity; 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, including consideration of landscape position, hydrology source, and hydrodynamics, with the acceptable range of the seasonal hydroperiod specified in the approved mitigation plan. A water budget model shall be used for the design of the compensation site and will utilize scientifically estimated components for this mitigation site and shall include resiliency in the system's design to account for the extreme variability in the data input and lack of precision of the model. Adaptive management techniques must be easily applied to achieve success if the initial target hydrograph is not achieved.

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

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[9] "Canopy cover" is defined as the percentage of ground covered by tree leaves, when the edges of the leaves are mentally projected down to the ground surface.

[10] Determination of what constitutes an above, below, or normal precipitation year is discussed further in Section C.1.b.iii. Note: Lack of inundation and/or a water table ≤12 inches below the soil surface during drier than normal conditions is not necessarily a negative indicator as many types of reference wetlands can be naturally dry during drier than normal conditions. However, it also does not inform the Agencies of whether the requirements for inundation and/or depth to the water table would be met during normal and wetter than normal conditions. Similarly, positive hydrological indicators during wetter than normal conditions do not necessarily mean that the site has wetland hydrology, since it does not inform the Agencies of whether the site would meet hydrology requirements during normal conditions.

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[11], 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.

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/

[11] 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.

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. **Vegetative Cover Standards:**
   a) For sites that require monitoring in year one, the mitigation site shall have a minimum of 50% absolute[2] and relative[3] cover of native species.
   b) By the end of year two, the mitigation site shall have a minimum of 60% absolute and relative cover of native species.
   c) By the end of year three, the mitigation site shall have a minimum of 70% absolute and relative cover of native species.
   d) By the end of year five and each monitoring year thereafter, the mitigation site shall have a minimum of 85% absolute and relative cover of native species.
   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*[12] and the Maryland Invasive Species Council Invasive Species of Concern in Maryland[13]. Native status will be based on the Natural Resources Conservation Service Plants Database[14]. 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.

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

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, plant density of at least 435 living native 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

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 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. A longer monitoring period of more than 5 years is required for aquatic resources with slow development rates (e.g., vernal pools, riparian forest, forested wetlands, bogs, and coastal salt marsh) (33 CFR 332.6(b)). 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[15]. However, for aquatic resources with slow development rates (e.g., forested wetlands, bogs), the extent of monitoring may be reduced or waived no earlier than the end of the seventh monitoring year over part or the entire site. Remediation measures[16] (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 or 7 monitoring years (as applicable) 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 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. Video imagery taken from unmanned systems such as drones can be a very effective way of qualitatively documenting vegetation.

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 latest version of the "Mitigation Monitoring Report Summary Content 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,*

[15] 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.
[16] An exception may include treatment for small amounts of invasive species that are not likely to persist.

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 individual data for each plot should be provided separately in Appendix A. **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. Plot data cannot be averaged across plots over the entire site to obtain a single figure for purposes of demonstrating success in meeting performance standards**:

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. Tree and shrub species may be separated in

the table from herbaceous species, even if they do not yet reach the sapling/shrub stratum requirement. Calculate relative percent cover of only the native trees and shrubs. This information must be included in a separate table for each plot 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. See Appendix 1 for an example table. 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 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.

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.

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. Well water table depths i must be recorded at least once per day.

iii. In each monitoring report, an explanation or graphical representation that explains whether the site had an above, below, or normal precipitation year. 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[17]), WETS tables[18] , Standard Precipitation Index[19] , NOAA/National Weather Service Meteorological Stations, National Weather Service – MidAtlantic River Forecast Center – Precipitation Departures[20] , USDA National Water and Climate Center[21] , 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

[17] https://github.com/jDeters-USACE/Antecedent-Precipitation-Tool/releases/latest

[18] https://www.wcc.nrcs.usda.gov/climate/wets_doc.html

[19] https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/indices

[20] https://www.weather.gov/marfc/Precipitation_Departures#

[21] https://www.wcc.nrcs.usda.gov/

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 hydrographs showing data for each individual well (see Appendix 2 for an example). *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. Discuss how the measured hydroperiod is within the acceptable range of the reference or target wetland hydroperiod specified in the approved mitigation plan. This should discuss depth, degree, duration, and periodicity.

vi. A summary table shall include results of all hydrology monitoring for each well, by cell, and for the entire site, including if each meets/does not meet the performance standards, the number of days of saturation, and percent hydroperiod. 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. **Note: IRIS films are the preferred method for verifying active reduction in soils for mitigation sites as they use much less plastic, are easier to analyze, and may be slightly cheaper than IRIS tubes. Additionally, films are more defensible than only testing with Alpha-Alpha Dipyridyl paper test strips once a week.*

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 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 microtopography 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 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.

iv. Measurements of vegetation based upon performance standard and methods used to evaluate the vegetative success of the mitigation site.

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.

4. Supplemental plantings must be present for at least two growing seasons before counting toward meeting performance standards for monitoring year seven and ten. Supplemental plantings that cover more than 20% of a site, use small stock, or are conducted during the 7-year or later monitoring years are more likely to require additional monitoring.

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 ($\geq$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 only 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. Well water depths should be recorded at least once per day. 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 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 by documented evidence of above-ground growth and development of vascular plants and the use of soil temperature as an indicator of microbial activity.
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>.
**Note: This is the preferred method for verifying active reduction in soils.*

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[22], 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. It is recommended that the films be analyzed by a professional lab[23], so there is no doubt about the percentage of paint removed.
q. At least three of the five replicates must show this paint removal for the soil to demonstrate that it is reducing.

Recommended Method of Indicator of Reduction in Soils (IRIS) Tube Placement and Data Collection
(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.

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

[23] Advanced IRIS Oxides provides information about analysis of IRIS films: https://irisoxides.com/analytical-services. Other companies may also provide this service.

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. Multiple strips may be required to show the entire 4-inch layer is reducing. **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. 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.
g. 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.

Appendix 1: Example Vegetative Data for an Individual Plot

Happy Hills Mitigation Project								
2023 Vegetation Monitoring								
Plot 1	Common Name	Botanical Name	Absolute Cover %	Relative Cover by Plot %	Relative Cover by Native Tree/Shrub %	Non-native/ Invasive	Indicator Status	Dominant
Herbaceous	Soft Rush	Juncus effusus	35	41			FACW	Y
	Jointhead Arthraxon	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	38		FAC	
	Sycamore	Plantanus occcidentalis	5	6	38		FACW	
	Black Willow	Salix nigra	3	3	23		OBL	
	Multiflora Rose	Rosa multiflora	2	2	N/A	Y	FACU	
Total			86	100				

Plot size	5' radius herbs, 15' radius trees/shrubs
Dominance test (% of absolute total)	*50% cover=43; 20% cover=17.2; 100%
Absolute canopy cover native FAC or wetter	13%
Relative cover 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"; ave=25"

*Since tree and shrub species are not tall enough yet to meet the sapling/shrub stratum requirement, this plot only has a herb stratum.

Appendix 2: Example Hydrograph