# ECOLOGICAL PERFORMANCE STANDARDS AND MONITORING PROTOCOL FOR NONTIDAL WETLAND MITIGATION BANKS AND IN-LIEU FEE SITES IN MARYLAND

February 1, 2022

Nontidal wetland mitigation bank and in-lieu fee (ILF) sites ("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 Interagency Review Team (IRT) co-chairs (the U.S. Army Corps of Engineers and the Maryland Department of the Environment), in coordination with the Maryland Interagency Review Team (IRT). 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 12-18) for the recommended techniques for monitoring wetland mitigation sites.

**I. Performance Standards:** The Bank or ILF Sponsor shall provide all required documentation, including monitoring reports, construction completion reports, and as-built surveys to the co-chairs for distribution to the IRT. The co-chairs, in consultation with the IRT, will use visual observations during site visits and 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 Invasive Species and Wetland Species Richness, 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. Wetland Area(s):**

1. **Wetland Vegetation Dominance:** Wetland vegetation dominance, 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. **Aerial Cover 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.
   e) 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. However, if non-native or invasive species are present, no more than 10% of relative plant cover[1] over the entire site shall be made up by non-native or invasive

[1] "Relative plant cover" is defined as the cover of a particular species as a percentage of total plant cover. Thus,

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, Pueraria montana*, or *Lythrum salicaria*. The presence, location, and percent cover of invasive and/or non-native species shall 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*[3] and the Maryland Invasive Species Council Invasive Species of Concern in Maryland[4]. Native status will be based on the Natural Resources Conservation Service Plants Database[5]. *Phalaris arundinacea* and *Typha* spp. may also be considered as invasive species by IRT. Alternatively, for specific problematic species, the IRT may consider justification for different requirements; 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 65% relative cover of one species, over the entire site. Loblolly pine cannot be more than 35% relative cover.
   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 65% relative cover of one species, over the entire site. Loblolly pine cannot be more than 35% relative cover; 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 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[6] of native wetland (FAC or wetter) trees and shrubs must be at least 30% by the end of the monitoring period; and

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relative cover will always total 100%, even when total absolute cover is quite low.

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

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

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

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

[6] "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.

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[7], 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 IRT. 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. Alternatively, if the site was designed to have similar soils as an approved reference wetland soil, the organic matter content is within the range specified in the approved Mitigation Plan.

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

[7] 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.

(prior to adding topsoil or organic matter). Sites designed to be precipitation driven may include alternate bulk density requirements specified in the approved Mitigation Plan.

11. **Microtopography:** Microtopographic variations are up to 0.5 feet from design elevation, with no more than 25 percent of each wetland cell remaining at the design elevation. Alternatively, if microtopography was designed to mimic a reference wetland, the elevation variations are within the range specified in the approved Mitigation Plan.

12. **Woody Debris**: Coarse woody debris (e.g., logs, brush piles, root wads, overturned stumps, standing snags, etc.) is present throughout the mitigation site at a density and type specified in the approved Mitigation Plan.

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 co-chairs 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.

**B. 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. **Aerial Cover 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. However, if non-native or invasive species are present, no more than 10% of relative plant cover[1] 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 shall 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*[8] and the Maryland Invasive Species Council Invasive Species of Concern in Maryland[9]. Native status will be based on the Natural Resources Conservation Service Plants Database[10]. Alternatively, for specific problematic species, the IRT may consider justification for different requirements.

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

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[11] 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 Corps of Engineers' 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 Corps 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

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

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 co-chairs, in consultation with the IRT, that the site has achieved all performance-based milestones each monitoring year and all final performance standards for two consecutive monitoring events[12]. Conversely, the co-chairs, in consultation with the IRT, 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. Remediation measures[13] (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 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.

**A.** Monitoring reports, a paper copy, and an electronic version, must be submitted to the co-chairs by December 31 of each monitoring year. The Sponsor must concurrently upload a copy of the monitoring report to RIBITS for access by the IRT. 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 Corps and MDE in consultation with the IRT.

**B. Content:** The following information must be included with the monitoring report:

1. **Monitoring and Performance Standards Summary Report and Table** comparing the required performance standards to the conditions and status of the developing site must be completed and attached to the beginning of the Monitoring Report. The table will list the monitoring requirements and performance standards, as specified in the approved mitigation plan, and evaluate whether the overall site, including each area (plot, well or cell as appropriate), is successfully achieving the approved performance standards or trending towards success. This table should include whether each performance standard was met for the current and past monitoring report years, to allow easier review of how the site is progressing. Monitoring reports shall be submitted consistent with the current IRT-approved

[12] 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 IRT to consider reducing or waiving monitoring early.
[13] An exception may include treatment for small amounts of invasive species that are not likely to persist.

monitoring report format, using the "Mitigation Monitoring Report Form."

2. **Project Overview / Background Data:**
   a) Title page indicating the bank/in-lieu fee site name, umbrella bank name (if applicable), in-lieu fee program name (if applicable), project phase (if applicable), monitoring year, any requested action (e.g., credit release, IRT review), Sponsor identification (name, address, phone number, and email address) and preparer identification (name, address, phone number, and email address).
   b) Written description of the location, any identifiable landmarks of the site, including information to locate the site perimeter(s), and coordinates of the mitigation site (expressed as latitude and longitude).
   c) Date(s) of site inspections.
   d) 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. Include the dates the mitigation construction was started, and the planting was completed.
   e) A brief narrative description of the site addressing its position in the landscape, adjacent waterbodies, and adjacent land use.
   f) Describe methods used to evaluate performance standards. Plot locations should be clearly identified on the appropriate maps.
   g) A short statement on whether the performance standards are being met.
   h) 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.
   i) Dates of any recent corrective or maintenance activities conducted since the previous report submission.
   j) 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.
   k) Specific recommendations for any additional corrective or remedial actions.
   l) 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.
   m) 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.
   n) Discussion of growing season and how it was determined for this site.

3. **Summary data:** Summary data should be provided to substantiate the success and/or potential challenges associated with the compensatory mitigation project. Refer to Section IV below for monitoring report measurements to include for the overall site.

4. **Photographs:** Take one set of photographs from established photographic points any time between May 1 and September 30 of each monitoring year (pictures should be taken at the same time of year when possible). Photo location points should be identified on the appropriate maps and labeled with the direction in which the photo was taken. Submitted photos should be formatted to print on a standard 8.5 by 11-inch piece of paper, dated, and clearly labeled with the direction from which the photo was taken. It is highly recommended that aerial photos are also provided, as these are good indicators of hydrology and vegetative cover.

5. **Maps and Plans:** Maps should be provided to show the location of the site relative to other landscape features, habitat types, locations of photographic reference points, transects, sampling data points (e.g., vegetation plots, wells, soil samples, etc.), and/or other features pertinent to the mitigation plan. GPS coordinates should be shown on the plans for each photographic reference point and sample plot. In addition, the submitted maps and plans should clearly delineate the mitigation site perimeter(s), which will assist the project managers in locating the mitigation area(s) during subsequent site inspections. Each map or diagram should be formatted to print on a standard 8.5 by 11-inch piece of paper and include a legend and the location of any photos submitted for review. As-built plans should be included if they were not already submitted to the co-chairs.

6. **Conclusions:** A general statement shall 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 co-chairs, in consultation with the IRT, will ultimately determine if the mitigation site is successful for a given monitoring period.

**IV. Monitoring Report Measurements.** Monitoring reports should include all the following information for the overall site, and each plot, well or cell:

**A. Wetland Area(s):**

**1. Vegetation:**

a) Estimate the actual and relative percent cover by plant species, in order of dominance, across all strata for each plot. Include this information in a table. For each species listed in the table include native/non-native status and wetland indicator 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.

b) 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).

c) 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.

d) 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. Include a discussion of water movement into and through the site. Do not include the raw plot data in your monitoring report.

**2. Hydrology:**

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

b) 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.

c) 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[14]) , WETS tables[15] , Standard Precipitation Index[16] , NOAA/National Weather Service Meteorological Stations, National Weather Service – MidAtlantic River Forecast Center – Precipitation Departures[17] , USDA National Water and Climate Center[18] , 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)

d) 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.

e) 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.

**3. Soils:**

a) Monitoring data to determine if hydric soils are actively developing. Data should be included for each sample location. 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.

b) 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.

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

d) Provide a soil profile description with accompanying soil photos for each soil location tested above.

e) 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.

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

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

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

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

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

4. **Physical Structure:**
    a) Estimate percentage of site with microtography and compare with approved Mitigation Plan.
    b) 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.

5. **Wetland function assessment:** Provide an assessment of the specific wetland functions and values being provided at the mitigation site.

**B. Buffer Area(s):**

1. **Vegetation:**
    a) Estimate the actual 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.
    b) 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).
    c) 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.
    d) 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.**

**C. 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 IRT, acting through the co-chairs, 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 IRT 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 IRT 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 co-chairs, in consultation with the IRT.

**B.** The Sponsor must include appropriate information in the monitoring reports about performance issues and implementation of approved adaptive management measures to allow the IRT to assess how the project is progressing. The Sponsor must notify the co-chairs as soon as possible if the site is not achieving its performance standards as anticipated. The co-chairs, in coordination with the IRT 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 IRT 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 co-chairs, in consultation with the IRT, 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 co-chairs, in consultation with the IRT.
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 co-chairs, in consultation with the IRT, 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 IRT 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. Each plot shall be of a size no less than 400 square feet for woody plants and 3'x3' for herbaceous plants (or circular with approximately the same surface area). The vegetation data shall be collected during the growing season and shall include:
    i. Dominant vegetative species identification
    ii. Percent ground cover assessment
    iii. Number of woody plant stems greater than 10 inches in height (total and #/acre)
    iv. The percentage of dominant species FAC or wetter
    v. Percent survival by planted species
    vi. A non-native/invasive species assessment including percent cover

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 co-chairs, in consultation with the IRT.

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 co-chairs, in consultation with the IRT, 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 IRT 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. Each plot shall be of a size no less than 400 square feet for woody plants (or circular with approximately the same surface area). The vegetation data shall be collected during the growing season and shall include:
    i. Total actual and relative percent cover of native plant species.
    ii. Number of native woody plant stems greater than 10 inches in height (total and #/acre).
    iii. A non-native/invasive species assessment including relative percent cover.

<u>Recommended Groundwater Well Placement and Data Collection</u>

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 Corps 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 Corps' guidance.
b. Specific details on the groundwater monitoring wells and locations shall be provided in the mitigation plan, and must be approved by the co-chairs, in consultation with the IRT.
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 co-chairs, in consultation with the IRT, 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://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051608.pdf).
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.
b. 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).
c. 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.

d. 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.

d. 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.

e. 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 co-chairs, in consultation with the IRT, 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. Estimate the amount of paint removed from each film by overlaying with a mylar grid and marking and counting the grid[19], or by using some other IRT-approved procedure.
n. 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.
o. 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.
p. At least three of the five replicates must show this paint removal for the soil to demonstrate that it is reducing.

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

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

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

g. 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.
h. The bulk density sample should be extracted soon after the topsoil has been replaced.
i. 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.
j. 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.

k. 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 location on the site should not be mixed together but should be clearly labeled.
l. Dry the sample in a microwave at full power for two or more four-minute periods, allowing venting between cycles.
m. 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.
n. Weigh an empty plastic bag and remove this weight from the sample weight.
o. 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