MONITORING REQUIREMENTS

The submission of monitoring reports will be required for a period of ten years from the completion of the construction of the mitigation site or phase thereof. Monitoring reports should be concise and effectively provide the information necessary to assess the status of the compensatory mitigation project. Reports should provide information necessary, including supporting data such as plans, maps, and photographs, to illustrate site conditions and whether the compensatory mitigation project is meeting its objectives and performance standards. 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. Monitoring reports, both paper copies and an electronic version, must be submitted to the agencies by December 31 of each monitoring year. Monitoring must be conducted a minimum of once per year during the monitoring years following construction of any phase of the project site.

Monitoring may be terminated or the extent of monitoring may be reduced over part or the entire site at the discretion of MDE and the Corps. Conversely, the agencies may extend the original monitoring period upon a determination that performance standards have not been met or the project is not on track to meet them.

If all performance criteria have not been met in the tenth year, then a monitoring report shall be required for each consecutive year until two sequential annual reports indicate that all criteria have been successfully satisfied.

Monitoring Report Measurements:

1. Wetland Area(s) – Restoration and Enhancement

a. Vegetation
   i. During each monitoring year, to assess the overall site, estimate the actual and relative percent cover by dominant plant species (including volunteer plants) and any invasive plant species. Estimate percent cover by plants with a wetland indicator status of FAC or wetter. Estimate the percent survival of woody planted material and number of native trees/shrubs per acre (including native volunteer woody species taller than 10 in.). 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).
   ii. For forested wetlands, measure the height of the tallest five trees within each sample plot in each monitoring year. In year 10, measure canopy cover of trees and shrubs.
   iii. For forested wetland areas directly adjacent to the stream, canopy coverage over the stream will be quantified.
   iv. Measurements of vegetation based upon performance standard and methods used to evaluate the vegetative success of the mitigation site.
   v. For each monitoring year, summarize the results from the vegetation plot study, including the density trees/shrubs and percent cover of wetland species present in order of dominance and for each vegetative stratum. Data should be summarized

for each plot and also by field or cell. **Do not include the raw plot data in your monitoring report.**

b. Hydrology
   i. Estimate percent of site that is inundated or saturated to the surface on the dates of the site visits.
   ii. Monitoring data for surface water and groundwater, including hydrograph of measured depth to water table, after calibrating for above-ground height of well. Data should be included for each well separately and then summarized by field or cell. Well locations should be identified on the appropriate maps.
   iii. Discuss how precipitation during this monitoring year compares with historical precipitation data for that location.

c. Soils
   i. Monitoring data to determine if hydric soils are actively developing. This must include evidence that saturated and anaerobic soil conditions are being met, as measured by alpha-alpha Dipyridyl, IRIS tubes, or platinum electrodes. Locations of soil tests should be identified on the appropriate maps. The preferred monitoring method for this site will be to use IRIS tubes.
   ii. Provide a soil profile description with accompanying soil photos for each soil location tested above. Photo location points should be identified on the appropriate maps.

d. Recommended Wetland Vegetation Density Measurement Technique
   i. 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 of the second, third, fifth, seventh, and tenth monitoring years subsequent to the completion of the construction of the mitigation project, unless an alternate schedule is agreed upon by the agencies. For any year in which planting was conducted, monitoring of woody vegetation shall take place no earlier than October and at least 6 months following planting. Monitoring of vegetation (herbaceous and woody species) shall be conducted during the growing season.
   ii. Vegetation sample plots shall be located on a stratified random basis over the site in order to sample all areas of restored/constructed wetlands at locations adjacent to each photo location marker. If the random plot location is an outlier, the plot can be moved but justification should be provided in the monitoring report. Once the sample plots are established, they should be stationary, unless the Sponsor recommends, and the agencies agree, to moving the sample plot in future years. The following minimum numbers of samples will be required:
      - If the site is < 5 acres, then a minimum of 3 plots/acre is necessary.
      - 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.
      - 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.

- All cells, fields, or blocks 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.

iii. Each plot shall be of a size no less than 400 SF for woody plants and 3 feet x 3 feet for herbaceous plants (or circular with approximately the same surface area). The vegetation data shall be collected during the growing season and shall include:

- Dominant vegetative species identification
- Percent ground cover assessment
- Number of woody plant stems greater than 10 in. in height (total and #/acre)
- The percentage of dominant species FAC or wetter
- Percent survival by planted species
- An invasive/noxious species assessment including percent cover

e. Recommended Groundwater Well Placement and Data Collection

i. 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 so they do not penetrate the restrictive layer but are instead no deeper than the top of the restrictive layer (as discussed in the 2005 Corps document entitled *Technical Standard for Water-Table Monitoring of Potential Wetland Sites ERDC TN-WRAP-05-02*). 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 in. of the soil surface. Well design and installation shall be consistent with current Corps guidance.

ii. Specific details on the groundwater monitoring wells and locations shall be provided in the final mitigation plan and must be approved by the agencies.

iii. The following minimum numbers of groundwater wells will be required:

- If the site is < 10 acres, then a minimum of 1 well/acre is necessary.
- 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.
- 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.
- Hydrologic zones differentiated by a 1-foot change in elevation should have a minimum of one groundwater monitoring well installed.
- For sites with multiple cells, each cell should have at least one well.

iv. Begin the collection of groundwater well data within 14 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. Record to the nearest inch. Well data should be collected every year during the monitoring period. 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.

v. The growing season (as further detailed in the Regional Supplement to the Corps

of Engineers Wetland Delineation Manual) has begun on a site in a given year when two or more different non- evergreen vascular plant species growing in the wetland or surrounding areas begin to exhibit visible aboveground growth or soil temperature measured at the 12-in. depth is 41°F (5°C).

vi. Measure and record any surface water present at the monitoring wells.
vii. Include a copy of the plan showing the location of the wells and surface elevation beside each well.
viii. Summarize the information regarding groundwater and surface water elevations and provide monthly rainfall data for the areas.

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

i. 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:
   - For a soil to meet the Saturated Conditions part of the HSTS, free water must exist within 10 in. (25 cm) of the ground surface for at least 14 consecutive days; and
   - 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:
     - Positive reaction to alpha-alpha-Dipyridyl, determined at least weekly
     - Reduction of iron determined with IRIS tubes installed for 30 days
     - Measurement of redox potential (Eh) using platinum electrodes, determined at least weekly

   Methods to demonstrate the presence of anaerobic conditions are outlined at (http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html).
ii. If using alpha-alpha Dipyridyl to show soil reduction, soils should be measured at least weekly during the growing season, at a depth of 6 in. Note that alpha-alpha Dipyridyl is also available as paper strips for easier measurement.
iii. Plot locations shall be determined after baseline hydrology data are collected for two years 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 5 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.
iv. Include a copy of the plan showing the location of the data collection, summarize the information, and provide monthly rainfall data for the area.
v. If soil testing confirms the presence of actively reducing soil conditions during multiple years of monitoring, 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.

g. Recommended Indicator of Reduction in Soils (IRIS) Tube Placement and Data Collection (summarized from the 2008 document entitled *Protocol for Using and Interpreting IRIS Tubes*).
   i. IRIS Tubes should be installed during the time of the growing season anticipated to have the highest amount of soil reduction (often in the early growing season). They should be installed in a representative portion of the mitigation site, rather than in the lowest/wettest areas. Additional IRIS tube samples should be taken for larger sites and sites with higher changes in elevation.
   ii. Create a pilot hole in the soil using a 7/8-in. push probe.
   iii. Be sure tubes are labeled.
   iv. 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.
   v. Install five replicates, up to a meter apart, within the study area.
   vi. Tubes should be left in place for two to four weeks. Then should be removed and replacement tubes can be installed in the same holes for an additional two to four weeks.
   vii. Gently wash off any adhering soil from the tubes.
   viii. Estimate the amount of paint removed from each tube.
   ix. To improve accuracy, have two people estimate the amount of paint removed, then average the two sets of data.
   x. Find a 6-inch area on the tube, entirely within the upper 12 in., with the most paint removed. Estimate the percentage of paint removed from this 6-inch area.
   xi. 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 6-inch section must be removed.
   xii. At least three of the five replicates must show this paint removal for the soil to demonstrate that it is reducing.
   xiii. Include a copy of the plan showing the location of the IRIS tubes, summarize the information, and, if relevant, provide monthly rainfall data for the areas.

h. Recommended Method of Application of the Alpha-Alpha Dipyridyl Paper Test Strips
   i. Locate a representative sample area with similar micro topography, vegetative community, etc. as is recommended for most sampling approaches in the Regional Supplements. The area should represent the average condition and not one extreme or another.
   ii. Excavate a soil pit to a depth at least the length of your sharp shooter, generally 14-16 in. length*. 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 in. or more thick and located within 12 in. 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.
   iii. 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.

iv. 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.
v. 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.
vi. 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.
vii. 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.
viii. If the soil is allowed to dry before implementing the test strips or characterization of the profile, dig another representative pit and start over.

2. Buffer Area(s)

a. Vegetation
   i. For each monitoring year, estimate the actual and relative percent cover by native plant species and by invasive plant species. Estimate the number of native trees/shrubs per acre (including native planted or volunteer woody species taller than ten inches). Data should be summarized for each plot and also by field or cell. 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).
   ii. 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.**

b. Recommended Buffer Vegetation Density Measurement Technique
   i. The following method for measuring the success of the vegetative colonization should be conducted once between May 1 and September 30 of the second, third, fifth, seventh, and 10th growing seasons subsequent to the completion of the construction of the mitigation project, unless an alternate schedule is agreed upon by the agencies. For any year in which planting was conducted, monitoring of woody vegetation shall take place no earlier than October and at least 6 months following planting. Monitoring of vegetation (herbaceous and woody species) shall be conducted during the growing season.
   ii. Vegetation sample plots shall be located on a stratified random basis over the

site in order to sample all areas of wetland buffer at locations adjacent to each photo location marker. If the random plot location is an outlier, the plot can be moved but justification should be provided in the monitoring report. Once the sample plots are established, they should be stationary, unless the Sponsor recommends, and the agencies agree, to moving the sample plot in future years. The following minimum numbers of samples will be required:

- If the site is < 5 acres, then a minimum of 3 plots/acre is necessary.
- 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.
- 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.
- All cells, fields, or blocks 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.

iii. 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:

- Total actual and relative percent cover of native plant species
- iii. Number of native woody plant stems greater than 10 in. in height (total and #/acre)
- v. An invasive/noxious species assessment including relative percent cover

3. Stream Area(s)

After Year 2, physical monitoring of stream condition (e.g. Longitudinal profiles, cross-sections, channel Width and Depth) may be conducted outside of the growing season.

Stream chemical (i.e. temperature) monitoring will occur continuously, year-round. For stream biological monitoring, event shall occur consistently within the index period as required by the Maryland Biological Stream Survey (MBSS); between March 1 and April 30 for benthos sampling and between June 1 and September 30 for fish sampling. For any year in which planting was conducted, monitoring of woody vegetation shall take place no earlier than October and at least 6 months following planting. Monitoring of vegetation (herbaceous and woody species) shall be conducted during the growing season.

a. Stream Channel Preservation: Limits will be visually monitored and documented with photographs on an annual basis.

b. Stream Restoration: For the linear footage of stream with stream enhancement activities, the following monitoring will occur in addition to those outlined for Stream Preservation areas:

i. Reach-wide data will be collected including the following:

- Bank Erodibility Hazard Index (BEHI) will be assessed to provide a representative reach assessment.
- Beginning with Year 3, The U.S. Forest Service Stream Reach Inventory and Channel Stability Evaluation (Pfankuch, 1975) will be performed on each reach to provide a representative assessment.

- Monitoring of the pre- and post-restoration instream habitat using the Rapid Bioassessment Method
- Radius of curvature shall be assessed within a representative reach.
- Sinuosity shall be assessed in a representative reach.
- Percent estimated canopy coverage over restored streams

ii. Permanent cross-sections shall be established to ensure that the same locations are used each monitoring year. Representative cross-sections (with permanent markers established during the first monitoring interval) will be surveyed at intervals on a representative sample of riffles and pools. The total number required will vary depending on project length and complexity. Additional cross-sections may be required to show areas where aggradation, degradation, erosion, and mid-channel bars have developed. The following cross-section data will be collected:
    - Bankfull width/depth ratio
    - Bank/height ratio and entrenchment ratio
    - Baseflow discharge measured at least once during both the wet and dry seasons
    - Photographs documenting the structural integrity and function at each habitat structure
    - Documentation of structure use by intended species. Each instream structure shall have the following data collected:
        - Photographs documenting structural integrity and function.
        - Surveyed profile documenting invert elevation

iii. A surveyed longitudinal profile of the stream within the thalweg with measurements of the locations, depths, and slopes of riffles, runs, pools, and glides. A separate profile will be prepared depicting all previous longitudinal profiles superimposed.

iv. Stream classification pebble count

v. Bar sample or pavement sample

vi. Wetted-perimeter cross-section pebble count of representative riffles

vii. The D50 analysis of the pebble count data

Chemical and Biological Monitoring: Monitoring events shall occur in years 2, 3, 5, 7, and 10 and consistently in either spring or fall of each monitoring year. Stream chemical (i.e. temperature) monitoring will occur continuously, year-round. For stream biological monitoring, event shall occur consistently within the index period as required by the MBSS; between March 1 and April 30 for benthos sampling and between June 1 and September 30 for fish sampling. The number and location of monitoring stations shall be determined, and approved by the agencies, on a case-specific basis and shall remain consistent throughout the monitoring period. Surveys of other biota (e.g. fish, waterfowl, amphibians, etc.) should occur on a case-by-case basis.

Scientific Collection permits for conducting benthic and fish sampling will be coordinated with the Maryland Department of Natural Resources (DNR). All field sampling as well as laboratory sample processing shall be performed by or under supervision of a professional aquatic biologist.

i. Chemistry – Temperature shall be collected at each designated monitoring location site using a HOBO data logger.

ii. Biological – A quantitative survey for benthic macroinvertebrates and fish habitat assessment shall be conducted at designated monitoring locations using a modified MBSS methodology.

Habitat Assessment: A habitat assessment shall be conducted at each identified site using the Rapid Bioassessment methodology.