

## EXHIBIT J MONITORING REQUIREMENTS

Monitoring activities will follow the timing and guidelines set forth in the Monitoring Requirements of this MBI, and according to the following monitoring schedules and requirements.

After Year 3, physical monitoring of stream condition (e.g. Longitudinal profiles, cross-sections, channel Width and Depth) may be conducted outside of the growing season.

For stream chemical and biological monitoring, monitoring event shall occur consistently in either spring or fall of each monitoring year. Spring sampling shall be conducted between March 1 and May 31. Fall sampling shall be conducted between September 1 and November 30. 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.

If all performance criteria have not been met in the 10<sup>th</sup> 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.

**Wetland preservation, stream buffer preservation, and upland buffer preservation areas** shall consist of:

1. Methodology: Methodology necessary to demonstrate compliance with the approved INU treatment plan.
2. Visual Observations: Visual observations shall be provided with each monitoring report through written discussion of the buffer condition, any changes to the buffer, and photographic documentation, as necessary to further describe the buffer condition.

**Stream or upland buffer restoration/establishment/reestablishment areas** shall consist of:

1. Visual Description: Visual descriptions shall be provided with each monitoring report by one of the following means: (i) ground level photographs, taken facing north, south, east and west, from stations located adjacent to each vegetation plot [permanent markers shall be established to ensure that the same locations (and view directions) are monitored in each monitoring period], or (ii) one color aerial photograph (8" x 10" or larger) depicting the entire site. An aerial photograph should be taken after site construction (including planting) and again in the 3<sup>rd</sup> and 7<sup>th</sup> year following final grading. Existing aerial images (if current) may be substituted (i.e. Google Earth images or state aerial images).
2. Vegetation. Sample plots shall be located on a stratified random basis over the site in order to sample all habitat areas of buffer at locations adjacent to each photo location marker. A minimum of 3 plots per acre shall be required regardless of the size of the Bank.

Each plot shall be of a size no less than 400 square feet for trees and shrubs and 3'x3' for herbaceous plants (or circular with approximately the same surface area).

Alternative sampling methods (*for instance use of point-line, point frame, or line-*

*intercept sampling techniques; use of species-area curves or sample size analyses to establish numbers of samples, etc.)* may be submitted for IRT review and approval, acting through the Chair(s). The vegetation data shall be collected in each sample plot during the growing season and shall include:

- (a) For herbaceous plots: identification of all herbaceous species found in the sampling plot (with corresponding estimate of actual percent cover, indicator status, native status, planted/volunteer category for each species), and the percent of bare ground and open water;
- (b) For forested or shrub/scrub plots: identification of all live woody stems of tree and shrub species found in the sampling plot (with corresponding indicator status, native status, planted/volunteer category, stem count, extrapolated stems/acre of tree species or shrub species as required by the performance standards), number of dead stems and canopy coverage;
- (c) Vegetation species identification by common and scientific name;
- (d) Estimates of percentage cover overall, and for each species;
- (e) Identification of dominant species in each vegetation stratum;
- (f) Species Richness – the number of species found at the site at time of data collection (include all species found in a plot with individual % cover estimates);
- (g) Survival of planted species (per plot and per acre);
- (h) Percent cover and/or stem count of non-native or INU species in each vegetation layer; and
- (i) Average height of planted woody stems of tree species in each sample plot and percent change in height by species since previous monitoring event.

**Wetland restoration and creation** shall consist of:

1. Visual Description: Visual descriptions shall be provided with each monitoring report in narrative form along with documentation by one of the following means: (i) ground level photographs, taken facing north, south, east and west, from stations located adjacent to each vegetation plot and hydrology monitoring station [permanent markers shall be established to ensure that the same locations (and view directions) are monitored in each monitoring period], or (ii) one color aerial photograph (8" x 10" or larger) depicting the entire site. An aerial photograph should be taken after site construction (including planting) and again in the 3<sup>rd</sup> and 7<sup>th</sup> year following final grading. Existing aerial images (if current) may be substituted (i.e. state aerial images).
2. Growing Season Documentation:
  - (a) Documentation of the end of dormancy of above Ground Vascular Plants:
    - i. Dated photographs of two or more different non-evergreen vascular plant species growing in the mitigation site AND from adjacent forested sites

which exhibit indicators of biological activity outlined in the applicable Regional Supplement.

- ii. Maps depicting the locations of the documented species;
- iii. The names of the documented species.

(b) Soil temperature as an indicator of soil microbial activity:

- i. Data on soil temperature measured on-site at the -12 inch depth below the mineral soil level (below the root mat); holes dug to access the -12 inch depth shall be re-filled after each reading.
- ii. The equipment used and the dates the data was collected. Daily soil temperature data collected by data loggers are preferred but information from soil thermometers may be acceptable (the thermometer used must be calibrated with proof of calibration provided to the Corps).
- iii. If using manual readings, soil temperature data should be collected at least two times a week starting in January to provide information in support of the Corps' establishment of the start of the growing season;
- iv. Maps which indicate the locations of the data collected by the soil temperature equipment.

(c) Soil temperature and above-ground plant growth data must be collected at locations approved by the Corps. For mitigation sites proposed as forested wetlands, soil temperature and plant growth data must be collected in a similarly situated (hydrogeomorphically) adjacent reference wetland area, as well as on the mitigation site itself.

(d) The mitigation site must be monitored each year to determine the growing season for any particular year. Prior year's data expires after it is submitted to the Norfolk District and cannot be used for future years.

3. Hydrology. This is a \_\_\_\_\_ driven system on top of a \_\_\_\_\_ substrate. [*For surface saturation driven systems located on top of a clayey substrate, soil saturation measurement devices may be used in lieu of groundwater wells and other secondary hydrology indicators to determine groundwater elevations and/or hydro period in these wetlands areas.*] Specific details on the soil saturation measurement device and location or groundwater monitoring wells shall be provided in the Final Construction Documents for IRT approval, acting through the Chair(s) as described in Exhibit E (FMWP). For each monitoring report, either 60 days of continuous automated monitoring, or 8 consecutive weekly measurements shall be provided during the growing season to demonstrate achievement of the hydrology performance criterion (actual monitoring may be of longer duration, as needed, to obtain proof of wetland hydrology).

4. 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. All community types should be sampled. A minimum of 3 plots per acre shall be required regardless of the size of the Bank.

A minimum of 2 plots/acre is necessary regardless of the size of the Bank.

All plots shall be sampled.

Each plot shall be of a size no less than 400 square feet for woody stems of native tree species and 3'x3' for herbaceous plants (or circular with approximately the same surface area). Alternative sampling methods may be submitted for IRT review and approval, acting through the Chair(s). The vegetation data shall be collected in each plot during the growing season and shall include:

- (a) For herbaceous plots, identification of all herbaceous species found in the sampling plot (with corresponding estimate of percent cover, indicator status, native status, planted/volunteer category), and the percent of bare ground and open water.
- (b) For tree plots, identification of all live tree and shrub species found in the sampling plot (with corresponding indicator status, native status, planted/volunteer category) tree stem count, extrapolated tree stems/acre, number of dead stems.
- (c) For scrub/shrub plots, identification of all live shrub species found in the sampling plot (with corresponding indicator status, native status, planted/volunteer category), shrub stem count, extrapolated shrub stems/acre, number of dead stems.
- (d) Vegetation species identification by common and scientific name and wetland indicator status;
- (e) Estimates of percentage cover overall, and for each species utilizing the same cover classes required for upland buffer restoration presented above. Cover class data shall be relativized within each plot to 100% cover to allow for comparison between plots of varying sizes
- (f) Identification of dominant species in each vegetation stratum
- (g) Species Richness – the number of species found at the site at the time of data collection (include all species found in a plot with individual % cover estimates)
- (h) Counts of native tree or shrub species stem density (per plot and #/acre);
- (i) Survival of planted species (per plot and per acre); and
- (j) Percent cover and/or stem count of non-native or INU species in each vegetation layer,
- (k) Average height of planted woody stems of tree species in each sample plot and percent change in height by species since previous monitoring event
- (l) An INU species assessment including percent cover and/or stem count;

(m) An assessment of the specific wetland functions and values being provided should be conducted.

(n) Number and species of native *Quercus* (sp) rated FAC or wetter growing in wetlands (total and #/acre) *(if data on specific oak species required in MBI/MWP)*

**Streams** shall consist of:

1. Stream Channel Preservation: For the linear footage where no instream work was accomplished (regardless of riparian buffer activities), the following monitoring shall occur:

(a) Permanent cross-sections shall be established to ensure that the same locations are used each monitoring year. A minimum of one cross-section per 1000 linear feet will be required. 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 will be documented at each cross-section:

i. Ground level photographs shall be provided with each monitoring report for the purpose of documenting vegetation and stream stability. The photographs will be taken annually during November or December of that monitoring year at representative cross-sections and will clearly show the channel upstream and downstream, the riparian buffer area, and each stream bank. *For one-sided stream channels, photo documentation of the condition of the stream channel and buffer located outside of the property limits shall be included. Photos and descriptions can be obtained from within the property limits controlled by the Sponsor.*

ii. Cross-sectional measurements shall include streambanks, streambed, water surface, bankfull, and adjacent floodplain elevations. *For one-sided stream channels, cross-sections should extend from top of bank to the property line within the stream channel.*

iii. The same cross section for all previous monitoring years will be overlain on this cross section. *For one-sided stream channels, these monitoring protocols must occur on the stream bank where this activity occurred.*

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

(a) 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.

- i. Stream bank vegetation plots (10 square feet in size) shall be located on each bank 100 feet upstream or downstream of each cross-section where streambank plantings were completed.
- ii. Bank Erodibility Hazard Index (BEHI) will be assessed at each permanent cross-section and additional locations selected in consultation with the IRT to provide a representative assessment.
- iii. Beginning with Year 2, 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.
- iv. Radius of curvature shall be assessed within a representative longitudinal profile
- v. Sinuosity shall be assessed in a representative section.
- vi. Bankfull shear stress and mean depth and slope (calculated using dimensionless shear stress) shall be assessed in a representative longitudinal profile
- vii. Bankfull event gage documentation shall be provided. *The number of stream gages will be determined on a case-by-case basis for each Bank depending on the number of stream reaches and proposed mitigation types.*
- viii. Photographs documenting the structural integrity and function at each habitat structure.
- ix. Documentation of structure use by intended species.

3. Stream Enhancement with Structures: Photo documentation will be provided for each structure, regardless of type, depicting the full width, length, and landscape position so that all portions of the structure are visible. For the linear footage of stream with stream enhancement with structures activities, the following monitoring will occur in addition to those outlined for Stream Preservation and Stream Enhancement areas:

- a. Each instream structure shall have the following data collected:
  - i. Photographs documenting structural integrity and function
  - ii. Surveyed profile documenting invert elevation
- b. *(For constructed riffles)* Wetted-perimeter cross-section pebble count at constructed riffles.

4. Stream Restoration: For the linear footage of stream with stream restoration activities, the following monitoring will occur in addition to those outlined for Stream Preservation, Stream Enhancement, and Stream Enhancement with Structures areas:

- a. 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.
- b. Stream classification pebble count
- c. Bar sample or pavement sample
- d. Wetted-perimeter cross-section pebble count of representative riffles *(not constructed riffles)*

- e. The D50 analysis of the pebble count data
- f. Monitoring of the pre- and post-restoration instream habitat and macroinvertebrate community

5. Chemical and biological monitoring: Monitoring events shall occur in years 1, 2, 3, 5, 7, and 10 and consistently in either spring or fall of each monitoring year. Spring sampling shall be conducted between March 1 and May 31. Fall sampling shall be conducted between September 1 and November 30. Water chemistry and benthic samples shall be collected simultaneously at each of the monitoring locations. The number and location of monitoring stations shall be determined, and approved by the IRT, 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 sampling shall be obtained from Virginia Department of Game and Inland Fisheries (information available at <http://www.dgif.virginia.gov/permits/guide.asp>). All field sampling as well as laboratory sample processing shall be performed by or under supervision of a professional aquatic biologist. As required by the collection permit, all sampling data shall be submitted to VDGIF using their annual reporting protocol, in addition to the reporting requirements within this MBI.

a. Chemistry – Temperature, total dissolved oxygen, pH, and conductivity shall be collected at each designated monitoring location site using a multi-probe meter. *[Detailed information on testing, inspection, and maintenance requirements of all multi-probe meters for measurement of stream physicochemical parameters can be found in Section IV of the “Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment Program” (2010) located at <http://www.deq.virginia.gov/Portals/0/DEQ/Water/Guidance/wqmsop.pdf>*

b. Biological – A quantitative survey for benthic macroinvertebrates and a habitat assessment shall be conducted at designated monitoring locations. Benthic macroinvertebrates shall be identified at least to the genus level. *[Detailed procedures and methods for biological monitoring, field methods, laboratory methods, and quality assurance can be found in Biological Monitoring Program Quality Assurance Project Plan for Wadeable Streams and Rivers (2008) at [http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityMonitoring/BiologicalMonitoring/BioMonQAPP\\_13Aug2008.pdf](http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityMonitoring/BiologicalMonitoring/BioMonQAPP_13Aug2008.pdf)*

The Virginia Department of Environmental Quality has developed the “*Biological Monitoring Program Quality Assurance Project Plan for Wadeable Streams and Rivers*” (2008) for their biological monitoring program. This document shall serve as the basis for the field monitoring and laboratory data collection methods. Two sampling procedures are presented:

- a. Single Habitat is used for streams in which riffles with appropriate substrate (cobble) are available for sampling and are large enough so that at least 1m<sup>2</sup> of the substrate can be sampled.

- b. Multiple Habitat is used in cases where no riffles are present, the riffles in the reach are too small and/or too few to sample 1m<sup>2</sup> of substrate. Multi-habitat sampling is most commonly performed in, but not limited to, low gradient streams.

6. Habitat Assessment: A habitat assessment shall be conducted at each bioassessment site. Procedures and forms for habitat assessment can be located in Appendix B (iii) of the “*Biological Monitoring Program Quality Assurance Project Plan for Wadeable Streams and Rivers*” (2008).

- a. For non-coastal streams, use the resulting benthic macroinvertebrate data to calculate the Stream Condition Index for Virginia Non-Coastal Streams (VSCI). This Stream Condition Index for Virginia Non-Coastal Streams (September 2003) is found at <http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityMonitoring/BiologicalMonitoring/vsci.pdf>
- b. For coastal streams, use the resulting data to generate a Coastal Plain Macroinvertebrate Index (December 2013) found at <http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityMonitoring/ProbabilisticMonitoring/vcpmi.pdf>
- c. The data sheets for the chemical and biological monitoring can be found in *Biological Monitoring Program Quality Assurance Project Plan for Wadeable Streams and Rivers (2008)* at [http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityMonitoring/BiologicalMonitoring/BioMonQAPP\\_13Aug2008.pdf](http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityMonitoring/BiologicalMonitoring/BioMonQAPP_13Aug2008.pdf)

The objective of habitat and benthic macroinvertebrate sampling is to allow for comparison between mitigation banks involving stream channel restoration activities; to identify issues that may need to be addressed in the restoration design; to determine realistic expectations for the post-restoration aquatic community; and to inform future stream restoration efforts.

*An Access database used to calculate VSCI and CPMI can be provided upon request.*