



STREAM AND WETLAND MITIGATION MONITORING GUIDELINES FEBRUARY 2014

Introduction

The purpose of monitoring is to determine whether or not a project is successful in restoring ecosystem services lost from permitted impacts that the mitigation is intended to offset. Because project success is based on meeting the success criteria defined in the approved mitigation plan, it follows that monitoring activities should provide the quantitative and qualitative measures needed to demonstrate project performance within the context of those agency-approved success criteria.

The NCDENR Ecosystem Enhancement Program (EEP) is providing the following guidelines for post-construction monitoring on EEP mitigation projects. Applicability is limited to EEP-owned projects developed to provide credits through full-delivery, design-build, and design-bid-build contracts. Mitigation banks are outside the purview of EEP guidance and nothing in this document bears on any mitigation bank's performance requirements or any bank's ability to sell mitigation credits to EEP.

Background

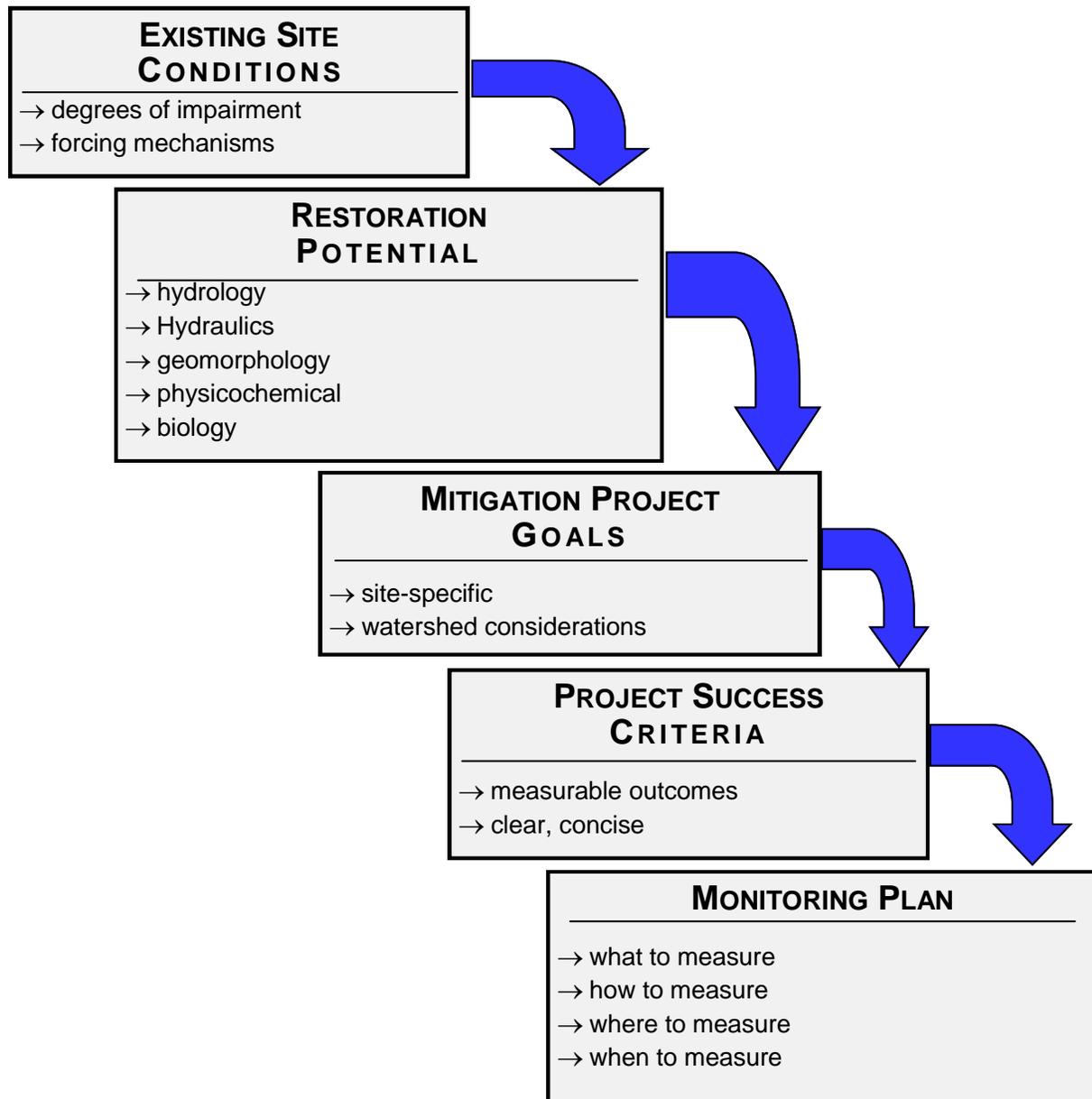
In 2003, the USACE Wilmington District promulgated [Stream Mitigation Guidelines \(SMGs\)](#). In 2014 the USACE stated unequivocally that the applicable regulatory guidance for monitoring stream mitigation sites in the Wilmington District remains that of the 2003 Stream Mitigation Guidelines.

Since 2003, restoration science and practice have evolved considerably, and hundreds of mitigation projects across the state have broadened the frames of reference for everyone in the mitigation community. EEP's post-construction monitoring requirements have also evolved over the past ten years, typically in response to lessons learned and regulatory impetus. However, the several incremental changes adopted by EEP were often developed in relative isolation to address specific issues as perceived at a particular time and place. Mitigation monitoring and reporting requirements are now also informed by the 2008 Federal mitigation rule "Compensatory Mitigation for Losses of Aquatic Resources" [33 CFR Parts 325 and 332](#) and [EEP's 2010 In-Lieu-Fee Instrument](#)

In addition to rethinking technical requirements, the monitoring guidance provided here reflects changes in how EEP does business. Stream and wetland mitigation plans for all EEP projects are prepared by external service providers. In that process we depend on the professional judgment of our service providers to: evaluate existing site conditions and restoration potential; to articulate mitigation project goals; define measurable criteria by which project success can be objectively determined; and to describe the field methods and frequency by which measurements will be collected over the post-construction monitoring period. EEP recognizes and respects the knowledge base of our business partners, and this guidance is intended to encourage direct applications of their technical expertise and mitigation credit delivery experience.

Approach

EEP's approach to monitoring is to apply robust, cost-effective methods to measure progress toward desired outcomes. EEP endorses a WATERFALL MODEL for developing the component parts and details of the post-construction monitoring plan. In a waterfall model, typically, the outcome of one phase acts as the input for the next phase sequentially. Following is a diagrammatic representation of different phases of a waterfall model for developing a monitoring plan.



Generally, service providers are responsible for integrating all of the waterfall components into the mitigation plan. As memorialized by contract, EEP service providers understand their responsibilities for producing mitigation plans that receive approval from the Interagency Review Team. This document provides basic considerations for monitoring EEP projects. The intent here is to allow experienced professionals to apply their judgment to develop and implement monitoring plans that will demonstrate project results. For some ecosystem functions, brief discussion of success criteria is

included. Requirements of long standing (e.g. plant survival) success criteria may be reiterated herein. Other potential mitigation outcomes may be discussed more generally to provide examples of how goals might relate to possible success criteria, thence to monitoring practices.

In preparing this document EEP has tried to avoid being overly prescriptive. However, certain established formatting and data submittal requirements are retained for program consistency. We are also retaining the visual monitoring protocol (Current Conditions Plan View), and recommend that the resulting maps and documentation be considered the minimum annual monitoring report requirements for each year. In addition, EEP requests that vegetative data be submitted through the CVS web-based portal even if the vegetation data is not collected by the CVS method.

As with all other aspects of compensatory mitigation projects, EEP subscribes to two basic tenets for post-implementation monitoring:

- The North Carolina Ecosystem Enhancement Program affirmatively supports innovation, sound science, and cost-efficient improvements to all aspects of mitigation;
- All work must be in accord with applicable Federal and state regulations.

As stated above, the applicable regulatory guidance for monitoring stream mitigation sites remains the 2003 Stream Mitigation Guidelines. Monitoring must also comply with the 2008 Federal Mitigation Rule ([33 CFR Parts 325 and 332](#)). Should any apparent contradictions arise between this EEP document and the 2003 Stream Mitigation Guidelines, the USACE document shall prevail.

Monitoring Guidelines

1.0 General

- 1.1 **Monitoring Period** - Site monitoring for all mitigation projects shall occur for five to seven years after project implementation, with the final duration dependent upon performance trends toward achieving project goals and objectives.
- 1.2 **Reporting Frequency** - Unless otherwise specified in the approved mitigation plan, complete monitoring reports should be submitted for monitoring years 1, 3, 5 and 7. At a minimum, the following should be submitted in monitoring years 2, 4 and 6, as appropriate: a brief summary narrative of site developments, representative photo images, a Current Condition Plan View (CCPV), and any hydrology data/tables/plots
 - 1.2.1 EEP requires at least a 6 month period between the as-built baseline measurement and the first monitoring year measurement.
- 1.3 **Submittals** – All monitoring report documents should be submitted to EEP by November 30 each year.
- 1.4 **Report and Data Format**: The documents listed below can found on the [EEP Portal](#). They and provide required details on the formatting and submittal requirements for the Baseline and Annual Monitoring reports and associated data:

As-built Baseline Monitoring Report Template – February 2014
Annual Monitoring and Closeout Reporting – February 2014
Monitoring Baseline and Annual Monitoring Excel Tables – Feb 2014
Format, Data Requirements, and Content Guidance for Digital Drawings.

- 1.5 **As-built Monitoring Baseline**: As-built surveys should be completed within 60 days after project implementation to capture an accurate assessment of the constructed condition.

- 1.6 Preservation - Monitoring is not required for preservation elements of a project. As described in the 2003 Stream Mitigation Guidelines, reference photos should be taken of preservation areas. These photo images shall be included in the Baseline Report submitted to EEP.
- 1.7 Success Criteria and Performance Parameters - Success criteria provided in the approved mitigation plan or in the permit conditions must be restated verbatim in the monitoring documents.

2.0 Hydrology

Project goals that include floodplain reconnection would logically include appropriate hydrologic and geomorphic success criteria to (at a minimum) describe the improved frequency of overbank flooding. Monitoring protocols would then be needed to measure restored floodplain connections.

Project goals that include flood attenuation would similarly include appropriate hydrologic success criteria to describe improvements to the magnitude and duration of floods attenuated on the project. Monitoring protocols would then be needed to (at a minimum) calculate the amount of water stored and record the amount of time flood waters were retained.

2.1 Wetland Hydrology Monitoring

- 2.1.1 A sufficient number of gauges should be deployed to document the hydrologic response to mitigation activities. Monitoring Gauges should be distributed across the site to characterize variable conditions such as soils, topography and off-site influences (e.g. adjacent ditches).
- 2.1.2 Groundwater elevation data should be downloaded at least quarterly and presented in reports as summary tables and graphs.

2.2 Stream Hydrology Performance Criteria

For purposes of stream mitigation monitoring, EEP defines a geomorphically significant flow (Q_{gs}) as:

$$Q_{gs} = 0.66 * Q_2$$

The Q_2 is the “2-year discharge”, or a flow which has an exceedance probability of 0.50 in any given year according to the Annual Peak data series. The 2-year flow is routinely calculated from published USGS regression equations for the various regions of North Carolina, and is often calculated in stream design analyses. Research has demonstrated that $0.66 * Q_2$ is the threshold above which significant geomorphic work will occur in most streams in most hydro-physiographic regions. The Q_{gs} is typically 20 to 40 percent lower than the bankfull discharge. The Q_{gs} will need to be estimated and described in the mitigation plan.

The 2003 Stream Monitoring Guidelines require two flow events that equal or exceed the design bankfull discharge to occur in separate monitoring years. For all Restoration and Enhancement I reaches, EEP requires an additional two (2) geomorphically significant flow events to be documented for all monitored reaches prior to closeout. Therefore, a total of four (4) high flows must be documented before closeout: two (2) flows at or above the design bankfull stage and two (2) separate flows at or above the stage of the

Q_{gs} stage. There are no requirements regarding the temporal distribution of geomorphically significant flows.

2.3 Stream Hydrology Monitoring

- 2.3.1 At a minimum, peak flow events are to be monitored via a crest gauge installed at riffle cross sections in locations necessary to represent the project drainages. This includes any tributaries with distinct design criteria that were subject to levels of grading commensurate with restoration or systemic enhancement. More than one crest gauge may be needed on streams where tributaries significantly increase the drainage area. Photos of flood indicators can augment the monitoring record and are encouraged.
- 2.3.2 The occurrence of flood events shall be monitored and cataloged throughout the monitoring period. When crest gauges are used to monitor stream hydrology, the stage corresponding to the Q_{gs} will need to be calculated and described in the mitigation plan.
- 2.3.3 The use of at least one continuous stage recorder is strongly encouraged. The capture of multiple flow peaks and associated durations provides extremely useful information for estimating the overall work performed on the channel, optimizing hydraulic geometry measurements and facilitating interpretations of stream stability. (See also section 3.1.3).
- 2.3.4 On-site measurement of precipitation or use of an appropriate surrogate weather station data is also encouraged for stream mitigation projects to allow comparisons of the monitoring year to long term norms. The Wetlands Determination (WETS) data plots provided in association with wetland monitoring will service this need.

3.0 Stream Geomorphology

3.1 Morphology Success Criteria

Geomorphic success criteria and the associated monitoring protocols in the approved mitigation plan should be appropriate for the project goals and objectives. Although the absence of any appreciable change in hydraulic geometry will generally be interpreted as stability, some degree of dynamism should be expected. It is incumbent on the service provider to describe acceptable ranges and the direction(s) of anticipated variation from the as-built baseline conditions. For example, it is relatively common for design documents to describe reductions in the width:depth as expected during the monitoring period. For many alluvial streams, lateral migration of meanders should be expected and more sophisticated designers may include planned deformability of stream banks as a design feature. For those projects that can accommodate alluvial channel dynamics, estimating methods and limits of lateral dynamism should be presented in the mitigation plan to describe the rates, directions and extents of acceptable variability. Increased density of hydraulic geometry measurements may be advisable for alluvial channels.

3.2 Hydraulic Geometry and Channel Monitoring

3.2.1 The longitudinal profiles for all constructed streams shall be surveyed as part of the as-built baseline report. Additional profile measurements may be required if problems are identified during the monitoring period.

3.2.2 In general, a representative meander wavelength should be selected for hydraulic geometry measurements for each reach having discrete design criteria (i.e. hydraulic geometry, design discharges) that differ from adjacent reaches. Generally, two (2) riffle and two (2) pool cross sections should be measured, along with water surface slopes, according to standard methods. The locations and number of cross sections should be modified as needed to capture data from other features that may have been constructed (e.g. compound pools, extended runs). Additional measurements may also be necessary for long reaches with consistent dimensions.

For reaches that are not supply limited, it is preferred that while maintaining the representative nature of the sample, the wavelength chosen for monitoring should be in the upper 20% of the reach to maximize the likelihood of observing channel responses to bedload inputs within the monitoring timeframe.

3.2.3 EEP encourages the use of geomorphically significant flow data (see section 2.4.1) to influence the timing of hydraulic geometry measurements. If no flows capable of significant geomorphic work have been recorded, then hydraulic geometry measurements may be postponed until such time as meaningful data can be collected. Those data may be presented in the next scheduled monitoring report. Similarly, if several flows exceed the Q_{gs} in a monitoring period, additional data collection may yield useful results.

A minimum of three sets of post-construction hydraulic geometry measurements are required prior to project closure. Designed alluvial channels with migrating banks may require additional data collection.

3.2.4 Bank erosion pins may be used to monitor lateral erosion. In general, bank pins are not a substitute for cross sections and may best be used to quantify or document qualitative observations.

4.0 **Vegetation Monitoring Guidance**

The following guidelines apply to all stream and wetland mitigation projects that include the planting of stream buffers and/or forested wetlands. The April 2003 Stream Mitigation Guidelines require plant survival analysis as a central component of Level I monitoring. Additional requirements may apply to projects that generate Riparian Buffer Mitigation or Nutrient Offset credits.

4.1 **Vegetation Success Criteria**

Plant survival success is based on density levels at monitoring year 5 of 260 native stems/acre and for monitoring year 7 at 210 native stems/acre.

4.2 **Vegetation Monitoring**

4.2.1 There is a range of standard sampling methods for monitoring tree survival, stocking levels and growth. Service providers should select the method (or combination of methods) best suited to the site and mitigation activities. The methods to be used should be described in the mitigation plan to include plot size,

sample density, etc. EEP requires samples be distributed across the entire project site to include data from all plant communities established. Representative plots may be semi-permanent (fixed), or sampling may employ quasi-random plot locations and those locations may vary from year to year.

- 4.2.2 To provide a basis for a robust plant survival analysis, EEP recommends monitoring survival and height by species, with volunteers counted separately from planted trees.
- 4.2.3 For wetland projects, especially larger sites, the number and locations of plots should be based on best professional judgment to accurately represent the variability of soils and hydrologic conditions restored at the site.
- 4.2.4 If addressed in the Mitigation Plan with stated goals and related success criteria, exotic/invasive species should also be monitored.
- 4.2.5 Reporting shall include a map showing the approximate location of plot centers or, for larger plots, the actual plot boundaries.

5.0 **Visual Assessment**

The visual assessment should be completed every year and is inclusive of the Current Condition Plan View (CCPV) and tables that house the visual assessment metrics. The CCPV provides the spatial distributions and qualitative performance ratings for certain monitoring features. The accompanying table provides actual performance proportions for various stream and buffer metrics. See Appendix B of the Monitoring Report Templates at the link above for details on formats and guidance related to the elements of the visual assessment.