Success Standards for Wetland Mitigation Projects - a Guideline

Mary Ossinger
(principal author)
Washington State Department of Transportation

August 1999

Washington State
Department of Transportation
Environmental Affairs Office

Table of Contents

Preface ... i

Acknowledgments ... i

Introduction ... 1

Background and Problem Statement ... 1

Purpose of These Guidelines ... 1

From Seed to Success: Elements of a Well-Defined Project ... 2

Hydrology ... 2

Overview of Mitigation Planning Process ... 3

Selecting Performance Objectives for a Project ... 8

Primary (Tier 1) Performance Objectives ... 9

Secondary (Tier 2) Performance Objectives ... 9

Objectives Filter ... 11

Writing Success Standards ... 12

General Guidelines ... 14

Success Standards - Tier 1 ... 16

Success Standards - Tier 2 ... 18

Monitoring Methods ... 20

Contingency Measures ... 22

The Toolbox ... 24

References ... 30

Preface — About the Success Standards Work Group

A group of wetland professionals from state, federal, and private sectors have come together to help bring more clarity to the issues surrounding the use of success standards in wetland mitigation. The group has been meeting since September 22, 1997. Four subcommittees were formed to address the elements identified as highest priority:

- Research on plant succession and development of created or restored wetlands.
- Development of guidance on success standards for hydrology.
- Investigation and guidance on uses of reference sites in evaluating success of wetland mitigation projects.
- Documentation of general guidelines and suggested benchmark values for writing project-specific success standards.

While the work group has accomplished a lot, a great deal of work remains. One of the most critical needs is inclusion of suggested benchmark values for commonly used success standards (e.g. % cover of woody vegetation). A research project is underway which should help us develop these benchmarks.

Acknowledgments

Several wetland specialists provided ideas, additions, and editorial comments during the evolution of this document. I'd like to thank all the members of the Success Standards Work Group, listed below, for their dedication and hard work. Special thanks to those who provided extensive comments or text, as indicated with bold text.

Fred Bergdolt
Mason Bowles
Nancy Brennan-Dubbs
Marion Carey
Sarah Cooke
Lauren Driscoll
Brent Haddaway
Catherine Houck
Bill Leonard
Arvid Lindstrum
Sandra Manning
Mark Maurer
Chris McAuliffe
Doug Myers
Charlie Newling
Rus Rosenthal
Bill Ryan
Meredith Savage
Laura Scott
Steve Shipe
Linda Storm
Doug Swanson
Jennifer Thomas
Chris Thoms
Chris Tiffany
Yvonne Vallette

Introduction

Background and Problem Statement

A critical element in the planning of any wetland mitigation project is the selection of objectives and success standards. Unfortunately, this task is much more difficult than most people realize, and the result is often a set of objectives and standards that don't make sense. Appropriate application of this task requires detailed technical knowledge and careful consideration of each of the following:

- regulatory requirements
- wetland functions
- wetland construction methods
- wetland monitoring methods
- expected (achievable) quantitative values for monitored wetland attributes

There are few wetland professionals who have detailed knowledge in all of these areas. This is compounded by the fact that wetland science and understanding are constantly being expanded. Presently there are no well-researched and standardized criteria to tell us what we should expect to achieve with a given project. Success standards for most projects are based more upon professional judgment than upon actual data. Every project is unique, making it unlikely that standardized criteria will ever (or should ever) be developed. Nonetheless, some data-based guidelines would greatly increase the validity of the success standards we use to determine if our mitigation site is developing and functioning as expected.

Purpose of These Guidelines

This document represents an attempt to provide practical guidelines that should be considered in the mitigation planning process. The intended audience is the community of wetland professionals involved with design, regulation, and monitoring of wetland mitigation projects. It is assumed that the reader understands the common terms and issues related to wetland science and regulation in the Pacific Northwest.

Input has been solicited from a wide variety of wetland professionals in order to develop a broad set of sample objectives and standards that are clear, measurable, and achievable. We have provided a "toolbox" from which the reader should be able to select a subset of appropriate performance objectives and standards for any wetland mitigation project in the Pacific Northwest. Guidelines are set forth to help users write their own customized objectives and standards that are based on best available science along with due consideration of constraints.

From Seed to Success:
Elements of a Well-Defined Project

The best way to ensure a successful mitigation project is to do a thoughtful and complete job of site selection, design, and construction. The following summary of the compensatory mitigation process is intended to point out some of the key elements that should be considered in most cases. It is not intended to be a complete description of the process or to include all the essential considerations.

The best way to ensure success is to:

- Involve a multi-disciplinary team of experienced professionals
- Select an appropriate site
- Allow sufficient time for analysis and design

Hydrology

The single most important driving factor of a wetland is water. In order to design a successful project, you must have detailed knowledge about the water source. The source can be precipitation, groundwater, or surface flow alone or in combination. Once the source is established, the pattern of depths over time (i.e. the hydroperiod) must be planned. The hydroperiod is defined in part by seasonal and annual pulses of flow, seasonal patterns and frequencies of flooding, and depths of water (Mitsch and Gosselink, 1993.)

Mitigation plans should document the preparatory work required to ensure that the selected site will have an adequate hydrologic regime. For example, if precipitation is to be a major water source, you must specify how the water will be diverted to and retained on the mitigation site by considering such factors as watershed, soil preparation, presence of till layer, etc. If stormwater runoff from nearby impervious surfaces is to provide water to the site, pretreatment in stormwater BMPs is needed and should be planned in conjunction with the wetland mitigation. If groundwater is used, data about the elevation and duration of the water table are required. Rates of groundwater flow and hydraulic conductivity of the soils and subsurface geology on the site are also vital. Of extreme importance here is the hydraulic head, which is measured only by piezometers, not water wells. Head reveals the direction the groundwater is flowing (up or down, toward or away from the mitigation site). This understanding is important to avoid an overabundance of water during the wrong time period or dewatering of adjacent uplands that may change the rate of water loss (through increased evapotranspiration) in the wetland (Winston 1997). If surface flooding is an important element, the frequency, duration, pulsation, and retention of water are important to understand when preparing a planting plan, designing for a wetland function, or avoiding fish stranding.

Knowing the location, depth, and residence time of the water is important to the success and survival of transplantings, particularly when excavation of uplands is involved. Successful germination of emergent plants can be dictated by depths of the water (Hammer 1992). Several other wetland functions are influenced by hydrologic regime and its affects on biochemical processes. Deep water promotes nitrification, whereas shallow water promotes denitrification. Decomposition is slower in anaerobic conditions; nutrient cycling is enhanced by reduced substrate conditions. The greater the flow-through, the more vegetation can be diversified by mineral enhancement, decreased anaerobic condition, and spatial heterogeneity (Mitsch & Gosselink 1993). Knowledge of depth, hydroperiod, and seasonal pulses of water and the relations of each to vegetation types, composition, and biochemical reactions can thus be tied into the design of a wetland's function (e.g. downstream food chain support, nutrient transformation, floodflow alteration, etc.)

Finally, site preparation, contouring, and grading are essential to the success of the planting plan. To attain correct water depths and durations, wetland mitigation sites should be: 1) excavated or graded as designed, 2) hydroseeded with appropriate grasses to preclude reed canarygrass and other highly aggressive invasives, and 3) observed for at least one wet season to determine if the correct elevation ranges for the plants are obtained. This type of observation can fine-tune grading and contouring and prevent large scale planting disasters. Monitoring water levels and providing daily guidance in earth moving actions can be particularly important when excavating low lying areas to enlarge existing wetlands (Gildersleeve et al 1989).

Water in the required amount, at the proper time, and over the correct duration will contribute greatly to the success of a wetland mitigation project.

Overview of the Mitigation Planning Process

The following text may be used as a checklist to aid in the development of compensatory mitigation projects. It is not intended to be complete for all projects, but it is hoped that it will provide ideas about items which should be considered at various stages of project planning and implementation.

Impact Analysis

In addition to determining the acreage and Cowardin classes of impacted wetlands, determine what functions were lost or reduced.

Determine if these functions are critical and/or limiting onsite, or in the general project area, or in the watershed.

Mitigation Strategy

Determine which functions, if any, must be replaced onsite and in-kind or offsite and in-kind.

Consider using credits from an established wetland bank

Consider lumping mitigation for two or more small impacts.

Consider whether alternative mitigation may be the most appropriate for the greatest ecological benefit (e.g. riparian enhancement instead of wetland creation). See Alternative Mitigation Work Group (1999).

Site Selection: Finding Potential Sites

Check these resources:

Watershed plan for affected basin(s).

WA State Dept. of Transportation Partnering database/GIS layer (under development) to see if there are potential project partners in the area.

Aerial photos (look for restoration/enhancement opportunities adjacent to existing natural areas, or providing connectivity between areas).

Talk to:

Biologist who did project impact analysis.

Project engineers.

Resource agency local or regional staff.

NRCS local office (along with Conservation District office, often together).

The Nature Conservancy, Trout Unlimited, other NGOs.

Local landowners (ask about flooding or other problems, areas that would be good for habitat restoration, etc.).

Site Selection: Evaluating Potential Sites

Consider:

Size (including adequate buffers).

Location (onsite, in vicinity, or within watershed).

Surrounding land uses (present and potential future).

Low level of existing ecological function (except for preservation areas).

Water source (preferably permanent surface water source, e.g. perennial stream).

Opportunity to provide target functions.

Connectivity to other natural areas.

Construction access.

Concept Report: Include the Following:

Summary of wetland impacts (acres, categories, functions).

Approximate compensation ratios.

Description of selected site (location, size, existing topography, existing vegetation, water resources).

Setting and surrounding land uses.

Proposed target functions for compensatory mitigation, and justification if different from impacted functions.

General strategy of mitigation (e.g. enhance wet pasture to scrub-shrub with open water areas).

Hand-drawn sketches of conceptual design.

List of proposed dominant plants.

Concept should be peer-reviewed by biologist who may provide valuable criticisms or enhancements.

If partnering on project, need to involve partner(s) in development or concurrence with concept, as appropriate.

Following peer reviews, route to all permitting agencies who will have approval authority over the final wetland mitigation plan.

Site visit may be useful.

Site Characterization

Note: *Allow at least 6 months to complete these tasks. Some sites may require a full year of hydrologic monitoring.*

General Site Map

Note vegetation communities & dominant species.

Existing culverts, ditches, areas of open water, streams, etc. (including inlet & outlet, if present).

Trees or other vegetation to be preserved.

All other notable features.

Water regime

Install and periodically check appropriate water level monitoring devices (groundwater wells, staff crest gages) at key locations.

Get stream level data from USGS gauging stations or other sources.   See the following website:

http://wa.water.usgs.gov/wrd-home.html

Consult with hydrologist with appropriate expertise.

Soils

Evaluate substrata, mapped soil unit, texture, organic content, pH, nutrient content.

Existing Wetlands

Delineate and assess functions.

Biological Assessment for threatened & endangered species (if project uses federal money or permits).

Survey & Plan sheets

Wetland boundaries.

Topography (to smallest practicable contour interval).

Survey water well and gauge locations.

Objectives & Detailed Design

Develop framework for design

Determine approximate areas of wetland restoration, enhancement, creation, preservation, and upland enhancement.

Finalize major target functions.

Look at nearby natural wetlands, if possible with similar water source as will be used at mitigation site, as reference site for ideas about hydrologic features and native plant assemblages.

Decide upon target plant communities and water regimes.

Develop and document water budget.

Consider including a research component to improve future projects.

Design strategies

Grading & water control measures (including berms, upland islands, inlet/outlet elevation controls, constrictions).

Safest design utilizes surface water with greater inputs than needed along with outflow control structure to set maximum depth.

Keep slopes as shallow as possible.

Consider observing water regime for one year following grading before planting, if possible.

Plant establishment (full planting, phased planting, managed succession).

Wildlife structures as appropriate.

Prepare detailed plans and report

Include details about all factors discussed above

Set performance objectives, success standards, and monitoring protocol as discussed later in this guideline. Monitoring team should review and approve selected standards and monitoring protocol.

Construction timing, soil amendments, weed control, and other implementation details should be included in the report.

Review

Peer review by another biologist.

If partnering on project, need to have partner(s) review.

Regulatory Approval

Draft mitigation package is sent along with permit applications to all agencies with jurisdictional authority.

If resource agency concerns or requested changes are substantial, a meeting should be held to bring regulator(s) and mitigation design team together to discuss.

After agreed-upon revisions are incorporated, the mitigation plans and report are final and should be identified as the document of record for the project permit conditions.

Plans and Specifications

All parts of draft plan sheets and specifications related to wetland mitigation should be reviewed by the mitigation design team.

Construction

Project construction inspector and contractor should meet with mitigation design team before construction begins to ensure understanding of project objectives and critical elements.

Grading should be inspected when 90% complete, while it is not too late to make changes if necessary.

Plant installation should be inspected early to catch errors in plant materials or installation, and again following completion.

Monitoring & Long Term Management

Mitigation design team should visit site during first year after construction to evaluate successful development toward stated goals and objectives.

Selecting Performance Objectives for a Project

A Note About Definitions

Some common terms are described below. These terms have special meaning when used in the context of wetland mitigation planning, and, since the meanings vary somewhat among authors, their intended use in this document is described below. See examples in the following section on Writing Success Standards.

Goal:

A broad statement of what you intend to accomplish through the mitigation project. The purpose of the goal statement is to provide an overview of the intended results, allowing the reader to visualize the anticipated end result. The goal statement should include a listing of the major wetland functions and values to be achieved.

Objective:

A specific element of the overall goal that is usually, but not always, stated in terms of a wetland function or value. The list of objectives for a mitigation project should include all functions and values that are expected to be provided by the site along with any other key characteristics (e.g. acreage).

Performance Objective:

In the context of this discussion, every performance objective must have one (or more) corresponding success standards; therefore, the performance objectives should be a subset of the objectives for the project. (See next section on selecting appropriate performance objectives.)

Success Standard (or performance standard):

An observable or measurable benchmark for a particular performance objective, against which your mitigation project can be compared. If the standards are met, the related performance objectives are considered to have been successfully achieved.

Monitoring Method:

The technique used to observe or measure an attribute of your mitigation project in order to compare it to the stated standard.

Contingency Measure:
The corrective action that will be implemented if a stated standard is not met within a specified period of time.

The general goals and objectives for a site are intended to describe the planned ecological functions of the site and need not be defined too precisely. However, the purpose of stating performance objectives and standards is to allow the success of the project to be evaluated. Therefore each performance objective must be matched with one or more appropriate and carefully crafted success standard, monitoring method, and contingency measure. Contingencies are included because it is assumed that failure to meet a standard indicates a shortfall in the project which may require remediation in order to adequately compensate for wetland impacts.

Primary Performance Objectives: Tier 1

Nearly all wetland mitigation projects should have performance objectives that specify the acreage of wetland and buffer to be created, restored, enhanced, or preserved (or a combination thereof). Such objectives are structural rather than functional. The success standards to evaluate them are stated in terms of the acreage, hydrology, and vegetation that should be evident after construction and planting. The Tier 1 performance objectives generally relate more to form than to function.

Primary performance objectives may include:

___ acres of wetland restoration (enhancement/creation/etc.)

A minimum buffer width of ___ feet around the entire perimeter of the wetland.

Secondary Performance Objectives: Tier 2

The trend in mitigation planning is to focus on functional objectives (Perkins et al, 1996; Mitsch and Gosselink, 1993; Marble, 1990; Horner and Raedeke, 1989). The selection of performance objectives related to wetland functioning is not straightforward. Once the primary objectives related to area and form are achieved (Tier 1), it is clear that your wetland mitigation project has succeeded at some level: a wetland of specified minimum size is in place and is providing some wetland and habitat functions. In some cases, especially where impacted wetlands were of low quality, this may be all that's needed to declare the project successful.

Occasionally, though, one or more specific wetland functions may need to be achieved in order for the project to successfully compensate for wetland losses. These necessary functions should be the targeted for additional (Tier 2) performance objectives. Tier 2 objectives are project-specific and are usually functional rather than structural, although the related success standards may refer to structural components of the mitigation site.

Secondary performance objectives may include:

Habitat for______ (Specify a target group such as waterfowl, shorebirds, raptors, anadromous fish, or amphibians or a particular species)

Food chain support

Vegetation species diversity

Sediment retention

Nutrient & pollutant removal & transformation

Stream base flow support

Flood water storage & conveyance

Flood velocity attenuation

Groundwater discharge or recharge

Erosion control

Shoreline stabilization

There are two necessary phases to selecting functional performance objectives for a wetland mitigation project.

1) When setting a goal and beginning early planning, you should list the wetland functions you want to restore, enhance, or create on the site. Next, you need to consider whether those functions are appropriate given your constraints in site location, size, hydrologic regime, and design. Site location and size may limit the opportunity of the site to perform a specific function. (For example, a wetland could be designed to provide water quality improvements, but the capacity to perform this function is meaningless if no surface water enters or leaves the system.) And there are always design constraints due to budget, time frame, local regulations, and the best available science. Finally, there may be conflicts between two or more of the functions you want to achieve. Be sure to look at the site as a whole and consider what is achievable given the project constraints[1].

---

[1] See Table 12 in *A guide to wetland functional design* (Marble 1990) for ideas about compatibility of wetland functions.

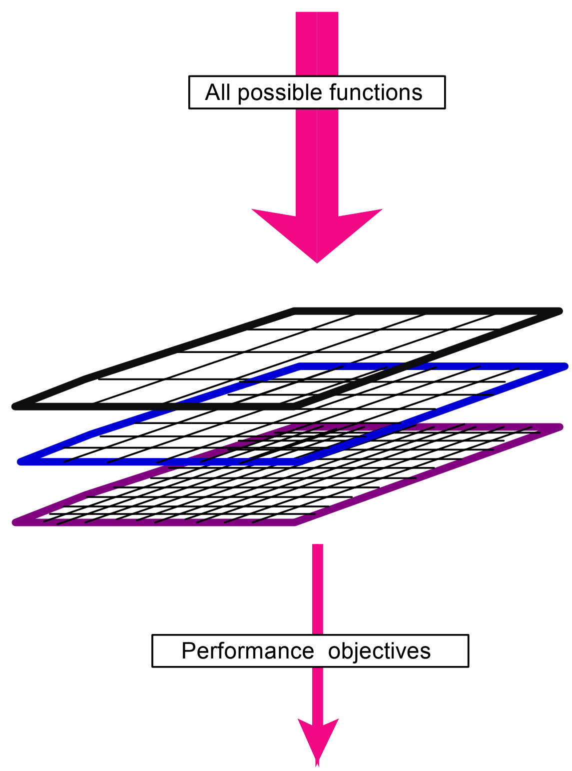
2) After developing a list of potential functions in step 1, you must determine which of these should be tied to the evaluation of the project's success.

These functions will be stated as performance objectives and must be measurable relative to a definable success standard. Also, if the performance objectives are tied to a commitment (e.g. through a permit condition), you must have a contingency plan and the resources to implement it if monitoring shows that the standard has not been met.

The elements needed to select one or more meaningful performance objectives are represented in the following questions. You can think of this series of questions as a filter that can reduce the set of all possible wetland functions to a small set of meaningful performance objectives.

Objectives Filter

- What functions do I want the site to perform?
- Of those, which functions will the site have the opportunity to perform?
- Of those, which functions can be achieved given my design constraints?
- Of those, which functions are critical to the overall success of the mitigation effort?
- Of those, which functions can be evaluated through a known monitoring method that I am capable of implementing (considering time and budget constraints)?
- Of those, which can I define with a success standard that is both 1) a known or likely benchmark of success, and 2) achievable on my site within my designated monitoring period?
- Of those, which functions could I expect to achieve after implementing a reasonable remedial action if the monitoring shows that the success standard is not being met?



Answering the questions above before investing a lot of time into crafting a performance objective will save you (and your monitoring team) a lot of grief. For example, you might locate and design your wetland in such a way that it will most likely provide groundwater discharge. What quantity of discharge would you consider "successful?" How would you measure it? If you didn't meet the success standard, what remedial action would you have to implement in order to increase the groundwater discharge? After thinking this through, you are likely to not use groundwater discharge as one of your stated performance objectives. However, this does not preclude your identifying this objective to guide site selection and design.

When you hope to achieve a particular function but recognize that it may not be possible to do so, even after employing all possible corrective measures, that function should *not* be stated as a performance objective. That doesn't mean you can't mention in your proposal the likelihood that the site will provide the function - it just means that you will use other criteria to determine the overall success of the project. A good example of this situation is proposed occupation of the site by a certain wildlife species. Even if appropriate habitat is provided, you cannot guarantee that a population will be established at the mitigation site within your monitoring period. If you decide to monitor for very specific habitat features, consider whether you really want to be committed to redesign, regrade, replant, etc. if those specific features are not achieved. (See Example 3 below.)

Writing Success standards

Once you have selected a set of performance objectives, you must select appropriate success standards to evaluate your progress toward achieving those objectives. Good success standards require a balance between accountability and flexibility. In some cases, there is a very simple and obvious way to evaluate success. Example 1 provides such an example. For other objectives, the success standard is not so straight-forward, as in Examples 2 and 3.

Example 1

Goal: Restore 10 acres of ditched pasture to emergent and scrub-shrub wetland. The restored wetland will be similar to historic wetlands in the area and will provide floodflow attenuation and storage, food chain support, overwintering habitat for salmon, breeding habitat for spotted frogs, and water quality improvements for surface outflow to the adjacent stream. A subset of these target functions are identified as performance objectives for the project; these will be evaluated to gauge success in achieving the overall goal.

Performance Objective 1: Restore 10 acres to wetland conditions.

Success Standard: Wetland area will be a minimum of 10 acres after 5 years.
Monitoring Method: Wetland delineation and survey.
Contingency: Evaluate potential causes for absence of wetland hydrology or vegetation over some or all of the desired area. Corrective actions may include revision of water control structures, minor grading, and replanting.

Example 2

Goal: ..see above…

Performance Objective 2: Provide sediment retention.
Success Standard: Wetland will have at least 80% cover by herbaceous vegetation after 3 years.
Monitoring Method: Herbaceous areal cover.
Contingency: Evaluate potential causes for poor vegetation establishment, rectify site conditions (e.g. water control structures) and plant additional vegetation.

Example 2 illustrates some of the confounding factors in the setting of performance objectives and standards. It may not be possible or practical to directly measure the capacity of a wetland to perform a given function. A more direct approach to measuring sediment retention would be to monitor sediment accumulation or compare sediment loads of water entering and leaving the wetland. However, this may not be the most useful approach. There may be technical or logistical difficulties in monitoring these. Or, failure to achieve a given level of sediment retention could be caused by lack of sediment in incoming water, not by a design or implementation flaw. And what contingency could be used if the sediment accumulation was not sufficient?

Assuming that sediments were coming into the site, you would probably respond to inadequate sediment retention by altering one or more *attributes* of the wetland, such as vegetation or slope, because you know that those attributes are what enable the wetland to provide the target function. Therefore, it may be most useful to focus success standards and measurements on the attributes of the wetland, instead of the actual functions, since the attributes can be controlled through our design, implementation, and remedial actions.

Example 3

Goal: ..see above…

Performance Objective: Provide breeding habitat for spotted frogs.
Success Standard: After 5 years, there will be at least 20 spotted frogs breeding in the wetland.
Monitoring Method: Amphibian census & egg mass counts.
Contingency: ???

Example 3 exposes a pitfall that should be avoided. A difficult problem arises if, after 5 years, your wetland has no spotted frogs, or has less than the standard. Does this mean that you failed in your site design? Possibly. It could also mean that you failed to locate your site in a suitable geographic area with connection to an established spotted frog population. Or, you might have created perfect habitat with connectivity, but chance events may have prevented the establishment of the target species to date. So, do you declare your site a failure and undertake remedial action? This actually depends on factors other than the number of frogs living on the site. Therefore, this standard of success is not very useful unless you absolutely must have 20 breeding frogs onsite in order to be successful. A better standard might be to evaluate the habitat features to determine if they're suitable to support spotted frogs, and choose contingencies that could remedy habitat deficits.

General guidelines

- Language is very important in writing success standards - you must be extremely precise and unambiguous in order to define appropriate monitoring and contingency plans.

- Don't use action verbs in standards - standards should be measures, not actions. (i.e. Instead of "Build ten acres of wetland," use "The wetland area will be at least 10 acres.")

- Avoid using fixed numbers except in cases where you have a need to achieve exactly that amount: instead specify a minimum, maximum, or range.

- Plan your project and write your standards with the intent of exceeding the minimum thresholds by a wide margin. This will help avoid costly remediation for cases where the result is just slightly below the standard.

- The wetland design and monitoring teams must review and approve all standards and measures to ensure that they are both: 1) achievable, and 2) capable of being monitored with available resources.

The following section provides exact wording that can be used to write the success standards for almost any project. Following the descriptions you will find the Menu (Table 1) which matches performance objectives and standards with monitoring methods and contingencies. The monitoring methods and contingencies are not developed in detail in this document. To write the performance standards for your project, choose from these options or use them as models to develop others. The steps are:

1) Work through the Objectives Filter on page12 to develop a short list of performance objectives.

2) Find each performance objective in the Menu. Select any required standard of success for that performance objective. You may also select one or more optional standards as needed.

3) For each standard, select one monitoring method and one or more contingencies from the Menu.

4) Use the language and benchmark values detailed below to write a standard of success that is unambiguous and achievable.

5) Follow each standard with the appropriate monitoring method and contingencies, supplying details as needed in accordance with the particular project.

Vegetation Standards

Vegetation is one of the most commonly used indicators for overall project success and for a variety of functions. Therefore, many of the standards presented here deal with parameters used to measure plant community characteristics. Although vegetation is one of the easier wetland characteristics to quantify, it can be challenging to write good success standards for vegetation. Wetlands are typically a mix of different vegetation communities, and it may not be reasonable or appropriate to apply the same standard across all communities. Differentiation of standards by community can also lead to problems, due to the complexity of data collection & analysis and the fact that plant community boundaries and characteristics change over time in these newly developing wetlands. Use the simplest approach possible, and be prepared to justify the reasons if proposing a more complex set of standards.

When dealing with success of the vegetative portion of a project, several factors are frequently of interest. The most common considerations are percent survival of planted individuals, areal cover by herbaceous plants and woody plants, species diversity, presence of particular desirable species, and absence of undesirable species. Sometimes the success of the project is linked to the exact implementation of the written plan without allowing for natural influences. Although a viable option when trying to establish a particular priority species, this approach can make success very difficult and costly to achieve. Some mortality of planted material and some colonization by volunteers must be expected. If the soil, hydrology, or other environmental parameters of a site are not suitable for one or more of the specified plants it may be impossible to achieve success. Attempts to micro-manage the species assemblage will require a substantial commitment of resources for replanting and weed control. This may be counter-productive to achieving the desired functions - think carefully about the consequences of not achieving your agreed-upon standards. Don't set yourself up for failure.

Tier 1 Success Standards - (Use these for most projects)

S1 - Wetland hydrology:

The wetland will be saturated to the surface or ponded for at least 30 consecutive days between March 1 and October 31 in years when rainfall meets or exceeds the 30-year average[2].

S2 - Size of wetland area:

The wetland will be a minimum of ___ acres after ___ years.

S3 - Herbaceous cover:

By year ___, the ___ (*wetland/buffer/emergent zone/etc.*) will have a minimum of ___ % vegetative cover in the herbaceous layer[3,4,5] excluding areas designated as non-vegetated (e.g. open water).

Suggested benchmark values (use lower cover standards for slow-growing species; decreasing cover over time in scrub-shrub or forested areas):

Year	% cover
3	80
5	90

S4 - Survival of planted individuals:

There will be a minimum of ___ % survival of planted individuals after year ___ (*use only for the first 2 or 3 years after planting*).

---

2 In western Washington, the 30-day duration meets the 12.5% minimum criterion of the 1987 Corps Delineation Manual.

3 Year 1 is the first growing season after site planting is completed; year 2 is the second growing season, etc.

4 Use caution when designating standards for herbaceous cover in areas planted with dense woody vegetation. Ground cover will be mostly shaded out after a few years.

5 Consideration of native vs exotic species discussed under separate standards.

If you want to ensure presence of all planted species, include the following:

For each species planted, a minimum of ___% of the individuals will survive.

Caution - monitoring for individual survival requires stem counts and is not feasible for ground-covering or multi-stemmed species including many herbaceous species. Survival monitoring is most often used to determine contractor's fulfillment of planting obligation during the plant establishment period in the first year or two after planting.

S5 - Woody cover:

By year ___ (*3 or later*) the ___ (*wetland/buffer/forested zone/etc.*) will have a minimum of ___ % areal cover by woody vegetation (excluding areas designated as open water, emergent vegetation, or non-vegetated).

Suggested benchmark values:

Year	% cover
5	50

S6 - Control of invasives:
(to be revised)

___ (*species or category, e.g. non- native grasses*) will comprise no more than X% of the relative cover (adjusted to 100%) of the ___ (*wetland/buffer/etc.*) at year ___.

Note: If this standard is used, it is important to name particular species of concern. Also, remember to consider the initial ground cover treatment and follow-up management approach to be used. It may be useful to use non-native groundcovers during early site development if aggressive invasives such as reed canarygrass are a threat. Set a standard that can be achieved.

Tier 2 Success Standards - (Use these for project-specific special circumstances)

Most wetland functions cannot be measured easily (if at all) in a manner that allows them to be monitored directly. Instead, indicators are most often used to support the supposition that a particular function will be provided by a wetland if certain characteristics are present. The following success standards should be used sparingly. Several are listed in order to cover the wide range of possible performance objectives that may be used in mitigation planning. However, each standard should be used only as needed to verify establishment of a site characteristic that must be present in order for the site to provide a particular function.

Typical functions that may be related to these attributes are listed in italic print following each of these standards.

S7 - Size of any specified area:
wildlife habitat, amount of various functions

The ___ (*buffer/open water/forested wetland/etc*.) area will be at least ___ acres after ___ years.

S8 - Relative presence of wetland classes:
wildlife habitat

___ (*PEM/PSS/PFO/etc.*) will comprise no less than ___ % of the total wetland area after ___ years. (Vegetation may not meet exact Cowardin cover and height criteria until more mature, but appropriate species should be present.)

Caution - set percentages significantly lower than what is planned to allow for some flexibility.

S9 - Plant species diversity:
biodiversity

After ___ years, the ___ (*wetland/buffer/etc*.) will have at least ___ native plant species with a minimum of ___ (*1/5/10/etc.*) % cover each.

S10 - Slope
water quality functions

Slope (in the ___ zone) will not exceed ___ X%

Measurement of this attribute should be done one time only, immediately after grading and before planting.

S11 - Aquatic invertebrate diversity:
fish or wildlife habitat, food chain support

The minimum diversity index for ___ (*benthic, water column)* invertebrates will be ___.

S12- Aquatic invertebrate taxa presence:
fish or wildlife habitat

The following invertebrate taxa will be present in the wetland at sufficient numbers to be detected by the sampling protocol described in the monitoring section: ___

Note: Quantitative measures of invertebrates , such as density, may be very difficult to do accurately. Also, identification of species and, in some cases families, requires specialized skills that normally require contracting with a laboratory. Avoid using these as success standards unless necessary; when needed, be sure you know what monitoring and analytical methods will be required.

S13 - Area and depth of open water:
wildlife habitat, nutrient & pollutant retention

The area of open water (unvegetated or with submergent vegetation only) at least ___ ft deep will be no less than ___ acres during the period ___ (*specify a time of year, e.g. May 1 - June 30, or entire year depending on desired function)*

S14 - Surface water depth and duration:
nutrient & pollutant retention, fish or wildlife habitat

The deepest portion of the ___ (*wetland/emergent/pond/etc.*) area will be ponded with depths ranging from ___ inches to ___ inches during the period ___ (*e.g. April through June*) in years of average rainfall. (Depth may be greater or less than the given range during abnormally wet or dry periods.)

S15 - Channelized water flow:
base flow support, fish habitat

Stream flow will be at least ___ cfs during (*spring/all months/etc.*) in years when rainfall meets or exceeds the 30-year average.

S16 - Water temperature:
fish habitat

Measured mid-day summer water temperature will not exceed ___ degrees F.

Note: If water temperature is expected to be controlled by shading, don't apply standard until vegetation has had sufficient time to develop.

S17 - Water chemistry:
may be important in areas receiving stormwater runoff

(Several possible - nutrients, BOD, phosphorous, etc.)

S18 - Presence of ___ (miscellaneous design features)
wildlife or fish habitat, miscellaneous

Example: There will be 3 standing snags in the mitigation area after 5 years.

Write this standard in terms of presence or absence of particular design features, e.g. wildlife habitat structures, gradual slope, outlet elevation, etc. The presence or absence (and quantity, if relevant) will be documented by as-built plans and confirmed through visual observation.

S19 - Presence of ___ (amphibians, waterfowl, shorebirds, spotted frogs, etc.):
wildlife or fish presence

At least ___ individual ___ (*group or species*) will utilize the site during year ___.

Note - this is included for those rare cases when use of the site by a particular wildlife species or type is critical to the goals, and therefore success, of the project. Use this type of standard with caution. See Example #3 above.

Monitoring Methods

It is beyond the scope of this discussion to describe monitoring methods in detail. The WSDOT monitoring protocols are currently under revision; when that project is finished, the set of methods mentioned here will undoubtedly change. For purposes of this discussion, general descriptions are used to indicate the type of method likely to be employed.

Monitoring methods may require a variety of skills and special equipment to be performed accurately. Before selecting performance objectives and success standards, it is important to consider the capabilities of the monitoring staff, equipment needs, and costs. The methods referenced in the Toolbox are:

Area determinations:

M1 - Wetland delineation & survey (traditional or GPS)
M2 - Plant community mapping & survey (traditional or GPS)
M3 - Estimation from aerial photos

Vegetation:

M4 - Stem counts
M5 - Areal cover (quadrat sampling)
M6 - Areal cover (line intercept sampling)
M7 - Areal cover (belt transect or large area plot sampling)
M8 - Species inventory

Note - Because wetland vegetation varies widely, both in structure and development rates, success standards should be directed at specific vegetation community types within a given site (PFO, PSS, PEM). Success standards should clearly state that cover requirements reference the community type that is supporting the measured vegetation (i.e. emergent plant areal cover shall exceed 80% <u>in the emergent zone</u> by the site's fifth year of development). During monitoring, the location of the vegetation community types can be determined from the site plans, and data can be recorded with reference to community type. Division of collected data by vegetation community type will allow for the greatest efficiency in the application of monitoring data to success standards. It will also give clear indications of which community(ies) of the site is/are not developing as expected. Since vegetation on mitigation sites may develop differently than intended, this will also provide a comparison of the permitted plans and what has developed over time.

Wildlife:

M9 - Wildlife census for target groups (e.g. birds, amphibians, etc.)
M10 - Invertebrate census

Soil

M11 - Soil texture
M12 - Soil chemistry (including organic content)

Water:

M13 - Stream flow measurement
M14 - Water depth measurement (periodic or using max/min gage)
M15 - Water table or soil saturation determination (test holes or monitoring wells)
M16 - Water temperature measurement
M17 - Water chemistry measures (dissolved oxygen, pH, etc.)

Miscellaneous:

M18 - Documentation with as-built plans, visual observations, and informal mapping
M19 - Photographic record

Contingency Measures

When a standard of success is not met, some kind of remedial action may be needed. For that reason, some thought needs to be given to potential contingencies for some of the most common causes of failure.

However, you need to ensure that flexibility is not lost. Sometimes a standard is not met by the specified time but evidence suggests it will be met given more time. In those cases, it is almost always better to wait the extra time rather than invoke an expensive and disruptive contingency plan. Also, the science and art of wetland restoration are always evolving. Recognized standards and measures are constantly being refined, and our ideas may have changed significantly during the several years between the time a permit is obtained and the time the standard is supposed to be met. One overriding contingency should be included in every mitigation plan and should apply, as needed, to every standard of success:

C-0: Consult wetland experts (and permitting agencies if applicable) to determine an appropriate course of action.

Other contingencies include:

C-1: Plant additional vegetation

This is the most common contingency plan utilized for wetland mitigation projects. Replanting is most often used to remedy failures to meet cover or plant survival standards. But use caution: if plantings have failed it is likely that some underlying problem (e.g. too much or too little water) is at fault. Replanting without addressing the root cause is likely to result in another failure.

C-2: Weed control

This is a necessary contingency if you have a standard of success that limits the cover of invasive species on the site. Also, when plant survival or diversity standards are not being met, weed control may be needed. Specify the control method(s) which may be used.

C-3: Substrate amendment

If vegetation or invertebrate populations are not responding as expected, it may be necessary to add organic matter, structural components, or specific nutrients to the soil.

C-4: Modify water inlet/outlet controls

Inlet and outlet elevation control structures may be modified in order to adjust the maximum and minimum water depths.

C-5: Supplement surface water inputs

If the site does not have sufficient water supply, surface water may need to be diverted from a nearby stream or stormwater system. If such supplemental sources are not available, you may need to implement some drastic remedial measures such as C6 or C7 below.

C-6: Decrease soil permeability

Fine sediments may be added or subsoil could be compacted to decrease soil permeability and increase water retention time. This is best used very early after site construction in order to avoid the need to replant.

C-7: Grading revision

In groundwater-driven systems, site elevations may need to be adjusted in order to achieve specified water depths across the site. Grading may also be required to slow surface water sheet flow across the site or adjust stream dynamics of channelized systems.

C-8: Erosion control

If surface water drainage channels develop, additional planting might be adequate to control this. Or, erosion-control matting (e.g. biodegradable fiber mats) or physical controls (rock, hay bales) may be installed as an interim measure. The ultimate goal should be to have erosion controlled by an appropriate combination of reduced slope and increased vegetation density.

C-9: Access control

Fencing, blocking vehicle access points, and other measures can be employed to prevent vandalism, dumping of trash, and other impacts caused by humans or domestic animals. Planting a boundary of dense thorny shrubs may provide both access control and wildlife habitat.

C-10: Herbivore control

If revegetation is failing due to herbivory, the wildlife responsible need to be identified and appropriate damage control methods employed. Possible methods include goose fencing (using stakes and string), use of repellents, relocation of beaver, and temporary barriers.

C-11: Pretreat inflowing surface water

If monitoring indicates that water quality standards are not being met, it may be possible to add pre-treatment ponds or swales.

C-12: Replace or repair missing or damaged structures

This contingency may be used in case of loss or damage to inlet or outlet control structures, habitat structures, and other physical features installed on the site.

The Toolbox

For each performance objective of a mitigation plan, there are one or more appropriate success standards, monitoring methods, and contingency plans. Table 1 presents the most commonly used performance objectives and success standards for wetland projects in the Pacific Northwest. Select performance objectives for your project by following the guidelines starting on page 8. Then, for each selected performance objective, choose one (or more if necessary) of the listed success standards. Table 2 lists monitoring methods and contingencies for each standard. Choose one or more of each. Success standards and contingencies are described in more detail in the previous text, starting on page 16.

DON'T GET CARRIED AWAY! Remember the purpose of stating performance objectives and success standards: you want to evaluate the success of your project. Usually it takes only a few performance objectives to adequately do this.

Table 1. Suggested success standards for wetland mitigation performance objectives. This list is not comprehensive; other standards may be appropriate for each of the performance objectives. Those standards which are *italicized* may apply in some cases but usually are not be as closely related to the performance objective as the others listed.

Primary (Tier 1) Performance Objectives
These are objectives related to the size and fundamental attributes of a mitigation site. S1 - Wetland hydrology S2 - Size of wetland area S3 - Herbaceous cover S4 - Survival of planted individuals S5 - Woody cover <u>Also:</u> *S6 - Control of invasives*
Secondary (Tier 2) Performance Objectives
Provide habitat for______ **Specify target group such as anadromous fish, amphibians, waterfowl, shorebirds, raptors, etc.** ***or*** **a particular species.** Target species or assemblages that are reasonable for the location and connectivity of the site. Consider breeding, migrating, wintering, feeding, and resting habitat for each life stage. Do your homework to determine what site features are necessary! S3 - Herbaceous cover S5 - Woody cover S7 - Size of any specified area S8 - Relative presence of wetland classes S13 - Area and depth of open water S14 - Surface water depth and duration S18 - Presence of ___ (miscellaneous design features)

There are many design elements that may be important habitat features. Possibilities include structural diversity (vertical and horizontal), perch poles, brush piles, logs, islands, or bird houses.

Also:
S1 - Size of wetland area
S4 - Survival of planted individuals
S11 - Aquatic invertebrate diversity
S15 - Channelized water flow
S16 - Water temperature
S17 - Water chemistry
S19 - Presence of ___ (amphibians, waterfowl, shorebirds, etc.)

Provide food chain support for ____ (specify target groups)

S3 - Herbaceous cover (for target species or groups)
S12 - Invertebrate taxa presence

Also:
S4 - Survival of planted individuals (for target species or groups)
S5 - Woody cover (for target species or groups)
S9 - Plant species diversity
S16 - Water temperature
S17 - Water chemistry
S18 - Presence of ___ (miscellaneous design features)
S19 - Presence of ___ (waterfowl, small mammals, etc.)

Provide vegetation species diversity

S6 - Control of invasives
S9 - Plant species diversity

Also:
S3 - Herbaceous cover
S4 - Survival of planted species
S5 - Woody cover

Provide sediment trapping

S3 - Herbaceous cover (for target species or groups)
S10 - Slope
S14 - Surface water depth and duration

Provide nutrient & pollutant removal & transformation

S3 - Herbaceous cover (for target species or groups)

S10 - Slope
S14 - Surface water depth and duration

Also:
S13 - Area and depth of open water

Provide floodwater storage and conveyance

S2 - Size of wetland area

Also:
S18 - Presence of ___ (miscellaneous design features)

Provide flood velocity attenuation

S5 - Woody cover

Also:
S3 - Herbaceous cover (for target species or groups)
S4 - Survival of planted species
S18 - Presence of ___ (miscellaneous design features)

Provide erosion control

S3 - Herbaceous cover (for target species or groups)

Also (may be required for erosion control in some cases):
S5 - Woody cover

Provide shoreline stabilization

S3 - Herbaceous cover
S5 - Woody cover (for target species or groups)

Table 2. Possible monitoring methods and contingencies for given success standards. This list is not comprehensive; other methods and contingencies may be appropriate for each of the standards.

Standard of Success	Monitoring Method	Contingency
S1 - Wetland hydrology	M15 - Soil saturation determination (test holes or monitoring wells)	C-4: Modify water inlet/outlet controls C-5: Supplement surface water inputs C-6: Decrease soil permeability
S2 - Size of wetland area	M1 - Wetland delineation & survey M3 - Estimation from aerial photos	C-1: Plant additional vegetation C-4: Modify water inlet/outlet controls C-5: Supplement surface water inputs C-6: Decrease soil permeability C-7: Grading revision
S3 - Herbaceous cover	M5 - Areal cover (quadrat sampling)	C-1: Plant additional vegetation C-3: Substrate amendment C-4: Modify water inlet/outlet controls C-10: Herbivore control
S4 - Survival of planted individuals	M4 - Stem counts M8 - Species inventory	C-1: Plant additional vegetation C-2: Weed control C-3: Substrate amendment C-4: Modify water inlet/outlet controls C-10: Herbivore control
S5 - Woody cover	M6 - Areal cover (line intercept sampling) M7 - Areal cover (belt transect or large area plot sampling)	C-1: Plant additional vegetation C-2: Weed control C-3: Substrate amendment C-4: Modify water inlet/outlet controls C-10: Herbivore control
S6 - Control of invasives	M5 - Areal cover (quadrat sampling) M18 - Documentation with as-built plans, visual observations, and informal mapping	C-1: Plant additional vegetation C-2: Weed control
S7 - Size of any specified area	M2 - Plant community mapping & survey M3 - Estimation from aerial photos	C-1: Plant additional vegetation C-4: Modify water inlet/outlet controls C-5: Supplement surface water inputs
S8 - Relative presence of wetland classes	M2 - Plant community mapping & survey M3 - Estimation from aerial photos M18 - Documentation with as-built plans, visual observations, and informal mapping	C-1: Plant additional vegetation C-4: Modify water inlet/outlet controls C-5: Supplement surface water inputs C-7: Grading revision
S9 - Plant species diversity	M8 - Species inventory	C-1: Plant additional vegetation C-2: Weed control C-7: Grading revision C-10: Herbivore control
S10 - Slope	M18 - Documentation with as-	C-7: Grading revision

	built plans	
S11 - Aquatic invertebrate diversity	M10 - Invertebrate census	C-3: Substrate amendment C-11: Pretreat inflowing surface water
S12 - Aquatic invertebrate taxa presence	M10- Invertebrate census	C-3: Substrate amendment C-11: Pretreat inflowing surface water
S13 - Area and depth of open water	M2 - Plant community mapping & survey M3 - Estimation from aerial photos	C-4: Modify water inlet/outlet controls C-5: Supplement surface water inputs C-6: Decrease soil permeability C-7: Grading revision
S14 - Surface water depth and duration	M14 - Water depth measurement (periodic or using max/min gage)	C-4: Modify water inlet/outlet controls C-5: Supplement surface water inputs C-7: Grading revision
S15 - Channelized water flow	M13 - Stream flow measurement	C-7: Grading revision C-5: Supplement surface water inputs
S16 - Water temperature	M16 - Water temperature measurement	C-1: Plant additional vegetation
S17 - Water chemistry	M17 - Water chemistry measures (dissolved oxygen, pH, etc.)	C-11: Pretreat inflowing surface water
S18 - Presence of ___ (miscellaneous design features)	M18 - Documentation with as-built plans, visual observations, and informal mapping M19 - Photographic record	C-12: Replace or repair missing or damaged structures
S19 - Presence of ___ (amphibians, waterfowl, etc.)	M8 - Species inventory M9 - Wildlife census	C-9: Access control C-11: Pretreat inflowing surface water

References

Alternative Mitigation Work Group. 1999. Alternative Mitigation Policy Guidance. Cooperative effort of WA Dept. of Ecology, WA Dept. of Transportation, and WA Dept. of Fish and Wildlife.

Azous, Amanda L., Mason B. Bowles, Klaus O. Richter. 1998. Reference standards and project performance standards for the establishment of depressional flow-through wetlands in the Puget Sound lowlands of western Washington . King County Grant No. G9700017.

Gildersleeve, R.P. Jr, Douglas, J. Williams, D.J. Cooper. 1989. Two urban stream reconstruction and wetland restoration/creation projects in Aurora, Colorado. In: Wetlands concerns and successes, D.W. Fisk, Editor. American Water Res. Assoc. Tech. Pub. Ser. TPS-89-3.

Hammer, Donald A. 1992. Creating freshwater wetlands. Lewis Publishers Inc. Chelsea Mich. 298 pp.

Horner, R.R., and Raedeke. 1989. Guide for wetland mitigation project monitoring. Monitoring Guide - Operational Draft WA-RD 195.1. Washington State Department of Transportation, Olympia, Washington. 265 pp.

Hruby, Thomas and Cyd Brower. 1994. Guidelines for developing freshwater wetlands mitigation plans and proposals. U.S. Army Corps of Engineers. Publication No. 94-29.

Kunze, Linda M. 1994. Preliminary classification of native, low elevation, freshwater wetland vegetation in western Washington. Washington State Department of Natural Resources, Olympia, Washington.

Magee, T.K., S.E. Gwin, R.G. Gibson, C.C. Holland, J.E. Honea, P.W. Shaffer, J.C. Sifneos, and M.E. Kentula. 1993. Research plan and methods manual for the Oregon Wetlands Study. Document production by K. Miller. EPA/600/R-93/072. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR. 173 pp.

Marble, Anne D. 1990. A guide to wetland functional design. Technical Report No. FHWA-IP-90-010. Federal Highway Administration. 230 pp.

Meeks, R. L. 1969. The effect of drawdown date on wetland plant succession. Journal of Wildlife Mgt 33(4): 818-821.

Mitsch, W.J. and J. G. Gosselink. 1993. Wetlands - 2nd ed. Van Nostrand Reinhold. New York. 722 pp.

Perkins, John, Ralph Murphy, Lou Ellyn Jones, Ron Pratt, and Meredith Savage. 1996. Forging the links: the report of a policy study on created wetlands for the Washington State Department of Transportation. Research report WA-RD 433.1.

Pierce, Gary J. 1993. Planning hydrology for constructed wetlands. Wetland Training Institute, Inc., Poolesville, MD. WTI 93-2.

Stevens, Michelle L. and Ron Vanbianchi. 1993. Restoring wetlands in Washington. Washington State Dept. of Ecology Publication No. 93-17.

Turner-Fairbank Highway Research Center. 1990. A guide to wetland and functional design. Federal Highway Administration Report No. FHWA - IP - 90 - 010.

U.S. Army Corps of Engineers, Waterways Experiment Station. 1987. Wetland Evaluation Technique. U.S. Army Corps of Engineers, Federal Highway Administration. FHWA -IP-88-029.

Washington State Department of Ecology. 1993. Washington state wetlands rating system - Western Washington - 2nd edition. Publication No. 93-74.

Washington State Department of Ecology. 1991. Washington state wetlands rating system for eastern Washington. Washington State Department of Ecology Publication #91-58.

Weiher, E., I.C. Wicheri, P.A. Keddy, & D.R.J. Moore. 1996. Establishment, persistence and management implications of experimental wetland plant communities. Wetlands 16 (2): 208-18.

Winston, R.B. 1997. Problems associated with reliably designing groundwater dominated constructed wetlands. Wetland Journal 9(1): 21-25.

Zentner, John. 1997. Soil considerations in riparian restoration. Restoration and Management Notes 15(1): 56-59.