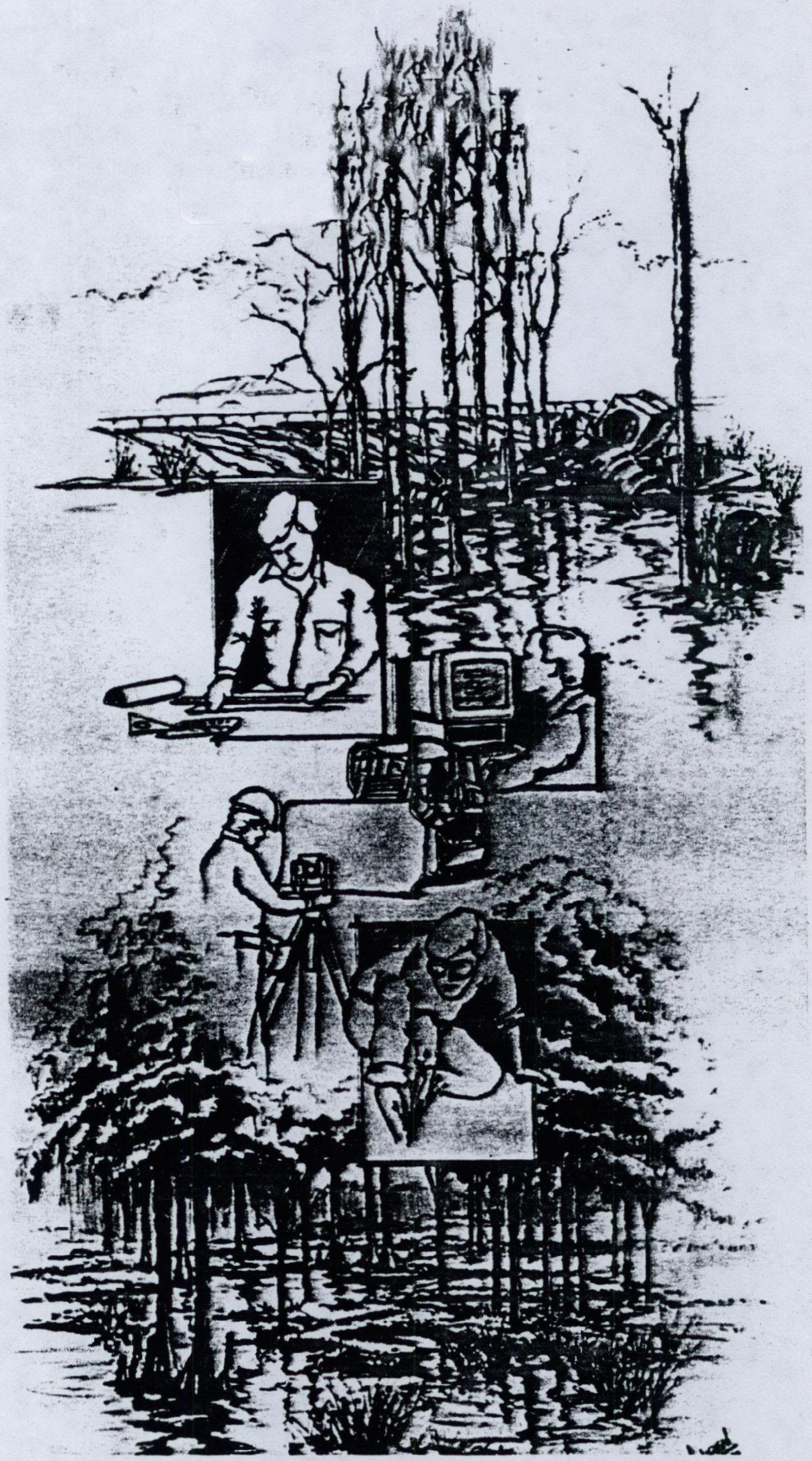
MiST

Mitigation Site Type Classification



A Methodology To Classify Pre-Project Mitigation Sites And Develop Performance Standards For Construction And Restoration Of Forested Wetlands:

Results of an EPA-Sponsored Workshop
Falls Creek State Resort Park • Pikeville, Tennessee •August 13-15, 1989

MiST:

A METHODOLOGY TO CLASSIFY PRE-PROJECT MITIGATION SITES AND DEVELOP PERFORMANCE STANDARDS FOR CONSTRUCTION AND RESTORATION OF FORESTED WETLANDS:

Results of an EPA-sponsored Workshop

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PREFACE

The goals of the Clean Water Act (CWA) are to protect and maintain the chemical, physical, and biological integrity of the nation's waters. The Environmental Protection Agency (EPA) and Army Corps of Engineers are given regulatory authority for the discharge of dredged or fill material into waters of the United States. Section 404 of the CWA has become the primary mechanism for the protection of wetlands by Federal authorities. While "no net loss" of wetlands - an interim goal of a stable national wetlands inventory in terms of acreage and function - has been identified by some groups as a top national priority (The Conservation Foundation, 1988), there remains the fundamental technical challenge of restoring or creating new wetland resources to offset inevitable or unavoidable losses that will continue to occur.

Lack of standardization has led to inconsistencies in the evaluation of mitigation plans by state and federal agencies across EPA Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee). EPA Region IV and the Tennessee Valley Authority approached the North Carolina State Hardwood Research Cooperative (HRC) to conduct a workshop to address these problems. The Workshop on BLH Forest Mitigation of Disturbed Sites was held at the Fall Creek Falls State Resort Park near Pikeville, Tennessee on August 13 - 15, 1989. The summaries of the deliberations of this Workshop and subsequent review are contained in this document.

HRC proposed that consistency in the evaluation of mitigation plans could be reached by developing a framework to classify pre-construction mitigation sites. The classification system would be used to objectively sort out the range of potential options available to monitor the success of mitigation projects. This framework could also serve to enhance communication throughout the Region. Consequently, a prototype classification system was developed by the HRC and presented to Workshop participants which they adopted and refined.

The end result of the Workshop is the *Mi*tigation *S*ite *T*ype Classification System (*MiST*). A decision was made early in the Workshop to expand the initial focus from BLH systems to a more regional approach encompassing all freshwater forested wetlands. The classification system is contained within this document.

MiST is composed of three parts including 1) the classification of mitigation sites; 2) the statements of performance standards for sites undergoing mitigation and; 3) the measurements required to evaluate mitigation performance. Performance is tied to a Reference Forest Ecosystem.

A fundamental assumption of *MiST* is that the potential for success (or, conversely, risk of failure) in forested wetland replacements is related to pre-replacement site conditions. Importantly, *MiST* requires a monitoring program of all forested wetland mitigations and monitoring intensity is related to the original site condition (perceived risk of failure).

While the goals of the Workshop were to address concerns related specifically to Section 404, an additional benefit of *MiST* is the potential for its use outside of regulatory programs.

Classification of mitigation sites and development of performance standards and monitored characteristics can lead to better restoration of lands currently under consideration for conversion to forested wetland ecosystems through the Conservation Reserve Program. Thus, *MiST* can also assist in an increase in the quality and quantity of the nation's wetland resource. Nevertheless, while *MiST* can assist in the evaluation of mitigation plans contingent to 404 permitting, it is not intended to supercede avoidance policies.

This document currently should be regarded as a DRAFT for use by Region IV EPA and interested parties including other federal and state agencies and forested wetland mitigators. It should not be considered an official EPA publication at this time. The editors welcome comments and criticisms of the *MiST* classification system and suggestions for its refinement.

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PART I

EPA PERSPECTIVES

MITIGATION OF BLH WETLANDS AND THE SECTION 404 PERMIT PROGRAM: EPA PERSPECTIVES

William Ainslie and William L. Kruczynski

INTRODUCTION

The growing realization of the importance of wetland habitats, and the fact that over one-half of our nation's wetlands have been lost, has resulted in several developments providing increased protection to our remaining wetland resources. In 1987, at the request of EPA, the Conservation Foundation convened the National Wetlands Policy Forum (NWPF) The goal of the NWPF was to take a broad view of how this nation can better protect and manage the remaining wetland resources. In response to the Forum's Final Report, the Agency has initiated an action plan with a goal of no net loss of wetlands. President George Bush has been quoted to be in direct support of this goal.

Development of wetland areas has been regulated at the national level since 1972 under Section 404 of the Clean Water Act. Section 404 requires a permit be issued before any fill material is placed in wetlands. The apparent dilemma of how a permitting program can remain in effect while achieving a goal of "no net wetland loss" has been approached by mitigating unavoidable wetland losses through wetland creation. However, there have been inconsistencies within the Agency in assessing the status of proposed mitigation sites and in the criteria used to evaluate mitigation projects and proposals. In addition, EPA

Region IV has expressed a need to develop standardized criteria to evaluate the success of permitted mitigation projects. It is Region IV's policy to only allow replacement mitigation for wetland communities in which replacement mitigation is proven possible.

The National Workshop on Bottomland Hardwood Mitigation of Disturbed Lands was convened to address these problems for BLH wetland communities. This Workshop evolved through discussions between EPA Region IV and the Tennessee Valley Authority (TVA). An interagency agreement between TVA and EPA utilized TVA's cooperative agreement with North Carolina State University's Hardwood Research Cooperative (NCSU-HRC) to organize and facilitate the Workshop because of their research expertise in BLH wetland functions and creation and their knowledge of industry and development impacts on forest habitats.

SECTION 404 - A HISTORICAL PERSPECTIVE

The goal of the Clean Water Act (CWA) is to "restore and maintain the chemical, physical and biological integrity of the Nation's waters." Section 404 of the CWA is the primary Federal wetlands statute and requires receipt of a permit for placement of dredged or fill material into waters of the United States of which wetlands are a subset. Discharges are allowed after receipt of a Corps of Engineers (COE) permit if these discharges are not restricted by EPA pursuant to its veto authority under Section 404(c) of the Act.

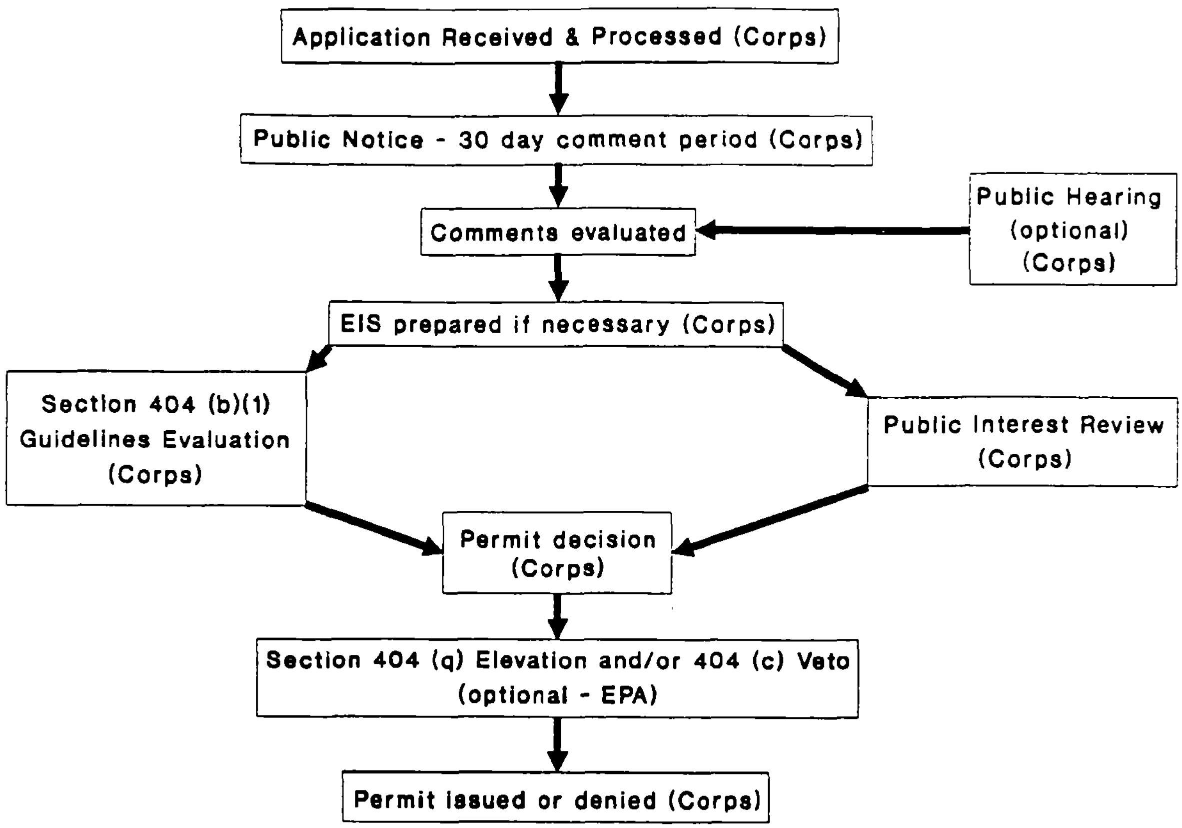
The Section 404 Permitting Process

The Section 404 permit review process is summarized in Figure 1. Applicants submit a permit application to the COE. Applications are advertised in public notices which are distributed for review. The public and resource agencies (EPA, U.S. Fish and Wildlife Service, National Marine Fisheries Service, State regulatory agencies) provide comments to the COE concerning potential environmental effects of the proposed project. The COE determines whether a public hearing and/or an Environmental Impact Statement is required to evaluate potential environmental impacts. Finally, the COE makes a determination whether it is in the public's interest to issue a permit.

If the COE District Engineer serves a notice of its intent to issue a permit for a project which Federal resource agencies have determined would result in unacceptable environmental impacts, agencies can elevate that decision to higher authority for review as specified in Memoranda of Agreement between the COE and resource agencies (Section 404(q)). In addition, EPA can veto a permit or predesignate areas as unsuitable for receipt of fill material under its authority given in Section 404(c). However, that option is not exercised frequently because it is very labor intensive and may be highly political.

The Regulatory Reform Task Force targeted the Section 404 program for reform in 1980 which resulted in new 404(q) Memoranda of Agreement which gave the COE the sole authority to determine whether a project could receive elevated review and at what level

Figure 1. Generalized Section 404 Permit Process

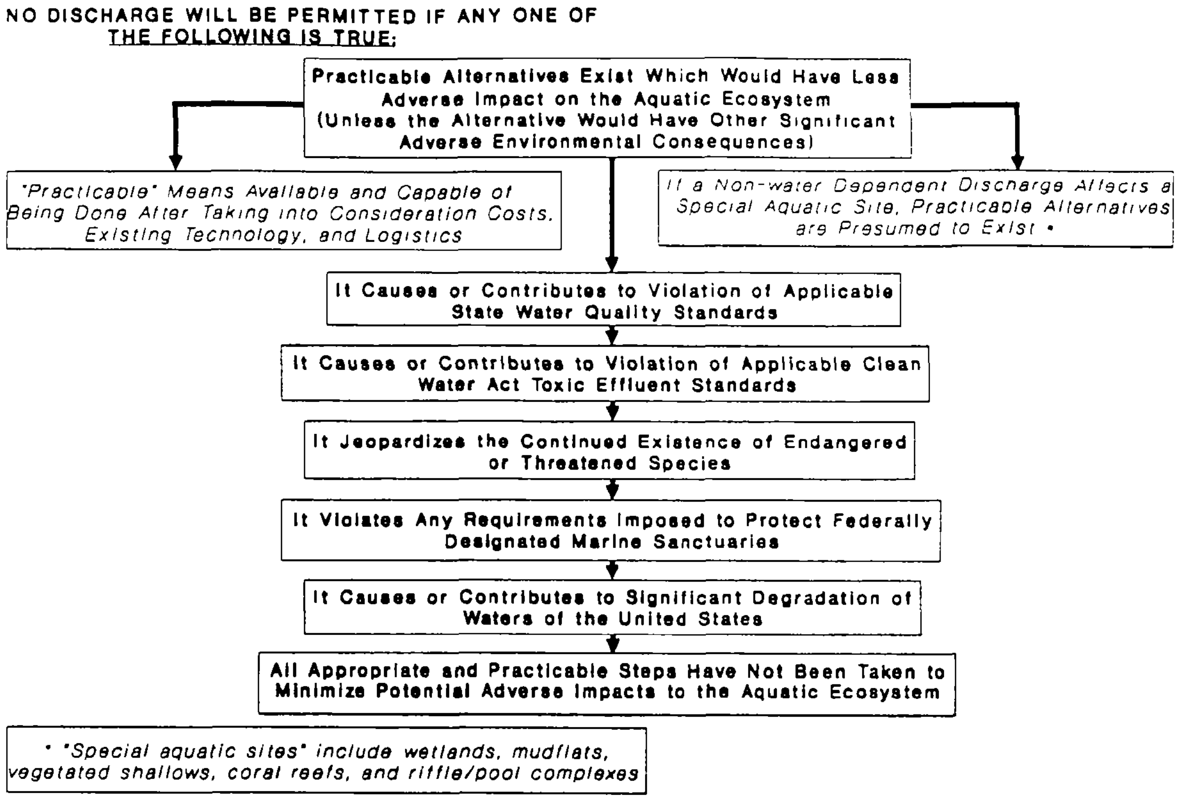


the review would take. This development, and a reluctance by EPA to exercise its Section 404(c) veto, resulted in Region IV increasing the number of recommendations that included wetlands creation mitigation in exchange for wetland losses, even when wetland losses were avoidable.

Section 404(b)(1) Guidelines

Section 404(a) states that the COE shall administer the permitting program. Section 404(b) requires that EPA, in conjunction with the COE, will develop guidelines by which permit applications are reviewed. The Section 404(b)(1) Guidelines are summarized in Figure 2 (40CRF230). There are four "Guidelines"

Figure 2. Generalized Section 404 (b) (1) Guidelines Evaluation Process



and EPA has adopted a policy that these guidelines should be evaluated sequentially; failure to satisfy any one of the four steps should result in denial of the permit application.

Guideline 1 (33CFR230.1(a)) requires that no discharge of dredged or fill material into waters of the United States shall be permitted if there is a practicable alternative which would result in less environmentally damaging impacts. For non-water dependent projects, the regulations establish a rebuttable presumption that such alternatives exist. The "alternatives test" is the threshold which must be satisfied before a Section 404 permit is issued. "Practicable" takes cost, distance, technology, purpose, and logistics into consideration.

Guideline 2 (33CFR230.1(b)) states that no permit should be granted if it causes or contributes to a violation of any applicable state water quality standard, toxic effluent standard, jeopardizes an endangered species or habitat, or impacts a marine sanctuary. If this requirement is met, the next step is to determine whether the discharge will result in significant degradation of waters of the United States (Guideline 3) (33CFR230.1(c)). This includes ecological degradation, degradation to fishery resources or aquatic ecosystems, human health or welfare.

If Guidelines 1 through 3 are met, the final step in the Section 404(b)(1) analysis is that no discharge will be permitted unless efforts have been made to minimize potential adverse impacts (Guideline 4, 33CFR 230.1(d)). This is the step in the process where replacement mitigation has been used to replace habitat values lost due to filling activities.

History of Wetlands Mitigation

Although the word "mitigation" does not appear in the CWA and has not appeared in any Section 404 regulations until the latest issue of the Corps Regulations (1986, 33CFR320.4(r)), mitigation has been used in the permitting process since the inception of the program in an attempt to minimize wetland losses. One meaning of "mitigation" is to reduce adverse impacts (Figure 3). If a project is reduced in size or modified to the point where the impacts have been reduced so that there is no significant

Figure 3. Council on Environmental Quality Mitigation Types (40 CFR Part 1508.20 a-e)

1. Avoiding the impact altogether by not taking a certain action or parts of an action.
2. Minimizing impacts by limiting the degree of magnitude of an action and its implementation.
3. Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
5. Compensating for the impact by replacing or providing substitute resources or environments.

degradation (Guideline 3), then a project is determined to be acceptable.

The Federal government has struggled since the inception of the program in 1972 with the role of wetland creation/replacement mitigation in the Section 404 permitting process. Many times issuance of a permit was considered for projects which reviewing agencies considered nonpermittable, but agencies did not have the ability to stop permit issuance. Consequently, the agencies sought to compensate for wetland losses through replacement mitigation. This approach seemed to work and some resources were returned for wetlands that were lost through filling. However, many wetlands that were lost were highly valuable, and many times the promised mitigation was never performed or did not work. Also, many of the permitted activities did not conform to Guideline 1, i.e. there *were* practicable alternatives which would have avoided wetland impacts. This practice of considering replacing wetland losses for any project became the standard procedure in permit review during the period of regulatory reform.

<u>Section 404 Today</u>

Seventeen years after the inception of the program, regulators are still wrestling with the role of mitigation in Section 404. The advent of "no net loss", as recommended by the NWPF and supported by President Bush, has resulted in closer scrutiny of the alternatives analysis (Guideline 1) by the Corps, EPA, and other resource agencies.

President Bush has been quoted as saying "All wetlands, no matter how small, should be preserved." Such a goal precludes a permitting program; if every wetland is to be preserved, no permits can be issued for filling of wetlands. Given the current Federal law, which does not preserve wetlands but regulates filling activities, regulators are viewing the President's statement as a goal consistent with the goal of the NWPF, i.e., no net wetland loss. For permitted wetland fills, compensatory replacement mitigation must be included to achieve no net wetland loss.

At the national level, the COE and EPA have drafted an interagency mitigation policy; however, basic philosophic differences in the role of mitigation in the Section 404(b) review must be resolved before a joint policy is finalized. The difference in opinion between the agencies on the role of mitigation in the alternatives analysis resulted in EPA's Section 404(c) veto of a COE permit in the Attleboro Mall case. It is EPA's position that replacement mitigation should not be part of the alternatives analysis. Practicable alternatives include sites or methods or project modifications which would result in less environmental damage. It does not include replacement of losses through creation. Some COE Districts, however, continue to opine that the promise of replacement of wetlands is a less environmentally damaging alternative than a project without mitigation. This issue must be resolved at the national level.

EPA Region IV has adopted the position that if a project conforms to the Section 404(b)(1) Guidelines, mitigation of wetland losses may be an acceptable option to replace losses. Replacement mitigation is an acceptable option in cases where the impacts to wetlands are not significant enough to warrant permit denial. Compensatory mitigation could be included as a special condition to a COE permit for projects where there are no less environmentally damaging alternatives (Guideline 1), no statute is violated (Guideline 2), the impacts have been minimized (Guideline 4) and have been determined to be not significant

(Guideline 3) or could be rendered insignificant with replacement mitigation.

EPA Region IV has adopted a policy that projects which conform to the Section 404(b) Guidelines and whose impacts can be made insignificant through proven compensatory replacement mitigation techniques will perform the mitigation at an acceptable credit ratio dependent upon the mitigation type. These ratios are summarized in Figure 4 and are presented as guidance to assure standardization of the mitigation requirement among permit reviewers and agencies. Exchange and preservation ratios should be determined on a case-by-case basis. The definitions of these mitigation options are given below.

MITIGATION OF FORESTED WETLAND SYSTEMS

History

The word mitigation was first defined in the regulatory context in the 1977 regulations of the National Environmental Policy Act (NEPA). Mitigation means to "moderate the intensity or to lessen the impacts" of a particular project. NEPA lists five different ways in which impacts can be mitigated (Figure 3), including impact avoidance (1), minimizing the impacts (2), and compensating for losses (5) through restoration and replacement.

Figure 4. Mitigation credit ratios.

Mitigation Type	*Acres mitigated : acres filled ratio*
Restoration	1.5 : 1 or 1 : 1, if upfront
Creation	2 : 1 or 1 : 1, if upfront
Enhancement	3 : 1 or 2 : 1, if upfront
Exchange	case by case basis
Preservation	case by case basis

Types of Mitigation

EPA recently completed a report entitled "Wetland Creation and Restoration: The Status of the Science" (Kusler and Kentula 1990). This report provides some standardization of the mitigation process including an analysis of where mitigation fits into the Section 404(b) review processs. In addition, it define project types where mitigation is an acceptable option, what kinds of and with what assurance communities can be replaced, and what criteria are used to judge the success of a mitigation project.

The mitigation options which are discussed in the EPA document are listed in Figure 5. It is important for regulatory

Figure 5. Options with compensatory mitigation

Types	
Restoration	former wetland, no or few functions
Creation	made from a different community
Enhancement	increases certain wetland functions
Exchange	enhancement to the extreme; hard to evaluate
Preservation	use only if area is not regulated
Timing	
Up-front (before)	most prudent; require if unknowns exist
Concurrent	encouraged for typical projects
After	discouraged
Location	
On-site	same watershed or ecosystem
Off-site	different watershed
Community	
In kind	same species composition
Out of kind	different species composition

activities to have standardized definitions of mitigation options. Restoration is defined as converting a former wetland, which is currently performing few wetland functions, to its previous capabilities. For example, a degraded wetland with little or no habitat value could be restored through re-establishing the hydroperiod and/or vegetation to their former condition.

Creation converts a non-jurisdictional community into a wetland community. Scraping down an upland area to bottomland elevations could result in a created wetland. Surface mining operations generally alter the site so completely that wetland replacement on mined land would almost always be considered creation even though a wetland may have once occupied the site.

Enhancement is performed as a result of a management decision. Enhancement results in improving some wetland functions often at the expense of other functions. For example, a typical enhancement project would convert an historically impounded marsh into a tidal area by breaking the dikes. This would result in reconnecting the wetland to tidal waters. However, this enhancement may result in reduced duck or wading bird habitat provided by the impoundment. In this case, a management decision was made to allow export of productivity to fisheries in adjacent waters instead of utilization within the impoundment by wading birds.

Exchange is enhancement taken to the extreme; it is converting one wetland type into another type. For example, deposition of dredged material in open shallow water may result in marsh creation in exchange for an open water community. Determining whether an ecological benefit has occurred in such a circumstance is difficult since the two systems are judged by different criteria.

Preservation is another compensatory mitigation option which EPA feels should be considered only under special circumstances following careful and extensive consideration of all available options. Preservation results in the maintenance of wetland functions in an existing tract to compensate for on-site project disturbances. The preserved land may be on-site or off-site and is usually donated to an organization such as the Audubon Society and/or a local or state resource agency. This is an approach which is frequently proposed by applicants with substantial resources and may be viewed by some as purchasing a permit. Since the ethical nature of this approach is questionable at best, preservation should be used only in very unusual circumstances and usually in combination with different mitigation options. For example, preservation may be used to compensate for the time that created or restored wetlands become fully functional.

Mitigation Options

Additional mitigation options which must be considered in the permit review process are listed in Figure 5. Mitigation can be accomplished up-front (i.e. before the impact), concurrent, or after the impact has occurred. An applicant should get more "credit" if a constructed wetland system is in place before the impacts occur. Concurrent mitigation should be encouraged for typical mitigation projects so that it is part of the permit review process and not a "tag-on project." After-the-fact mitigation should be discouraged since recent studies show that it may not be performed or may be performed poorly once the development project is completed.

Another mitigation option includes the location of the constructed wetland ecosystem. On-site mitigation is defined in the EPA manual as "within the watershed" and should be encouraged since it ensures that the replacement wetland is situated in the same ecosystem as the one which is removed through filling. Off-site mitigation is within a different watershed and should only be acceptable in unusual circumstances.

Different community types could be established during mitigation projects. In-kind mitigation should be encouraged since it replaces the same community type which was lost. Out-of-kind mitigation may be an acceptable option in circumstance where it is not feasible or desirable to replace the same community type. For example, it may be determined that the habitat function of an ecosystem could be improved by replacing a common habitat type with a different habitat type.

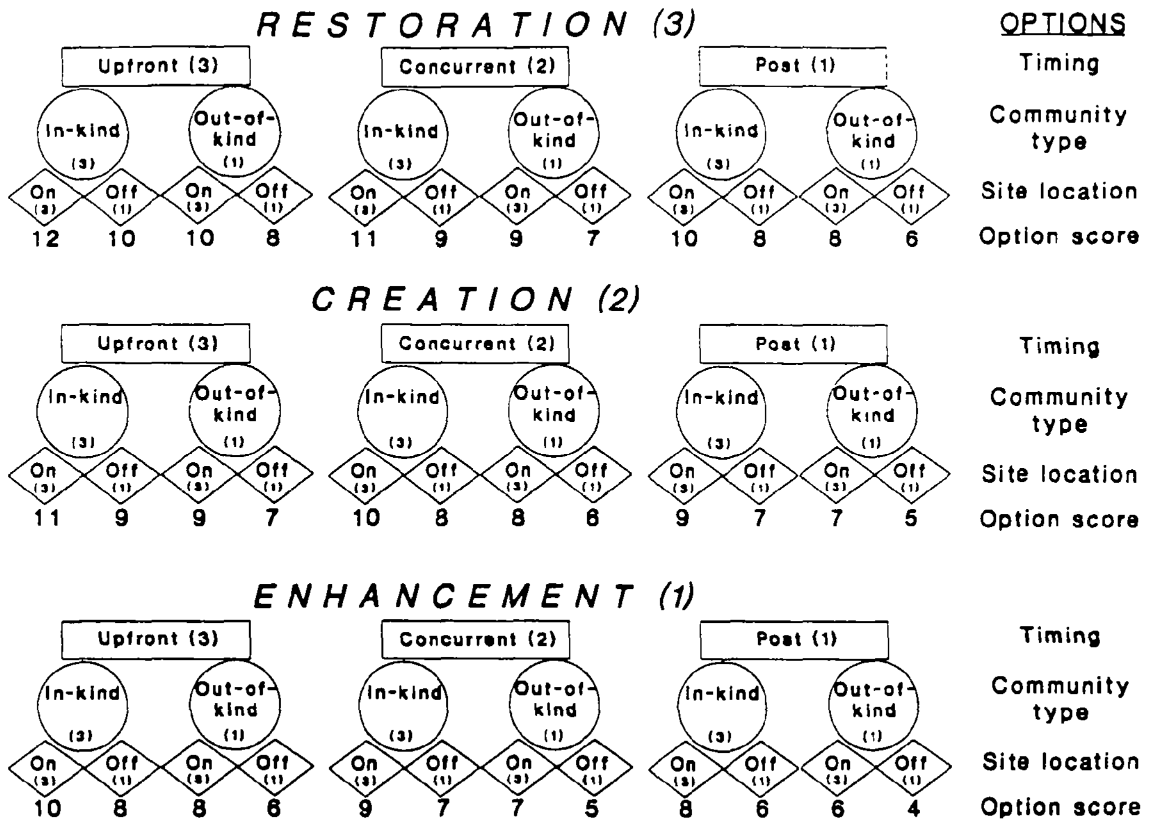
Ranking of Mitigation Options

The EPA mitigation report presents framework in which mitigation options can be evaluated through development of a mitigation matrix (Figure 6). This matrix can be used to help standardize the decision making process in evaluating a wide range of potential mitigation options.

The ranking of options given in the matrix is the result of weighting the different mitigation options. For example, restoration (3) is ranked higher than other options since more credit is given to restoring a degraded wetland to full function than creating (2) a wetland from a functional uplands or enhancing (1) an existing wetland.

By assigning values to other mitigation options, one can compare the different mitigation projects by summing the values

Figure 6. Ranking of mitigation options.



for the options. Thus, restoring, upfront, in-kind and on-site is rated the best mitigation option given in Figure 6 since that combination receives a value of 12 based upon the suggested weighting of options. Conversely, creating, after-the-fact, out-of-kind, off-site wetlands would only receive a value of 5.

Regulators could use such a decision matrix to determine whether a proposed mitigation project could be permitted by setting an acceptable level of mitigation combinations. For example, if the acceptance value is set at 9 in the proposed weighting, mitigation options which yield a value of 9 or greater could be approved for the project. This also allows some flexibility in options available to the developer. Thus, acceptable compensation for filling of a *Spartina* marsh could be accomplished through creation of upfront, in-kind, and on-site (11). However, the applicant could not create, concurrently, an out-of-kind wetland, off-site (6). This means that creation of one acre of cypress swamp would not be an acceptable replacement for one acre of *Spartina* marsh given the weighting system used in this example.

CONCLUSIONS

Region IV is particularly interested in forested wetland restoration because of mining activities in the west Kentucky coalfields. Two valuable resources are in direct opposition in this area: wetlands and coal. The inability to replace forested wetlands on some disturbed lands has led EPA to seek help in providing technical guidance to the regulatory and industrial communities on how to best restore forested wetlands to full functional capacity. Some of the problems which EPA has encountered in the coalfields are overburden removal, the swell factor, restoration of hydrology, and soil reconstruction. A general problem has been a general lack of detailed, long range mining plans and conceptual restoration plans by the mining companies.

There is a need in Region IV for establishment of test plots to demonstrate that forested wetlands can be restored on various types of disturbed lands. Replacement mitigation can only be considered a valid part of the permit process if it is proven to be possible in test plots. These attempts at replacing forested wetland areas must be documented to record successful and modify unsuccessful techniques. The prolonged nature and lack of monitoring of BLH restoration/creation projects makes the establishment of functioning forested wetland systems questionable and regulatory agencies leery of allowing destruction of naturally functioning wetlands for unproven mitigation.

Thus, a major reason for this Workshop is to establish the criteria and performance standards to use in the evaluation of mitigation test plots and mitigation proposals and to develop standardized criteria to be used to evaluate the success of created forested wetlands. In addition, it is hoped that some needs which are identified at the Workshop can be pursued by the research community to facilitate forested wetland mitigation. Finally, this Workshop is a vehicle for development of communication between regulatory, industry, and research communities to exchange information on ecological and economic parameters which must be factored into every permit decision. Increased information and knowledge will provide greater understanding of the difficulty and complexity involved in forested wetland mitigation and may provide for greater agreement and amicability in the management of the wetland resource.

PART II

WORKSHOP CHARGES

WORKSHOP CHARGES

No net loss and increases in the quantity and quality of the nation's wetland resource has been identified by the National Wetlands Policy Forum as top short and long-term national priorities (The Conservation Foundation, 1988). Avoidance policies of regulatory agencies serve to limit disturbances on functional forested wetland ecosystems and contribute to the realization of the no net loss policy. However, this approach alone will not result in increases in the quality and quantity of forested wetland ecosystems. This goal can only be accomplished through restoration ecology in conjunction with numerous subdisciplines. Mitigation can play a key role in the effort.

Replacement of ecosystem structure, particularly the vegetation component, is currently accomplished by mitigators. Unresolved is the extent to which desired functional attributes are achieved in the process of establishing ecosystem structure. Some functions have been defined for forested wetland ecosystems under different categories: hydrology, vegetation, wildlife, soils, fisheries, and ecosystem processes (Roelle, et al., 1987, Table 1). In the development of mitigation applications, an accounting of ecosystem processes will be necessary to ensure functioning forested wetlands are replaced.

Table 1. Some functions of forested wetland ecosystems (Roelle, *et al.*, 1987c)

HYDROLOGY

1. Flood control (storage and desynchronization).
2. Ground water recharge.
3. Ground water discharge.

VEGETATION

4. Primary productivity.
5. Timber harvest.

WILDLIFE

6. Provision of food, cover, and other life requisites both on and off site.
7. Recreation associated with wildlife.

SOILS

8. Sediment trapping.
9. Erosion control.

FISHERIES

10. Provision of food, cover, and other life requisites both on and off site.
11. Recreation associated with fisheries.

ECOSYSTEM PROCESSES

12. Inputs, outputs, and processing of nutrients, and/or carbon contaminants.
13. Water quality maintenance.

Charges to Workshop Participants

Workshop participants were given three charges. For the purposes of addressing Charge I, Workshop participants were divided into three Workgroups: Vegetation, Soils, and Hydrology. During consideration of Charges II and III, participants were redistributed into two additional Workgroups: Water Quality and Habitat. Consequently, some individuals will appear as co-authors for more than one Working Group paper.

Charge I: Development of a Site Classification for Forested Wetland Mitigation Projects

A conceptual framework was developed by which to classify the attributes of sites to be used for forested wetland mitigation. Such a framework was requested to facilitate communication between mitigators, regulatory agencies, and forested wetland researchers. This classification system was based on the condition of vegetation, soils, and hydrology on the proposed forested wetland mitigation site. Each class of disturbance represents an incremental change in impact to the functions delivered by forested wetlands. Thus, while the disturbance class of vegetation, soils, and hydrology was based on measurable field characteristics, each class also correlates as nearly as possible to a specific level of functional change to the ecosystem. A suggested framework was offered by the N.C. State University Hardwood Research Cooperative for the consideration of Workshop participants who adopted the concept and refined its contents during the Charge I phase of the Workshop.

Disturbance classification factors, while indicating the potential for forested wetland ecosystem establishment, also directly mesh with current characteristics agreed upon in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation, 1989). Consequently, adoption of these factors for classification of mitigation sites will enable regulators and mitigators to more quickly adapt their current delineation efforts to include classification of forested wetland mitigation project sites.

Working groups were requested to accept or reject the suggested classification framework as it related to their particular working group area and, if rejected, to develop more appropriate classification divisions. As a minimum, participants were requested to evaluate the classification with regard to its relevance to forested wetland function, its field thresholds, its broad-scale applicability and its ease of use.

Charge II: Development of Performance Standards

Before lists of monitored characteristics could be developed, definitions of the parameters by which successful forested wetland mitigation will be measured were needed. The second charge to Workshop participants was: Develop the basis upon which a given forested wetland mitigation will be deemed successful, i.e., define the goals toward which all forested wetland mitigations should strive. Each Working Group (Vegetation, Soils, Hydrology, Water Quality, and Habitat) evaluated this charge as it related to their specific expertise.

Charge III: Development of Monitoring Lists

The condition of the functions on a proposed forested wetland mitigation site correlates with the complexity of post-mitigation parameters to be monitored. The third charge to Workshop participants was to develop sets of measurable field characteristics for tracking the relative effectiveness of a mitigation plan. These characteristics represented, as nearly as possible, indicators of forested wetland developmental progress.

Each set of field measurements was developed for a given disturbance status found on the pre-mitigation landscape. For example, pre-project sites with considerable soil disturbances (Class III) might require more post-mitigation soil characteristics to be monitored for longer periods than pre-project sites with less soil disturbances (Class I). In addition to monitored features for vegetation, soil, and hydrology, characteristics for habitat and water quality functions were also developed. The latter two factors were included in post-project monitoring requirements because, along with vegetation, they represent measures of ecosystem restoration success that the ecosystem driving factors of soil and hydrology can not. Also, it avoided the practical problem of artificially trying to separate hydrology and water quality.

Participants were requested to base the requirement of each characteristic and its level of post-project performance upon the best available information at the time of the Workshop. Supportive information from refereed journals were given highest priority in this regard. Nevertheless, owing to the relatively high level of uncertainty associated with developing success criteria, this set of characteristics was viewed as a first approximation derived through group consensus; updating will occur as these levels are verified through research.

PART III

SUMMARIES OF WORKING GROUP DELIBERATIONS

1. VEGETATION WORKING GROUP

Andre Clewell (Chair), Russell Lea, William Harms, Clark Ashby, Russell Theriot, Don Walker, Ronnie Haynes, D. Thompson Tew (Recorder)

The *MiST* classification system for vegetation was adopted by consensus of the working group for use at pre-project forested wetland mitigation sites. This classification is presented in Table 1. It is easy to apply and it will characterize a broad range of project site types for mitigation purposes. The system quantifies the degree of disturbance for sites, both wetland and non-wetland, that are candidates for forested wetland mitigation projects.

This classification system compares the vegetation on a proposed mitigation site with that of a reference forest ecosystem (RFE, see Glossary). Description of the RFE will require a careful definition for each proposed project. In its simplest form, the RFE could be a particular wetland or forested wetland from which exotic and weedy species were ignored in the floristic inventory. In other cases, the vegetative component of the RFE could be *synthesized* from regional ecosystem descriptions in the literature. In any case, particular care must be taken to exclude species from the RFE that represent habitat types that are not targeted for restoration. For example, the RFE should not include deep tupelo swamp species, if the mitigation site is to be inundated only briefly each year.

Use of a RFE is chosen in lieu of mandating a specific "reference wetland" for two reasons: First, virtually all candidate reference wetlands have suffered at least some relatively recent disturbance, and forested wetland restoration

Table 1. *MiST* Classification for Vegetation.

CLASS	DEFINITION
0	Site has an overstory and understory species composition and physiognomy similar to the Reference Forest Ecosystem (RFE-see glossary).
1	Loss, relative to the RFE, of up to 50% of the: a) tree canopy, and/or b) canopy tree species composition, and/or c) undergrowth cover, and/or d) undergrowth species composition.
2	Loss, relative to the RFE, of more than 50% of the: a) tree canopy, and/or b) canopy tree species composition, and/or c) undergrowth cover, and/or d) undergrowth species composition.
3	Originally the project site was not sufficiently populated with hydrophytic vegetation to be delineated as a wetland or the forested wetland ecosystem was entirely removed prior to mitigation.

projects generally should not aim at emulating disturbances. Second, careful study of mature, relatively undisturbed wetlands often reveals considerable intra-stand variation in species composition and dominance, owing to subtle habitat differences and to the play of stochastic events in seral processes (Clewell and Lea, 1989). The selection of one reference wetland over another, therefore, is not justified ecologically. Consequently, the RFE will provide a more satisfactory target for calibrating project success.

The distinction between the reference wetland and the RFE approaches is exemplified in those instances where a reference wetland is dominated by an undesirable escaped exotic species.

The mitigation site will usually serve a greater public interest, if returned to a forested wetland stand lacking that exotic species.

MiST vegetation classes 1 and 2 are based on the degree of loss in both the canopy and the undergrowth in terms of cover and of species composition, as related to the RFE. Percent cover and species composition are parameters, which represent the broad structural components of forested wetland vegetation. Fifty percent loss (relative to the RFE) is used as a separation point to allow for ease of classification and to facilitate communication on the degree of disturbance. These classes also reflect the relative amount of time required for natural regeneration to rehabilitate a proposed project site.

As an example of how the classification would be applied, suppose a forest has been disturbed by the selective harvest of black walnut (*Juglans nigra*). When compared to a RFE which has a black walnut component, this vegetational condition would represent class 1, because it suffered a loss in tree species composition. Even if some walnut remained standing, the site would still represent class 1, because of loss of canopy cover. As another example, suppose an uncut forest has been subjected to heavy grazing by cattle. This forest would be classified as class 2 (if loss of undergrowth cover exceeded 50%) or class 1 (if less than 50%). Grazing may have caused a replacement of the original flora of the undergrowth by weeds. Even though there may be considerable weedy cover, the site would be classified as class 2 (not class 1) because of the loss of more than 50% of the species in the undergrowth, relative to the RFE.

The addition of class 3 to the *MiST* classification for vegetation allows for projects that lack on-site propagule sources to attain adequate revegetation by species typical of the RFE.

Charge II: Definition of Performance Standards.

Performance standards describe the minimum thresholds of acceptable vegetational recovery at mitigation sites. Performance standards are attained when the mitigated forested wetland project sites contain:

1) An approved composition of canopy and undergrowth species typical of the RFE and represented by self-sustaining populations.
2) An approved tree abundance in terms of density and spatial distribution throughout the project site.
3) Well established trees, that is, trees that have been rooted at the mitigation site long enough to survive the normal gamut of extremes in environmental conditions.

It is incumbent upon those responsible for developing and approving the restoration plan to determine to what degree, if any, that natural regeneration will lead to the prompt attainment of performance standards. Some restoration may be accomplished passively merely by protecting the project site, so that natural processes can proceed. Many projects, though, will require out-planting of nursery stock or other active measures.

Charge III: Specific MiST Vegetation Performance Standards

The following standards should be attained before the mitigation project is ready for release from regulatory liability:

1) A mean density of 400 trees per acre (TPA) are growing at the project site consisting of preferred, potential canopy species, which are at least 6 feet tall and which have been established on site for at least 24 months.

2) At least 400 TPA, regardless of height and duration of establishment, grow on every acre-sized parcel within the project site.

3) Included among the canopy tree species are certain key species (dominants, characteristic species, etc., to be approved in advance), each of which is present at a minimum density of 10 TPA.

4) At least some plants of selected woody and herbaceous undergrowth species will have been growing at the project site for at least 12 months prior to project release. The number of species shall be approved before mitigation activities begin and will include at least 10 percent of the preferred undergrowth species of the RFE.

5) Nuisance species will cover less than 10 percent of the project area at the time of release. To the greatest extent possible, potential nuisance species should be identified in advance, and their populations should be controlled at a level sufficiently low as to be non-threatening to the prompt release of the project.

Certain species with characteristically slow growth (e.g., cabbage palms, *Sabal palmetto*) may be allowed to meet the density standard as long as their terminal buds are elevated above the soil. This height requirement waiver is subject to the approval of the regulatory authority.

Exclusions of specific project acreage for determining tree density may be approved at the discretion of the regulatory agency, based on (1) non-anthropogenic physical habitat restrictions (e.g., naturally unproductive habitats, or seasonal sloughs where tree densities are normally low); (2) forest type considerations (e.g., cypress rings or cane breaks that normally have low tree densities); or (3) management considerations (e.g., intended future use of the site for wildlife species that require semi-open forest). Exclusions other than these examples may also be considered with regulatory authority approval.

Monitoring is required in order to determine whether or not the restored vegetation at a project site has attained the requisite levels of performance. Table 2 outlines the kinds of monitoring needed. The intensity of monitoring is dependent upon the vegetation class (Table 1), prior to the commencement of restoration activities.

Assessment methods should be approved prior to the onset of replacement activities. A report containing monitoring data should be submitted to the permitting agency immediately following each assessment.

Table 2. Monitoring Required for *MiST* Vegetation Performance Standards Assessment.

TREE CRITERIA: 400 TPA overall 6+ feet tall, 400 TPA on every acre, and approved species present at 10 TPA.	
CLASS 1:	Determine if all criteria are met at the end of the 2nd year. (Assumes no tree planting was necessary.)
CLASS 2:	a) Initially, assess potential for natural recovery. If adequate potential, determine if all criteria are met at the end of the 2nd year. If inadequate potential, then prepare & implement plan for tree planting. b) Oversee tree planting, if any. c) If trees were planted, determine their survival following the first growing season. d) If trees were planted, determine their species densities and heights following subsequent growing seasons.
CLASS 3:	a) Oversee tree planting. b) Determine planted tree survival following the first growing season. c) Determine planted tree species densities and heights following subsequent growing seasons.
UNDERGROWTH AND NUISANCE SPECIES CRITERIA: 10% of RFE represented, and <10% nuisance species present.	
CLASS 1:	Determine if undergrowth and nuisance species criteria were met after the 2nd year using approved sampling methods.
CLASS 2:	Prepare lists of all preferred undergrowth species and all nuisance species annually on a per acre basis using approved sampling methods.
CLASS 3:	Prepare lists of all preferred undergrowth species and all nuisance species annually on a per acre basis using approved sampling methods.

2. SOILS WORKING GROUP

Jack Nawrot (Chair), Ellis Clairain, David Cobb, Wayne Davis, Jeff Furness, Charles Hooks, Glenn Kelley, Steve Mader, Jim Sandusky, Thomas Welborn, Dennis Mengel (Recorder)

The goal of the Soils Working Group was to recognize the value of mitigation guidelines, but to avoid the regulatory pitfalls of site-specific performance criteria. The *MiST* Soil classification treats the soil as a physical substrate for establishment of the desired forested wetland type. *MiST* soil classifications emphasize physical disruptions of the soil profile that can adversely affect the ability of the proposed mitigation site to support the desired forested wetland type or RFE. The proposed soil condition classification system does not emphasize macro- or micronutrient conditions, or short-term organic matter (litter layer) development processes. These conditions and processes are site-specific or dependent on natural, short-term disturbances and, thus, not appropriate for a Region-wide classification system.

Table 1 presents the *MiST* classification system for project site soils. There are four classes ranging from sites free of anthropogenic disturbance (Class 0) to complete disruption of the original soil (Class 4). Increasing class level implies a higher degree of difficulty in mitigating the site, i.e., Class 4 will require more inputs than Class 2.

Table 1. *MiST* Soil classification system.

CLASS	CONDITION
0	Soils are undisturbed by other than natural means.
1	Disturbance limited to the top 12 inches of the soil[1] (e.g., clearing, plowing, significant changes to site hydrology) and/or loss of up to 50% of the top 12 inches of the existing soil.
2	1) Disturbance within the top 12 inches with loss of greater than 50% of the top 12 inches of the existing soil, AND/OR, 2) Compaction that has been identified affecting the rooting zone at a degree greater than the reference soil. The significance of the size of area affected should be determined on an on-site basis.
3	Reconstructed soil (e.g., mining - soil horizon replacement).
4	1) Loss of soil profile to a depth greater than 12 inches, OR, 2) Loss of the original subsoil structure, OR, 3) new soils developed from materials other than original mineral soil.

[1] Twelve inches was chosen because the majority of the root related activity in forested ecosystems occurs in the top 12 inches of the soil surface.

Charge II: Development of Success Criteria

The following statement defines successful soil mitigation of the site:

A soil will be considered acceptable from a restoration viewpoint if it has the physical and chemical properties that are necessary for the successful re-establishment of the desired reference forest ecosystem. At a minimum, the soil will contain hydric characteristics as listed in the definitions of the Federal Wetland Delineation Manual (1989).

The intent of the above statement is to define what needs to be accomplished, not how to accomplish it.

Two sites will be involved in the mitigation project, the RFE and the proposed mitigation site. These two areas may be at the same (on-site mitigation) or separate (off-site mitigation) locations.

The RFE will be characterized to obtain baseline data of the undisturbed soil condition. These baseline data will be used as the criteria against which the restored soil will be compared.

Monitoring the mitigation site will take place in two phases, an initial and a restoration / reclamation phase. The initial phase will establish a baseline characterization of the project site landscape prior to forested wetland mitigation. Soil physical and chemical conditions deemed necessary for successful vegetation establishment will be measured and physical or chemical conditions (e.g., toxicity), that require amelioration will be identified. The restoration / reclamation phase will consist of annual monitoring to document short-term trends and indication of long-term success.

Charge III: MiST Soil Success Parameters

To achieve the above objectives, specific variables need to be measured in the monitoring process. Table 2 presents the minimum set of variables that need to be measured on the RFE and mitigation sites. The measurements are divided into two groups: physical and chemical. The chemical group is further divided into potential phytotoxic/micronutrients and macronutrients subgroups. Each group or subgroup is designated by a letter code

Table 2. Chemical and physical factors to be measured on the reference and mitigation sites.

FACTOR	VARIABLES
<u>Physical</u>	
A	Saturated hydraulic conductivity, texture (to assess the ability to establish hydric soil conditions)
<u>Chemical</u>	
B	Potential phytotoxic/micronutrient conditions
	pH, pyritic sulphur, neutralization potential, Al, Cu, Zn, B, Mn, base saturation, conductivity, redox potential
C	Macronutrients
	N, P, K, organic C

in the Tables. Table 3 relates these codes to the frequency of measurement on each site by *MiST* soil class. Table 3 also indicates the depth of measurement of each group of variables on each site. Physical factors (Factor A) are measured as needed in the restoration/reclamation phase, because they are not likely to change over the length of the project. Only those physical factors that have been ameliorated during the restoration process will need monitoring to determine the success of the mitigation.

The intensity at which the sites are to be sampled will be based on the size of the project and the inherent heterogeneity of the specific soil-site conditions. The number of samples needed for each variable will be determined through consultation with the regulatory authority and/or soil science experts

Table 3. Measurement schedule of factors by disturbance class on the reference and mitigation sites.

	MiST SOIL CLASSES			
	I	II	III	IV
BASELINE REFERENCE FACTORS		ABC[1]		
INITIAL SITE CHARACTERIZATION[2]	ABC	ABC	ABC	ABC
RESTORATION / RECLAMATION[3]	<--------- A as needed ---------------->			
	<---- B C ----> (min. 2 years)		<------B C------> (min. 5 years)	

[1] These only apply to the reference forest ecosystem (Class 0). Factor A measured in rooting zone; B and C factors measured at 0 - 9 inches depth.

[2] Factor A to be measured in the rooting zone as defined from the reference site. Factors B and C to be measured at:
Class I, II - 0 -9 inches;
Class III - by horizon;
Class IV - by horizons or depth as determined by backfill placement technique)

[3] All factors measured as defined in 2 above on an annual basis.

conversant in hydric soils and their relationship to wetland vegetation and hydrologic characteristics.

The developed list is not exhaustive. Variables not identified in this document may be encountered and considered important on a site by site basis. Therefore, this list represents the minimum set of variables that need to be measured on a given site. Note that field and/or laboratory methodologies are not listed in this document in order to allow for regional differences in methodologies to obtain these data. However, regardless of the procedures employed for measurement, the same methods should be used when measuring specific variables on the reference and mitigation sites. For example, if pH is measured using a 1:1 soil to water ratio on the reference site, the pH should be determined on the mitigation site using the same ratio.

Detailed procedures for assessing chemical and physical parameters can be found in Page *et al.* (1982) and Klute (1986).

3. HYDROLOGY WORKING GROUP

Wade Nutter (Chair), William Ainslie, Phil O'Dell, Mark Brinson, Charles Belin, William Kruczynski, Delbert Hicks, James Allen, Donna Perison (Recorder)

Introduction

The hydrology present on a mitigation project site is the driving force of the wetland system. Hydrology is defined as the presence of hydrologic factors such as frequency, duration, seasonality, and source of inundation and/or soil saturation that result in the maintenance of a reference forest ecosystem (RFE). The hydrologic condition present on any site will dictate what type of plant community can be supported. The fact that specific hydrologic regimes are associated with different reference ecosystems, makes it necessary to integrate the evaluation of hydrologic mitigation success with the type of reference forest ecosystem that is desired.

Of the aforementioned hydrologic factors, source of inundation and/or saturation and seasonality of inundation and/or soil saturation are unique to specific RFEs. A project site with hydrologic conditions of equal magnitude to the RFE will be ranked as a Class 0 disturbance. If source and seasonality are not intact, a site will be ranked in the highest disturbance class (Class IV). Intermediate classes of hydrologic condition are determined by deviations in frequency and duration from the RFE with no departure in the crucial hydrologic factors of source and seasonality. (Table 1). For example, a mitigation site will be given a Class I disturbance if a 4 month period of inundation during the *dormant* season on the RFE is 3 months during the

Table 1. *MiST* Classification System for Hydrology.

CLASS	DISTURBANCE
Class 0	Undisturbed hydrology based on comparison with hydrologic conditions in the RFE.
Class I	A deviation in frequency and duration hydrologic conditions not greater than 25% of the RFE.
Class II	A deviation in frequency and duration of hydrologic conditions not greater than 50% of the RFE. The dominant season and source of inundation do not deviate from the RFE.
Class III	A deviation in frequency and duration of inundation greater than 50% of the RFE. The dominant season and source of inundation do not deviate from the RFE.
Class IV	A deviation in frequency and duration of inundation greater than 50% of the RFE *AND* the dominant season and source of inundation deviate from the RFE.

dormant season on the mitigation site. This would represent a deviation in a principal hydrologic condition not greater than 25% of the RFE.

Charge II: Development of Success Criteria

Both in-kind and out-of-kind mitigation efforts will be aimed at obtaining the RFE hydrologic conditions dictated in Class 0 which emphasizes the establishment of proper seasonality and source. In addition, if the vegetative, soil, and water quality conditions for success are satisfied within Class I hydrology criteria, hydrologic conditions will be considered to have been restored within the bounds of successful mitigation. The chosen

RFE is also assumed to fall *within* the bounds of a jurisdictional wetland.

The time required to produce a successful hydrologic condition is dictated in most cases by achievement of the vegetation and water quality success criteria. It is expected that between two and five years of normal climatic and hydrologic conditions may be needed to create conditions for judging success.

Charge III: Mist Hydrologic Perfomance Standards

A number of basic recommendations can be made with regard to the assessment of hydrologic success parameters. These include:

1) Because soil physical properties are important to maintenance of hydrologic conditions, those soil properties must be created/restored.

2) A techniques manual should be prepared describing fundamental methodologies for measuring/observing conditions for judging success.

3) Mitigation processes should not result in an adverse impact to the water resource (e.g., aquatic habitat in river)

Minimum monitoring by disturbance class

Tables 2 and 3 establish the minimum monitoring schedules for the hydrologic parameters of frequency, duration, seasonality and source of inundation. These schedules assume that a RFE is paired with the proposed mitigation site in a manner similar to a paired catchment.

Table 2. Measurements required for *MiST* Hydrology Performance Standards.

CLASS	MONITORED PARAMETERS
0	No monitoring is required.
I	Frequency and Duration 1) Semi-annual visual observation of site during dormant and early part of growing season 2) Follow-up visits to determine duration plus visual observation of drift lines, sediment on leaves, silt lines on trees, etc.
II	Frequency and Duration Quarterly monitoring visits coupled with a continuous recording device (combination piezometer/crest gage) with a frequency of recording not greater than seven days; couple recorded data with visual observations.
III	Frequency and Duration Monthly monitoring visits coupled with a continuous recording device.
IV	Frequency and Duration Same as Class III Seasonality and Source 1) Same as Class III

When local stream gaging data (e.g., USGS) are available and correlation of the gaging data can be made with at least one year of reference and mitigation site monitoring data, gaging station data may be substituted for on-site monitoring.

In addition to the above requirements for hydrologic monitoring, other considerations are:

1) Frequency of monitoring to determine depth of flooding or drawdown may be modified on a case by case basis dependent on the type of RFE to be mitigated (e.g., some forested wetlands have

Table 3. Frequency of monitoring of *MiST* Hydrologic Performance Standards

SUCCESS CRITERION	*MiST* HYDROLOGY CLASS 0	I	II	III	IV
Frequency	/	SA	Q	M	M
Duration	/	SA	Q	M	M
Seasonality	/	/	/	/	M
Source	/	/	/	/	M

/ - Not required
M - Monthly
Q - Quarterly
SA - 2 times/year

less variation in frequency and duration of flooding than others).

2) A minimum of one monitoring station is required. However, recognizing that instruments may fail or can be vandalized, at least two stations are recommended and must be strategically placed to represent the entire mitigated forested wetland when compared with the RFE.

3) A strong correlation of conditions at the mitigated site with the reference site shown early in the project may allow for the reduction in the frequency of monitoring if the establishment of vegetation and soils is progressing as planned. This determination should be made in conjunction with regulatory authorities.

The above plan represents the minimum instrumentation and sampling frequency to monitor mitigation. Additional instrumentation may be necessary to completely characterize the site. This may include several piezometers for manual measurements during site visits, a piezometer nest to determine vertical groundwater movement, and crest stage gauges to further characterize inundation across the site.

4. WATER QUALITY WORKING GROUP

Mark Brinson (Chair), William Kruczynski, Delbert Hicks, Don Walker, Charles Belin, Stephen Mader (Recorder)

Charge II: Develop the definition of success relative to RFE characteristics

Criteria for judging the successful achievement of acceptable water quality following mitigation are the same for all *MiST* classes (Hydrology, Soils, Vegetation). In practice, the more degraded the site, the longer is the expected time to achieve success. However, there is no *a priori* reason to alter the water quality parameters as a function of initial site condition. Monitoring of the RFE and the constructed or restored site should be approached as a paired watershed experiment. The RFE will serve as the control for establishing the levels and variability of target thresholds while the constructed/restored site will serve as the experimental treatment. Successful restoration is achieved when levels of water quality parameters approach those of the RFE. Minimally, levels should not violate state water quality (401) standards. When applicable, state-established variances for certain wetlands and classes of naturally-deviating surface waters should be accommodated during evaluation.

The permittee may choose to select more than one RFE, using average water quality values as goals. This is recommended if there is a possibility that background conditions (i.e., quality of source waters to the wetland) may change significantly within the 5-year evaluation period due to alterations in land use, point source discharges, or water flow. Also, the wide variation among natural ecosystems and the inexperience of most practitioners in recognizing realistic RFEs further argue for multiple reference sites.

Performance standards will be achieved when, for each water quality parameter, comparisons of the distributions of sampled data between the mitigation site and RFE overlap by a certain percentage. Both the methodology to determine the overlap and the percentage of overlap are to be approved by the regulatory agency. Importantly, approved overlap percentages may vary among water quality parameters.

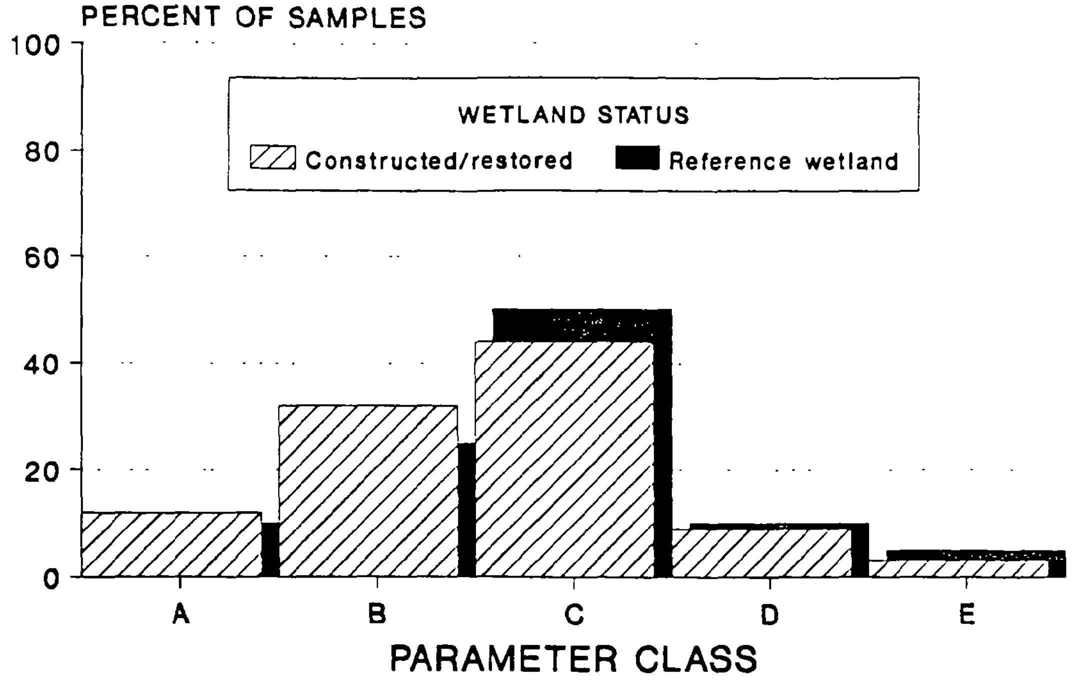
One example of methodology is the graphical analysis of paired histograms (Figures 1 and 2). Another approach is to calculate of means and standard deviations and applying appropriate statistical tests. All water quality parameters must meet its particular performance standard for the mitigation to be successful. However, it is paramount to recognize that sampling and methodological errors may preclude achieving high overlap in some cases. This should be considered by the mitigator and regulatory agency during the determination of appropriate overlap percentages.

Charge III: Develop a list of monitored characteristics within each level of project site condition.

Monitored characteristics were chosen for:

1) Simplicity: the list is short and methods of collection are straightforward.
2) Familiarity: standard procedures are available that can meet quality assurances.

Figure 1. Successful restoration of water quality parameter.



Frequency distribution of parameter for constructed/restored site overlaps ›90% of reference wetland distribution.

3) Information: the parameters provide insight into ecosystem function.

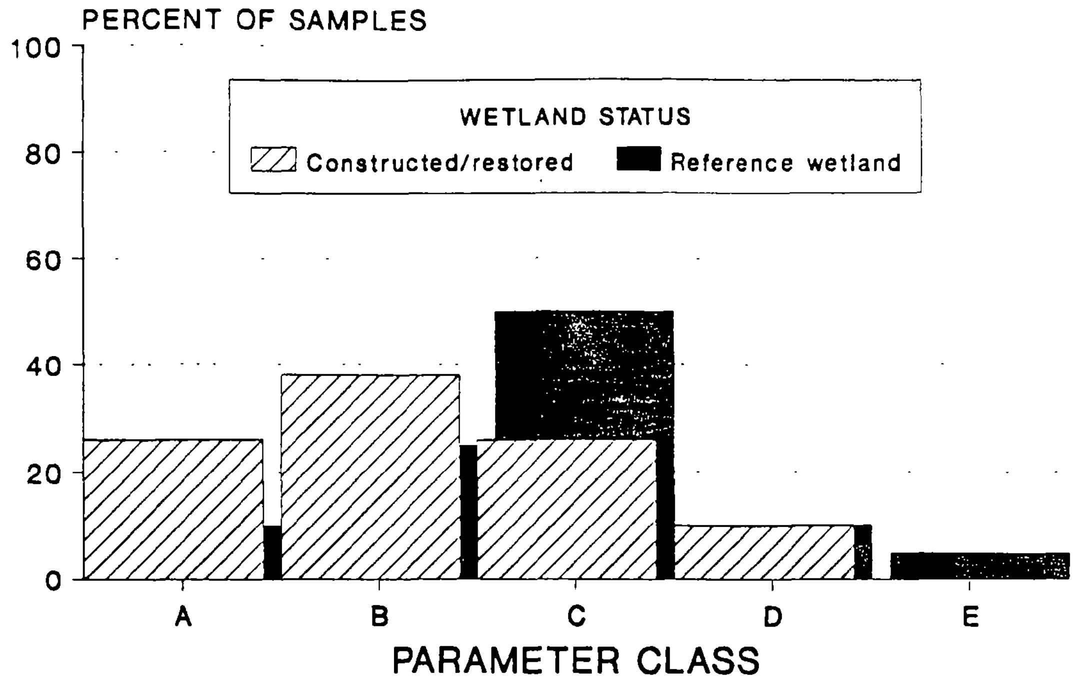
4) Cost: in large measure, these methodologies are fairly inexpensive.

The list of water quality parameters to be monitored following the execution of a mitigation plan is presented below with a brief rationale for each. Hem (1985) has provided more detailed descriptions. The types of analyses for monitoring water quality are shown in Table 1.

1) Temperature: This is needed for expressing dissolved oxygen as percent saturation.

2) Acidity, alkalinity, and electrical conductivity (surface water): These environmental properties are important to aquatic

Figure 2. Failed restoration of water quality parameter.



Frequency distribution of parameter for constructed/restored site overlaps ‹90% of reference wetland distribution.

organisms and biogeochemical processes. For example, many organisms have optimal ranges of pH values. Chemical equilibria that control the availability of phosphorus, other essential nutrients, and potentially toxic metals are pH dependent. Alkalinity is closely associated with pH because it is an index of the buffering capacity of water to resist change in pH. Conductivity is a robust index of total ion activity and total dissolved solids. Fresh water of high conductivity is less likely to create nutrient limitations to aquatic primary productivity than water of very low conductivity. Conductivity and alkalinity may be strongly correlated when calcium is the dominant cation. Depending on lithology of the area,

Table 1. Monitoring of Water Quality Parameters.

	Analyses[1,2]	Surface water	Ground water
Field:	Temperature[3]	X	
	Acidity	X	X
	Conductivity	X	X
	Dissolved oxygen[3]	X	
	Redox potential (Eh)		X[4]
Lab:	Alkalinity	X	X
	Suspended solids	X	
	TOC\ TOC/TON TON/	X	

[1]EPA quality assurance is implied. These are the minimum required; additional analyses may be added for special cases such as sites formerly occupied by mines, industry, or other intensive land-uses.

[2]The ecosystem parameters listed in this table are to be monitored for all *MiST* Classes. In the unique situation where a *MiST* Soils Classification III is determined, additional parameters judged appropriate may be added to this list of mandatory characteristics for ground water and surface water monitoring (i.e., former mine sites).

[3]Paired sites should be measured at nearly the same time of day because of anticipated diel functions.

[4]Precautions should be taken to assure that *in situ* values are not altered in the process of measurement.

conductivity may indicate the source of water masses, thus aiding in the interpretation of hydrologic functions. In cases where it is critical to know sources of water and their relative contributions, analysis of major cations and anions may be necessary.

3) Suspended solids: Suspended solids are usually derived from erosive surfaces. The amount should indicate the extent to which the wetland functions as a depositional environment and reduces suspended solids. High levels of suspended solids may be due to either a persistent source outside the system or an unstable depositional environment within the wetland.

4) TOC: Total organic carbon reflects the organic richness of the system. Watersheds with abundant wetlands and organic soils normally yield higher concentrations of TOC than those which are sparse in wetlands (Mulholland and Kuenzler 1979). Humic compounds are the major organic constituents of darkly stained waters whereas plankton production is the dominant source of organic compounds in clear waters.

5) TON: Total organic nitrogen can be used in conjunction with TOC to provide C/N ratios; such ratios in water exported from wetlands are high in "black-water" and low in water that lacks the organic staining. Wetlands that accumulate organic carbon in soils due to reducing conditions may vary greatly in absolute concentrations of TOC and TON, but the ratio between the two tends to normalize the indices by removing variation due to dilution and concentration effects.

6) Acidity, alkalinity, and electrical conductivity (ground water): The groundwater measurements of pH, alkalinity, and

conductivity yield essentially the same type of information as for surface water. The values may reflect soil chemical properties relevant to suitability for soil organisms and plant life.

7) Redox potential (Eh): Redox potential estimates the reducing status of soils/sediments on a scale that extends beyond the depletion of oxygen. It indicates the extent to which anaerobic respiration has taken place and, like pH, provides insight into the abundance, form, and activity of elements such as inorganic nitrogen, iron, sulfur, and heavy metals (Stumm and Morgan 1981).

Procedures for Sampling Water Quality Characteristics

The recommendations given below should be considered guidelines that may need to be modified extensively according to size, location, and other site-specific conditions. They are summarized below:

1. Number of samples.

   a. Minimally, sets of samples of surface water and ground water will be taken on a monthly basis for two years. Thus, at least 24 sets of samples will be obtained from the mitigation site and 24 sets will be taken simultaneously from the RFE. These data will be used in frequency analyses.

   b. If surface water is not present on either the reference ecosystem or experimental site at all desired monthly sampling times, samples will be taken until 24 surface water samples are collected. In this instance, sampling intervals will occur no shorter than monthly. If 24 samples have not been obtained within 5 years after the initiation of monitoring, a determination of success is based on the completed measurements. In this case, a trend analysis rather than frequency analysis might be more applicable.

2. Peak flows.

   Samples must include at least 4 peak flows. Peak flows are defined as maximum flow that occurs during a given stormflow event, usually expressed as cubic feet per second (cfs).

3. Sampling design.

   The sampling design will be sufficiently rigorous to characterize the reference and constructed/restored sites and physiographic heterogeniety within them (e.g., sloughs, flats, channels, discrete wetland types). Physiography affects the quality of exported water so that it may be necessary to arrange the analysis of results according to physiographic type.

4. Connectivity among sites.

   If a series of constructed/restored sites is connected, each site should be monitored separately. It should be noted that if hydrologic connectivity among sites is high, water quality values among sites are likely to be correlated. Consequently, this covariance could detract from the usefulness of related water quality performance standards of specific traits.

5. HABITAT WORKING GROUP

Ronnie Haynes (Chair), Wayne Davis, Ellis Clairain, Bob Bay, Jim Sandusky, James Allen (Recorder)

Charges II and III: Develop the definition of success relative to the reference ecosystem characteristics and develop a list of monitored characteristics within each MiST class.

Previous workshops dealt with the impacts of various activities and the assessment of functions associated with bottomland forest ecosystems (Forsythe, et al. 1987a - c). These workshops addressed the identification of criteria believed to be useful in evaluating the recovery of these ecosystems from a wildlife perspective and provided a basis for discussions within the present habitat working group.

Several conclusions can be reached about the identification and monitoring of criteria for determining the success of restoration of habitat factors associated with the establishment of freshwater forested wetland communities:

1) For activities that could result in a major loss of the freshwater forested wetland community (e.g., *MiST* classification II for vegetation or classes III or IV for hydrology), the selection and use of meaningful criteria for measuring and evaluating the performance of replaced habitat factors for species that reside in or use the ecosystem type are unclear given the typical regulatory time frames associated with permitting disturbance activities.

This conclusion was based on the fact that replacement of a mature freshwater forested wetland community, with functions and values similar to those that occurred prior to disturbance, requires a lengthy period of time. The time period required for this replacement will be influenced by many environmental factors including growth media and hydrologic conditions. Yet, regulatory permit requirements are usually specified for a period of only a few years to possibly 10 years in special demonstration cases.

2) Successful implementation of the specific mitigation measures for replacing vegetation, soils, and hydrology (as detailed in the working group reports herein) should provide reasonable and acceptable assurance that a freshwater forested wetland community similar to that which existed prior to disturbance will occur given sufficient time.

Natural regeneration produces a succession of community types over time leading to a freshwater forested wetland community. Given no intervention, the type of community eventually replaced will depend upon time, hydrologic, edaphic, and other environmental factors. Wildlife species being opportunistic, are expected to use the various habitat types over time according to their life needs (i.e., food, cover, water, etc.).

At the time when the replacement forest community resembles the habitat components found in the pre-disturbance or RFE, the wildlife species that reside in or use the replacement forest should correspond, unless habitat isolation problems or other unrecognized limiting factors exist.

Compensation measures

Although the habitat working group does not recommend monitoring of specific habitat factors for evaluating successful replacement of damaged freshwater forested wetland ecosystems within a short-term monitoring plan (i.e., 2-10 years), monitoring of key habitat factors for selected species of special interest is recommended as a compensation measure.

Compensation of habitat components lost as a result of major disturbance activities (i.e., *MiST* class II for vegetation or hydrology *MiST* class III or IV) is recommended because of the risk that a given forested wetland mitigation may not adequately achieve the performance standards set forth in this document and the potential lack of regulatory accountability given such a event.

Selected compensation measures should be developed and integrated into the mitigation plan in consultation with the state fish and wildlife agency and the U.S. Fish and Wildlife Service. The mitigation plan would address the reduction or elimination of limiting habitat factors that would occur as a result of the disturbance by 1) identifying the specific species or groups of species compensated for during the regulatory permit period and; 2) listing the specific habitat compensations needed based on the known life needs of the evaluation species.

Examples of potential compensation measures to benefit fish and wildlife are noted in Table 1. It should be noted that this list is not exhaustive. The need for compensatory wildlife measures must be project specific. Thus, some mitigations may not require any of these compensations while others would need all of them and more for the mitigation plan to be acceptable.

Habitat mitigation and monitoring will consist of three phases, two of which are required and one optional (Table 2). Identification of endangered species, preparation of species lists, etc., (i.e., most of Phase I) will often be components of

Table 1. Potential mitigation measures to benefit fish and wildlife during replacement of freshwater forested wetland ecosystems.

1. Installation and maintenance of wood duck nest boxes (Marcy 1986; Mitchell 1988).
2. Building and managing moist-soil areas for waterfowl and other species (Fredrickson and Taylor 1982).
3. Establishment of small food plots within forest areas.
4. Leaving dead snags and large trees with cavities whenever possible.
5. Leaving buffer zones along streams whenever possible.
6. Selective thinning to promote new vegetation growth.
7. Establishing brush piles for cover (Martin and Steele 1986).
8. Establishing a source of permanent water if none exists (Martin and Marcy 1989).
9. Establishing vegetative corridors between existing and replaced freshwater forested tracts.
10. Ensuring interspersion of habitat types over the total project area.

Other potential references include Mitchell and Newling (1986) and Teaford (1986).

the initial, pre-mitigation permit application process. Nevertheless, their identification will assist in developing compensation measures if the proposed disturbance is approved. Compensation measures, when needed, will be prepared according to the results of the Phase I analysis.

Table 2. Habitat Mitigation Phases

PHASE I - RFE[1] / PROPOSED IMPACT SITE ANALYSIS

A. Determine if endangered/threatened species are present.
B. Develop species lists.
C. Select evaluation species based on perceived importance, indicator status, etc.
C. Evaluate habitat quality for selected species.
D. Determine relationship of reference site to surrounding landscape (interspersion among other habitat types, total area of reference type, etc.)

PHASE II - MONITORING DURING PERMIT REGULATORY PERIOD
(Assumed to be up to 5 years, with maximum of 10)

A. Use *MiST* soils, hydrologic, and vegetation monitoring criteria as acceptable measures of long-term habitat mitigation success; assumes acceptable values for most species will be met.
B. For *MiST* Class II Vegetation and classes III or IV Hydrology, calculate habitat suitability index values[2] of selected evaluation species and community characteristics known to be important to wildlife (e.g., size of area, interspersion factors) during the following periods:
   1) One year after mitigation plan is implemented.
   2) Midway through regulatory period.
   3) Immediately prior to regulatory release.
C. For *MiST* Class II Vegetation and Classes III or IV Hydrology, ensure that short term habitat improvement practices were implemented (See Table 1).

PHASE III - LONG-TERM MONITORING (optional)

A. Follow-up study by management entity (to be identified in mitigation plan) to compare baseline values with post mitigation values with goal of replacement of habitat type(s) and associated values.

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[1] RFE = Reference Forest Ecosystem (see glossary).
[2] See Schamberger *et al.* (1982).

PART IV

USE OF MiST IN THE FIELD

AND

SELECTION OF A REFERENCE FOREST ECOSYSTEM

USING *MiST* IN THE FIELD: SUGGESTIONS AND KEY TO THE *MiST* CLASSIFICATION

T.A. White

Introduction

Information contained in this document can result in a significant contribution to the development of useful and high performance replacement forested wetlands. The purpose of this section is to transfer the information contained in the preceding tables and text into a format that can be immediately applicable in a variety of field situations.

A number of approaches can and will be developed to execute the *MiST* classification system. So although this section provides guidance in the use of *MiST*, it does not suggest that this is the exclusive manner in which to utilize the system. Instead, it relates current field testing considerations in a manner that, hopefully, will obviate some potential difficulties. As *MiST* continues to be field-tested, new and more appropriate approaches will certainly be developed.

Moreover, the variability of environmental and project-related factors renders much of the *MiST* system as negotiable between the mitigator and the regulatory authority. For example, the percentage of acceptable overlap of a mitigation site water quality parameter with its counterpart from the RFE may vary depending upon the importance that the contribution of given mitigation site has upon the water quality of its particular watershed. This determination can only be done on a case by case basis in conjunction with regulatory authorities.

Approximately 100 different combinations of vegetation, soils and hydrology could technically exist on the landscape. In practice, however, a number of them will probably not be encountered. This is because degradation of one parameter very often occurs in conjunction with degradation of another. For example, it is difficult to imagine total reconstruction of a soil (S4) without simultaneous total loss of forest cover (V3). Thus, S4-V0 or S4-V1 combinations are rather unlikely. Similar situations reduce the possible number of classification combinations.

Timing of *MiST* classification

Every *MiST* attribute should be given the highest class possible for a given mitigation project to ensure that an adequate level of monitoring intensity occurs following the execution of the mitigation plan. Consequently, timing of the *MiST* classification is extremely important and can depend upon the project, the attribute, and the permitted activity. In many cases, classification can be accomplished using currently existing site conditions. However, in certain situations, classifying the attribute on the basis of what will occur either during or after the conduct of the mitigation or as a result of the permitted activity may be desirable. For example, current soil conditions on a mitigation site may yield a classification of S1. Yet, if the mitigation plan dictates soil disruptions significant enough to yield a S3 or S4 classification, the soils should be classified at the higher level (i.e., S3 or S4).

On a given project, *MiST* classification timing may vary with the attribute. For example, one can invoke *MiST* classification of vegetation, soils, and hydrology simultaneously on an abandoned, previously forested wetland soybean field. In this case, the soybean field is at the point of greatest disturbance simultaneously for all three attributes and *MiST* classification is straightforward. Alternatively, suppose a mitigation plan calls for a wetland creation where lowering of site elevations is proposed with a consequent change in hydrologic conditions. In this project, soil and vegetative *MiST* classification would occur *following* the elevational manipulation. Yet, hydrologic *MiST* classification must occur *before* the site is carved down as it is at this point in time that the site's hydrologic conditions deviate the most from the RFE.

It is not always necessary to classify *MiST* at the *exact* point in time when attribute degradation is at its greatest, i.e., it is possible to predict the classification of an attribute in certain circumstances. This is particularly true in cases where the attribute is given the highest class. When the mitigator wishes to "pre-classify" the site at a classification level less than maximum, it is advisable that the mitigator do so only with the knowledge and endorsement of the regulatory authority.

HOW TO DETERMINE CLASSIFICATION LEVEL

Selecting the Reference Forest Ecosystem

Selection of a RFE to compare functionality and original site condition is one of the first tasks of the forest wetland mitigator. Choosing an appropriate RFE can be an easy or complex task depending on a number of factors. These factors are outlined and discussed in a separate section of this document.

The RFE should be thoroughly characterized with regard to vegetation, soils, and hydrology. In many cases, comparison of the mitigation site with the RFE will be necessary to obtain the appropriate *MiST* classification. Characterization procedures can be found in the Wetlands Delineation Manual (1989) and other publications listed at the end of this document.

Classifying forested wetland attributes

Classification of forested wetland attributes with *MiST* involves consideration of any of a number of potential disturbances. Site conditions need to be thoroughly studied before attempting to classify the site. Once the disturbances are understood, users of *MiST* can refer to the Key to *MiST* at the end of this section. Some approaches to analyzing site conditions follow.

Vegetation

Where V2 or V3 classifications are anticipated, determine whether the site is a jurisdictional wetland.

Where V0 and V1 classifications are expected:

a. Select an agency-approved RFE. Determine overstory and understory composition and cover through approved sampling methods.

b. Sample existing mitigation site to determine:
    1. Overstory cover (can be represented by percent cover and/or basal area)
    2. Overstory species composition
    3. Understory cover (percent cover)
    4. Understory species composition

Soils

On sites that are not jurisdictional wetlands or where soils will be removed and replaced, an S3 or S4 classification is assumed. No further activities are required for classification except to outline soil reconstruction procedures if an S3 classification is desired.

Classification of soils under other circumstances can vary in complexity. During the determination of soil classification, it is important to consider all potential disturbances and recognize that disturbance can be represented by physical and/or chemical disruptions. These disturbances may be obvious or more subtle. Nevertheless, both types can greatly affect the ability of the site to support desired communities. For example, erosion losses may be obvious and result in an S1 classification for the site. In contrast, a site with significant changes to frequency and duration of flooding may not show physical disruptions, but have significant changes to redox potential manifesting in an S1 classification. Note that change in and by itself should not be used as a criterion. Only changes that could result in shifts of species composition, productivity, or habitat degradation away from the desired ecosystem should be considered.

1. Types of Disturbance:

i. Erosion

Ideally, one evaluates soil erosion losses through comparison with adjacent, uneroded soils of the same series where possible. Examination of soil survey maps and field reconnaissance can assist in identifying areas of similar soils. Preferably, any comparison of horizon thicknesses should be done as close to the mitigation site as possible since considerable variation in horizon thicknesses as well as other soil properties can exist within a given soil series.

In the absence of similar comparatively undisturbed soils in the immediate area of the mitigation, erosion can be assessed by evaluation of mitigation site soil profile horizon thicknesses in comparison with type-profiles described in SCS soil surveys for the soil series under scrutiny. It is strongly recommended that this be done with caution and under the scrutiny of a soil scientist familiar with hydric soils and their properties for the region of the mitigation site.

ii. Compaction

Physical impediments to root growth and soil water movement can adversely affect site productivity for extended periods of time. Numerous approaches exist to estimate compaction. Use of bulk density rings, penetrometers, etc. can all provide relative estimates of compaction. However, determination of saturated hydraulic conductivity provides useful integrative soil physical data. Saturated hydraulic conductivity is related to factors influenced by water movement in the soil such as soil redox potential, acidity, oxygen percent, and total N in the soil water (Aust *et al.* 1989). Moreover, net production of woody plants was shown to vary directly with saturated hydraulic conductivity in one forested wetland study (Mader *et al.* 1989). In addition, this parameter has the added advantage of relative ease of determination. For these reasons, determination of saturated hydraulic conductivity is recommended over bulk density and soil strength estimates. Amoozegar and Warrick (1986) provides field methodologies for this parameter.

iii. Chemical changes

Addition of toxic materials, significant shifts in redox potential, significant increases in acidity or alkalinity, significant losses of macronutrients or potentially deficient micronutrients, addition of materials that inhibit exchange of gases and liquids between the soil atmosphere interface, etc.

Methods for assessing chemical levels in soils and, thus, contribute to the determination of chemical disturbance can be found in Page *et al.* (1982).

iv. Loss of litter layer integrity.

Forested wetland ecosystems, as well as other forested ecosystems are characterized by the development of a distinct layer of leaves, branches and other debris. This debris serves as a storehouse of nutrients, organic matter and microflora that contribute significantly to the productivity of the forest community. Absence of the litter layer is easily assessed by comparison with the RFE. Both litter layer thickness and areal extent should be considered.

Hydrology

Hydrologic deviation of the mitigation site from the RFE is the criterion used to classify this attribute. Departure in frequency and duration mark the delineation of the *MiST* hydrology classes 1, 2 and 3. Class 4 couples deviation of frequency and duration with deviation in seasonality and source of inundation waters.

Generally, it is easier to determine large deviations in hydrologic parameters from the RFE than small variations. This is particularly true when mitigation sites vary in water source. In cases where variation of the mitigation site from the RFE is expected to be small, the mitigator must obtain hydrologic data from both sites to evaluate. Some stream channels have been historically monitored by organizations such as U.S. Geological Survey. Several other potential sources of historical hydrologic information are listed in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands. Use of this information in conjunction with USGS topographic or on-site survey maps can assist in determining hydrologic deviations between the two sites. In the absence of historical hydrologic data, selection of methodology to determine deviation of the mitigation site should be done in conjunction with the regulatory agencies.

KEY TO THE USE OF THE *MI*TIGATION *S*ITE *T*YPE CLASSIFICATION SYSTEM (*MiST*)

Section 1. VEGETATION

1. Mitigation site (MiS) is a juridictional forested wetland.. 2
1. MiS is not as above.. **V3**

   2. MiS is currently a forested wetland ecosystem that will be removed or replaced prior to or as part of the execution of a mitigation plan¥....... **V3**
   2. MiS is not as above.................................. 3

3. Identify Reference Forest Ecosystem (RFE). MiS has greater than 85% of the overstory species cover AND composition relative to that present on the RFE..... 4
3. MiS vegetation is not as above.......................... 5

   4. MiS has greater than 85% of the understory species cover AND composition relative to the RFE.... **V0**
   4. MiS vegetation is not as above...................... 5

      5. MiS has greater than 50% and less than 85% of overstory species cover relative to that present on the RFE............................... 6
      5. MiS vegetation is not as above.................. **V2**

         6. MiS has greater than 50% and less than 85% of understory species cover relative to that present on the RFE........................... 7
         6. MiS vegetation is not as above.............. **V2**

            7. MiS has greater than 50% and less than 85% of overstory species composition relative to the RFE.......... 8
            7. MiS vegetation is not as above.......... **V2**

               8. MiS has greater than 50% and less than 85% of understory species composition relative to the RFE...... **V1**
               8. MiS vegetation is not as above....... **V2**

¥ Forested wetland ecosystems as considered here include the vegetation, soils, and hydrology of the site.

Section 2. SOILS

1. MiS is a jurisdictional wetland.......................... 2
1. MiS is not as above...................................... **S4**

   2. MiS soils will be removed prior to or as part of mitigation plan................................. 3
   2. MiS soils are not as above........................... 4

      3. Surface (A) horizon and subsurface (B) horizon to be replaced on MiS in their entirety................................ **S3**
      3. MiS soils are not as above....................... **S4**

4. Identify and characterize the chemical and physical properties of the soils found on the RFE................ 5

5. MiS soils have lost greater than 12 inches from the top of the profile when compared to existing, undisturbed, similar soil series[¥]............. **S4**
5. MiS soils are not as above............................. 6

   6. MiS soils have lost between 6 - 12 inches from the top of the profile when compared to existing undisturbed, similar soil series..................... **S2**
   6. MiS soils are not as above........................... 7

      7. MiS soil rooting zone significantly more compact than RFE rooting zone[¥¥].......... **S2**
      7. MiS soils are not as above....................... 8

         8. Chemical or physical disturbance[¥¥¥] limited to the top 12 inches of MiS soil..... **S1**
         8. MiS soils are not as above................... **S0**

¥ Properties of soil series are defined in current Soil Survey of the county where the mitigation site resides or must be defined by a soil scientist familiar with hydric soils and their properties in the region of the mitigation site.

¥¥ Significance of soil compaction is a function of both the quantitative estimate of the level of compaction and the relative proportion of the mitigation site that is compacted.

¥¥¥ Chemical and physical disturbance includes, but is not limited to, loss of litter layer or up to 6 inches of the top of the profile, presence of materials (nutrients, toxic chemicals, materials that disrupt gaseous or liquid exchange, etc.) at a level high enough to inhibit productivity of the site (relative to the RFE) and significant changes in redox potential.

Section 3. HYDROLOGY

1. MiS is a jurisdictional wetland........................ 2
1. MiS is not as above..................................... **H4**

   2. Identify and characterize the frequency, duration, seasonality, and source of hydrologic inundation to the RFE..................... 3

3. MiS seasonality of inundation differs from that present on the RFE........................... **H4**
3. MiS hydrology is not as above........................... 4

   4. MiS source of inundation differs from that present on RFE............................ **H4**
   4. MiS hydrology is not as above........................ 5

      5. MiS frequency of inundation deviates from that present on the RFE by less than 10%................................. 6
      5. MiS hydrology is not as above.................... 7

         6. MiS duration of inundation deviates from that present on the RFE by less than 10%.............................. **H0**
         6. MiS hydrology is not as above................ 7

            7. MiS frequency of inundation deviates from that present on the RFE by 10% to 25%............................ 8
            7. MiS hydrology is not as above............ 9

               8. MiS duration of inundation differs from that present on the RFE by 10% to 25%........................... **H1**
               8. MiS hydrology is not as above........ 9

                  9. MiS frequency of inundation deviates by 25% to 50% from that present on the RFE.......... 10
                  9. MiS hydrology is not as above.... **H3**

                     10. MiS duration of inundation deviates by 25% to 50% from that present on the RFE..... **H2**
                     10. MiS hydrology not as above.. **H3**

SELECTION OF A REFERENCE FOREST ECOSYSTEM: ISSUES AND APPROACHES

T.A. White

This document strives to provide technical assistance in the evaluation of mitigation plans. However, the selection of the Reference Forest Ecosystem (RFE), fundamental to the use of *MiST*, raises a number of practical issues that should be considered by mitigators, regulators and policymakers. The purpose of this section is to illuminate at least a portion of the issues surrounding the selection and use of the RFE in the *MiST* system.

Introduction

Permitted impacts to forested wetland ecosystems may require compensatory mitigation in the form of creation, restoration, or other types of replacement. Monitoring is required of the mitigation project to ensure that ecosystem structure and function are on the appropriate trajectory for successful replacement to occur. Establishing this trajectory would ideally be accomplished by monitoring the proposed impact area simultaneously with the mitigation project area. In that manner, one would know how the mitigation compared to the actual function of the impacted site over a similar time frame.

However, in most cases, the "up-front" mitigation type described above is not an available option for a variety of reasons. A common reason is the relative time period required for mitigation establishment and monitoring is much greater than that required for completion of projects proposed for 404 permitting. Consequently, the impacted area often cannot serve as half of the monitored pair for assessing mitigation success. In these instances, one must use a reference wetland to act as a surrogate for the area to be impacted. The reference wetland is defined here as a field community of organisms with attributes similar to the area to be filled.

While the reference wetland concept is sound on paper, the procedures for selecting it are often problematic. Several direct and indirect issues arise when attempting to define it.

For this reason, the *MiST* document proposes use of the Reference Forest Ecosystem (RFE) concept in place of the reference wetland as a means to monitor forested wetland mitigation projects. Selection of the RFE is fundamental to the implementation of *MiST*. As well as forming the basis for quantitative mitigation performance standard comparisons, the RFE also serves as a goal toward which to direct mitigation design and implementation efforts.

Issues surrounding the selection of the RFE

The RFE is defined earlier in this document as "The kind of forest selected for creation or restoration, as it is represented locally (same or nearby watershed) in terms of species composition and physiognomy. It is imcumbent upon the applicant to characterize the reference forest type to the satisfaction of the regulatory authority."

The RFE departs from the reference wetland approach in several important ways. Depending upon the site attribute, the RFE may be equal or very similar to the reference wetland or it may be quite different. It is, at least in part, a conceptual model. To examine the reasons for selecting the RFE based on a conceptual/field model rather than strictly an on-site approach, both direct and indirect issues will be discussed.

Direct issues

Vegetation

Species composition of the RFE should attempt to emulate the area proposed for impact. Yet, a key consideration in the selection of the RFE is to define exactly *what* the RFE is attempting to replace. Locating *undisturbed* forested wetland ecosystems is, at best, difficult on a regional basis and often impossible at the watershed-specific level. Studies indicate that even in relatively undisturbed forested wetland ecosystems considerable intra-stand species composition and dominance often are the rule (Clewell and Lea, 1989). Moreover, some sites have otherwise suitable overstories that have been overrun with exotic competitors such as *Pueria* or *Lonicera*. Consequently, selecting a RFE on the basis of species composition representative of a particular watershed is likely to be not only difficult to replicate but often undesirable as well.

Similarly, if the permitted fill area is a degraded wetland initially, the desirability of replacing this ecosystem may be questionable. In many cases, opportunities exist for enriching the mitigation area with additional species whose presence in the current landscape (including the permitted area) is diminished or entirely lacking. For example, suppose a permitted area is composed of a poorly stocked, monospecific river birch (*Betula nigra*) community. In the reference wetland approach, mitigation for this impact should replace the river birch community. In cases where river birch communities are not frequent on the landscape, this may be desirable. However, on landscapes where these communities are commonplace and where mast-producing species are lacking, a replacement forested wetland such as one dominated by overcup or Nuttall oaks (*Quercus lyrata* and *Quercus nutallii*, respectively) would have greater habitat value. Thus, while species composition should always be a focal point, it should not necessarily drive the selection of the reference.

The RFE provides positive flexibility to the reference wetland concept and allows the establishment of the oak community in spite of its relative absence from the local flora. RFE selection should use the species composition of an impacted area as a *minimum* sideboard to the mitigation project; species composition changes should be done in conjunction with regulatory and commenting agencies.

Habitat

Similar to vegetational condition, the habitat type present on many forested wetlands is often degraded. Consequently, opportunities to improve upon existing habitat in a particular watershed should, in many cases, outweigh the desirability of reproducing inferior habitat that might exist on available reference wetlands.

Soils and Hydrology

In contrast to vegetation and habitat, field characterization of soils and hydrology of the RFE is a crucial component in its selection. The soils-hydrology combination drives the development of any wetland community and the selection of RFEs with similar soils and hydrology to the impacted wetland is considered important for ensuring that many functional performance standards are achieved. Review of soil survey maps, historical hydrologic data, and field evaluations of both are recommended as part of the selection process.

Failure of many forested wetland mitigations can be traced to inadequate establishment of site hydrologic conditions appropriate to the tolerances of the woody species planted there. Understanding the hydrologic conditions of the RFE is best done *in situ* so, in the case of hydrology, the RFE and reference wetland concepts are similar.

MiST soils requirements do not necessarily attempt to duplicate entire soil profiles and are purposely open with regard to specific levels of soil attributes as they reflect the RFE. A good theoretical basis exists for this approach. First, similar to the reasoning for allowing freedom (with regulatory approval) to determine vegetational composition, situations exist in the landscape to improve upon bottomland soil properties that might benefit the overall productivity and site functions related to productivity such as food chain support.

Second, natural ecosystems are subject to environmental extremes in temperature and water availability during the growing season. High soil water tensions have the additional indirect effect of temporarily reducing nutrient availability. One reason that wetland ecosystems are often the most productive within a given watershed (indeed, in some cases, representing the most productive ecosystems in the world) is that they are naturally buffered from environmental extremes as a result of their position in the landscape.

Soils act as a medium for retaining and conducting water and nutrients to the rhizosphere and for anchoring the plant (as well as habitat for many organisms). Regulations requiring replacement of specific thicknesses of soil on upland sites have their theoretical foundation in assuring that the site has sufficient soil volume (and, thus, sufficient water and nutrient availability) to insulate it from the environmental extremes normally present during the growing season. Yet, since wetland soils are naturally buffered from these extremes, it may be inappropriate to equate the potential impacts of upland soil disturbances with similar disturbances on wetland soils.

As a consequence of the above, the driving force behind forested wetland soil replacement should be the assurance that the soil has the physical and chemical attributes suitable for good plant growth. This does not mean the soils will not be monitored; a vigorous soils monitoring program is required from all mitigations including measurement of the levels of total N, P, K and other macronutrients as well as micronutrients. Materials toxic to plant growth and physical attributes are also monitored. While pedogenic similarities between RFE and mitigation soils are not required, comparisons of the above parameters *are* part of the monitoring program. Nevertheless, since the aim of all forested wetland mitigation projects is to produce a fully functional ecosystem, the mitigator must carefully compare the benefits of mitigation designs with the cost of not attaining performance standards.

Water Quality

The RFE and reference wetland concepts are similar in the evaluation of water quality functions. Consideration of the ability of the constructed forested wetland to improve water quality is not only one of the most important aspects in the choice of the RFE but also a factor that can make RFE identification difficult. To minimize confoundment in the assessment of water quality improvement, RFE selection should attempt to equalize relative cumulative effects between the RFE and the mitigation site. At a minimum and to the extent possible, the RFE should emulate the forested wetland ecosystem that will be impacted or the condition that existed prior to the impact. Since all mitigations strive to replace ecosystem function as well as form, a landscape level approach should identify not only site specific functional effectiveness, but also the opportunity and social significance of site functions.

In short, activities within the RFE watershed should be as similar as possible to those within the permitted and mitigation site watershed(s) particularly on-site and upstream. The easiest way to ensure this is to select a RFE within the same basin and in a similar topographic position as the impacted area. However, in many cases, this option may not be available and one must look outside of the impacted watershed boundaries. This latter case may require more information than the former. While it may not be necessary in many cases, where selection of the RFE is controversial, one may wish to employ a Wetland Evaluation

Technique (WET) analysis (Adamus, 1987) to the potential RFE to ensure that the functional relationships of the off-watershed RFE approach those of the impacted area. This option is particularly useful in urban situations where development has caused significant changes to the upstream and downstream characteristics of the watershed.

Finally, as a result of the above complications and to alleviate the impact of any changes in upland land use upon water quality assessment, the Water Quality working group suggests selecting more than one RFE for this purpose. This determination must be done on a case-by-case basis.

Indirect issues

In some instances, the land base of the permit applicant may not contain a suitable RFE. In other situations, forested wetland disturbance may be so severe that a suitable RFE may not be available in the vicinity of the mitigation site. Some alternatives must be available to the permit applicant to offset such situations. A limited set of alternatives is presented here.

One alternative would be to obtain an easement from an adjacent landowner(s) on whose property a suitable RFE might reside. Another alternative would be to utilize portions of public lands such as state, national, or university forests as RFEs. Use of either of these options would depend upon the proximity of the RFE to the mitigation site, its vegetation, soils, and hydrologic makeup, position within the watershed, similarity to the impacted site, etc. Moreover, their utilization would require agreements between the permittee and the organization with authority over the proposed RFE. Selection of off-site RFEs must be made with extreme care and on a case-by-case basis to ensure that functions are monitored properly.

GLOSSARY

AND

LITERATURE CITED

GLOSSARY

CANOPY: The uppermost stratum of trees in the reference forest ecosystem.

COMPACTION: Degree of firmness in the soil. When present at a high degree, it reduces water movement and limits plant root penetration. Relative degrees can be determined by comparing bulk density and/or soil strength (e.g., as measured with a constant rate penetrometer).

DURATION: The average length of time in months that inundation and/or saturation occurs each year.

FREQUENCY: The number of inundation and/or saturation events that occur on the average each year. At least one inundation / saturation event must occur on the average each year to meet Federal guidelines.

HABITAT: The total of environmental conditions of a specific place occupied by a wildlife species or a population of that species. It can be described in terms of food, water, cover, and any other recognized life requisites and their relative location (interspersion) within a given area.

NATURAL DISTURBANCE: Physical processes (i.e., soil scouring, sediment deposition) normally associated with inundation of floodplain zones.

NEW SOIL: Recently deposited or drastically altered soil profiles atypical of undisturbed soils within the reference area (e.g., dredge spoil, mine tailings, mixed mine soil, overburden, construction backfill material).

NUISANCE SPECIES: Competitive weeds, vines, or other plants having the potential to retard project development and release.

PEAK FLOW: The maximum flow that occurs during a given stormflow event, usually expressed as cubic feet per second (cfs).

PREFERRED SPECIES: Plant species typical of the RFE that serves as the model for mitigation. Preferred species generally exclude exotic species, aggressively colonizing weeds of open environments, non-persisting canopy gap herbs, off-site species that may occur sporadically in the RFE but that are more typical of other ecosystems, and rhizomatous grasses with the propensity to form turfs.

REFERENCE FOREST ECOSYSTEM: The kind of forest selected for creation or restoration, as it is represented locally (same or nearby watershed) in terms of species composition and physiognomy. It is incumbent upon the applicant to characterize the reference forest type to the satisfaction of the regulatory authority.

REFERENCE SOIL: Soil type(s) associated with the reference forest ecosystem.

SEASONALITY: The season or seasons (growing and dormant) during which the dominant period of inundation and/or saturation occurs. The dominant season of inundation cannot be different from the reference BLH forest ecosystem, otherwise a different forest ecosystem would develop over time.

SOURCE: The principal source of inundation and/or saturation such as riparian (upland) discharge, overbank flow and rising groundwater. The dominant source of inundation cannot be different from the reference BLH forest ecosystem.

UNDERGROWTH: All species of vascular plants of the RFE that do not contribute ordinarily to the canopy (except as vines or epiphytes), including herbs, vines, shrubs, and small trees.

UNDISTURBED NATURAL AREAS: BLH forest communities that do not exhibit evidence of an adverse impact by man-made activities (e.g., logging, grazing, agriculture, construction runoff and sedimentation).

WETLAND HYDROLOGY: The hydrologic factors such as frequency, duration, seasonality, and source of inundation and/or soil saturation resulting in maintenance of a reference BLH forest ecosystem (as further defined in the Vegetation Criteria Section). By definition, the reference BLH forest ecosystem must meet Federal criteria for jurisdictional delineation as a wetland.

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