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Standard Guide for Assessment of Wetland Functions[1]

This standard is issued under the fixed designation E 1983; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers assisting wetland managers by prescribing a sequence of steps for defining and assessing wetland functions. This guide also identifies properties that must be considered in the selection of a wetland assessment procedure to determine whether it will assist in satisfying the requirements of wetland regulatory programs or produce valid design criteria for planned wetlands, or both. This guide can help wetland managers use existing assessment procedures more effectively during the decision-making process. The outcome of the assessment is dependent on many factors including the selected procedure, the sampling design, and assumptions; therefore, decisions and assumptions made should be documented throughout the process. While this guide is developed to assist in satisfying the requirements of wetland regulatory programs, it can also be used in a variety of planning, management, and educational situations.

1.2 The guide is not intended for use in assigning values to wetland functions in terms of economic (for example, dollars) or other value units. However, the information that is gathered while assessing wetland functions may be useful in meeting this objective when used in conjunction with other information (for example, see Refs **(1)**[2] and **(2)**).

1.3 This guide applies to assessment procedures designed for application at the ecosystem scale. It does not address the less commonly used landscape level models or the use of wetland assessment procedures for cumulative impacts analysis **(3-5)**.

1.4 *Limitations*—This guide does not include a standard wetland assessment procedure or models for assessing function. This guide has been written primarily to complement and to aid in the selection of current procedures. There are several procedures for quantifying wetland functions and each has been developed for specific purposes. The suitability of a procedure depends on assessment objectives, wetland type, availability of applicable models given the wetland type and objectives, and policy of local decision makers. There are continuous efforts to develop new and improved methods that could override any one recommended standard procedure.

1.5 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Terminology

2.1 *Definitions:*

2.1.1 *wetland assessment procedure*, *n*—a definitive procedure for identifying, characterizing, or measuring the functions that a wetland performs, or a combination thereof.

2.1.2 *wetland functions*, *n*—the physical, chemical, and biological processes or attributes that contribute to the self-maintenance of wetland ecosystems **(6)** and **(7)**. Wetland functions result directly from the characteristics of a wetland ecosystem and the surrounding landscape and their interaction.

2.1.2.1 *Discussion*—A wetland function is distinguished from wetland value. Wetland functions are a direct result of the characteristics of a wetland and the surrounding landscape. Examples of functions include the removal of dissolved substances, cycling of nutrients, maintenance of plant and animal communities, and short-term storage of surface water. These functions provide benefits, goods, and services which may be assigned a value (economic or noneconomic) describing the relative importance of a wetland function to an individual or group of people. The values of wetlands are estimates, usually subjective, of the worth, merit, quality, or importance of wetland functions **(8)**.

2.2 *Definitions of Terms Specific to This Standard*—Most of the following definitions are from Refs **(9)** and **(10)**.

2.2.1 *assessment model*, *n*—a simple model that defines the relationship between ecosystem and landscape scale variables and functional capacity of a wetland; it is used to derive a measure of functional capacity (that is, the functional capacity index).

[1] This specification is under the jurisdiction of ASTM Committee E50 on Environmental Assessment and is the direct responsibility of Subcommittee E50.02 on Commercial Real Estate Transactions.

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[2] The boldface numbers given in parenthesis refer to a list of references at the end of the text.

2.2.2 *conceptual design*, *n*—a design that provides a brief description of the planned wetland through drawings and text which confirms feasibility and facilitates early review by decision makers.

2.2.3 *functional capacity*, *n*—the magnitude or rate at which a wetland performs a function. Functional capacity is dictated by the characteristics of the wetland ecosystem and the surrounding landscape, and the interaction between the two.

2.2.4 *functional capacity index (FCI)*, *n*—an index of the capacity of a wetland to perform a function relative to other wetlands from a defined region or wetland class, or both. Functional capacity indices are by definition normally scaled from 0.0 to 1.0. An index of 1.0 indicates that a wetland performs a function at maximum functional capacity. An index of 0.0 indicates the wetland does not perform the function.

2.2.5 *functional capacity units (FCs)*, *n*—a measure of the capacity of a wetland to perform a function that links functional capacity with area ($FC = FCI \times$ size of wetland area).

2.2.6 *planned wetland*, *n*—design or an implemented design for a constructed, created, restored, or enhanced wetland.

2.2.7 *variable*, *n*—an attribute or characteristic of a wetland ecosystem or the surrounding landscape that influences the capacity of a wetland to perform a function; used in assessment models to derive a measure of functional capacity (that is, the functional capacity index). Variables may be described by direct measures or indicators. A direct measure is a quantitative measure of an assessment model variable. An indicator is an observable characteristic that corresponds to identifiable variable conditions in a wetland or the surrounding landscape.

2.2.8 *wetland assessment area (WAA)*, *n*—the wetland area being assessed. In regulatory situations, the WAA will usually be jurisdictional wetlands confined to the area of direct or indirect impact or both.

2.2.9 *wetland classification*, *n*—the grouping of wetlands into different categories based on specific criteria (that is, vegetation type, hydrology, geomorphology) for the purpose of inventory, assessment, and management.

2.2.9.1 *Discussion*—There are several wetland classification schemes including the Classification of Wetlands and Deepwater Habitats of the United States **(11)** and the hydrogeomorphic classification **(12)**. Each has been prepared for different purposes. One or more of these classifications may be used in the process of assessing wetland functions.

2.3 *Additional Terminology*—The following definitions and discussions, taken directly from the publication "Form and Style for ASTM Standards," shall be included in full in every standard guide or practice produced and passed by Committee E-50 or any of its technical subcommittees; approved April 16, 1997.

2.3.1 *guide*—a series of options or instructions that do not recommend a specific course of action.

2.3.1.1 *Discussion*—Whereas a practice prescribes a general usage principle, a guide only suggest an approach. The purpose of a guide is to offer guidance, based on a consensus of viewpoints, but not to establish a fixed procedure. A guide is intended to increase the awareness of the user to available techniques in a given subject area and to provide information from which subsequent evaluation and standardization can be derived.

2.3.2 *practice*—a definitive procedure for performing one or more specific operations or functions that does not produce a test result.

2.3.2.1 *Discussion*—A practice is not a downgraded test method. Examples of practices include procedures of interlaboratory testing programs or other statistical procedures; for writing statement on sampling or precision and accuracy; and for selection, preparation, application, inspection, and necessary precautions for the use, disposal, installation, and maintenance, and operation of testing equipment.

2.3.3 *standard*—as used in ASTM, a document that has been developed and established within the consensus principles of the Society and that meets the approval requirements of ASTM procedures and regulations.

2.3.3.1 *Discussion*—The term "standard" serves in ASTM as an adjective in the title of documents such as test methods or specifications, to connote specified consensus and approval. The various types of standard documents are based on the needs and usages as prescribed by the technical committees of the Society.

3. Summary of Guide

3.1 This guide is summarized in Table 1, that shows the steps in defining and assessing wetland functions and the sections of this guide that apply.

3.2 The remainder of this guide identifies properties to consider when selecting a procedure or models, and a summary of existing procedures (see Section 7). Appendix X1 describes the specific application of wetland assessment to planned wetlands.

4. Significance and Use

4.1 Wetland managers may be aware of wetland assessment procedures, but not use them as effectively as possible for a variety of reasons. There is no one universally accepted procedure; therefore, time is often lost to identifying and agreeing upon a suitable approach. The absence of guidance

TABLE 1 Suggested Steps in the Assessment of Wetland Functions

Steps	Rules
Characterization Phase:	6.2
Define objectives of the assessment	6.2.1
Select functions	6.2.2
Describe the project area	6.2.4
Identify wetland assessment area(s)	6.2.6
Screen for red flags	6.2.7
Identification of Assessment Approach:	6.3
Identify, modify, or develop assessment models	6.3.1
Select the units of measure	6.3.2
Assessment Phase	6.4
Analysis Phase:	6.5
Types of comparisons	6.5.1
Other criteria to consider when comparing wetland assessment areas	6.5.5

describing the sequence of steps to assessing wetland functions causes confusion and delays the decision-making process. Only recently has guidance been published by the U.S. Army Corps of Engineers **(9)**.

4.1.1 This guide shows the person(s) performing an assessment the steps to assess wetland functions. This guide also provides a summary of the variety of procedural options for measuring function, and includes a list of properties to consider when selecting an appropriate procedure.

4.2 *Situations Requiring Assessment of Wetland Functions*—While this guide is developed to assist in satisfying the requirements of wetland regulatory programs, it can also be used in a variety of planning, management, and educational situations.

4.3 *Rapid Assessment for Section 404 Permitting*—Section 404 of the Clean Water Act (33 U.S.C. 1344)[3] directs the U.S. Army Corps of Engineers, in cooperation with the U.S. Environmental Protection Agency (EPA), to administer a program for permitting and regulating the discharge of dredged or fill materials in waters of the United States, including wetlands. A permit application undergoes a public interest review that includes an assessment of the impacts the proposed project will have on wetland functions.

4.3.1 An assessment may be performed during one or more of the following steps of the review sequence that are prescribed in the U.S. EPA 404(b)(1) Guidelines (40 CFR Part 230)[4]

4.3.1.1 *Step 1*—Determine whether the proposed project is water dependent.

4.3.1.2 *Step 2*—Determine whether practicable alternatives exist for the proposed project.

4.3.1.3 *Step 3*—Identify the potential impacts of the proposed project on wetland functions in terms of project specific and cumulative effects.

4.3.1.4 *Step 4*—Identify how potential project impacts can be avoided or minimized in terms of project-specific and cumulative effects.

4.3.1.5 *Step 5*—Determine appropriate compensatory mitigation for unavoidable project impacts.

4.3.1.6 *Step 6*—Grant or deny a permit to discharge dredged or fill material by comparing the value of the benefits gained from the proposed project versus the value of benefits lost from the proposed project.

4.3.1.7 *Step 7*—If a permit is granted, monitor compensatory mitigation.

4.3.2 Wetland functions are assessed during Step 2 to compare impacts of practicable alternatives and to identify which is least damaging. During Steps 3 and 4, wetland functions are assessed to identify and then determine how to avoid or minimize project-specific and cumulative impacts. Wetland functions are assessed in Step 5 to determine what constitutes appropriate compensatory mitigation for unavoidable impacts. Compensatory mitigation is wetland restoration or creation, or enhancement or preservation of an existing wetland to compensate for wetland impacts. Several approaches to mitigation may be considered and compared at this time including in-kind, out-of-kind, on-site, off-site, and mitigation banking. Whichever option is chosen, the mitigation project is later assessed (during Step 7) to determine whether the function-based objectives have been met in the conceptual plans or the completed planned wetland, or both.

4.3.2.1 Many states and local governments have adopted regulatory wetland statutes which set forth procedures for permit applications similar to the federal Section 404 program (see review in Ref **(13)**). The need to assess wetland functions is similar, but specific requirements may differ depending upon the individual state program.

4.3.2.2 *Mitigation Banking*—One option for meeting any compensatory mitigation requirements is to use a mitigation bank. Mitigation banking is wetland restoration, creation, or enhancement undertaken expressly for the purpose of providing compensation credits for wetland losses from future development activities. A wetland assessment procedure can be used to asses the loss of functions at an impact site, to assess functions to date at the mitigation bank, and to determine the number of credits (expressed in terms of functional capacity or acreage, or both) that must be purchased at the mitigation bank to compensate for the impacts.

4.3.3 *Other Applications*—There are a variety of nonregulatory situations where there is a need to assess wetland function. A rapid wetland assessment procedure that is appropriate for the Section 404[4] program could be used, but time and resources may also allow for more detailed analyses.

4.3.3.1 *Advanced Identification (ADID)*—Advanced Identification is a planning process authorized by Section 404 regulations (40 CFR Part 230.80)[4] that allows the U.S. EPA, in cooperation with the U.S. Army Corps of Engineers and state and local agencies, to collect information on the functions of the wetlands in selected study areas. The agencies evaluate the information to determine which wetlands in the ADID study area should be protected from potential fill activities or which could serve as future disposal sites. This information is used by the agencies in the review of Section 404 permit applications, by local communities for land-use management, and by environmental organizations for wetland protection activities.

4.3.3.2 *Restoration*—Wetland restoration refers to the return of a wetland from a disturbed or altered condition by the reestablishment of one or more indicators of wetland hydrology, hydric soil, and hydrophytic vegetation. There are increasing efforts to restore wetlands, many of which do not require permits. The restoration goals may be broadly defined in terms of wetland type or functions, or both. Wetland assessment procedures can be used to define and measure the achievement of function-based goals.

4.3.3.3 *Resource Management*—Wetlands are resources that are managed by different government agencies, private organizations, or individual landowners for different purposes. Wetlands can be managed at site-specific (for example, water level and weed control management of waterfowl impoundment), watershed, or even larger scales (for example, a North American Waterfowl Management Plan, an agreement adopted

[3] Title 33, United States Code, Chapter 26, Section 1344: "Permits for Dredged or Fill Material."

[4] Title 40, Code of Federal Regulations, Part 230: Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material.

by the United States and Canada to manage waterfowl habitat **(14)**). A wetland assessment procedure can be used to define and monitor the achievement of management objectives. For example, the assessment of a degraded wetland can be performed at the site-specific scale to reveal what characteristics need modification to enhance wildlife habitat. The habitat could be altered and later reevaluated to determine if the management objectives have been achieved.

4.3.3.4 *Watershed/Regional Planning*—There are several state initiatives to manage land-use within watersheds or regions. A wetland assessment procedure can be used to provide an inventory of wetlands within a watershed/region, to prioritize these wetlands for land-use decisions, and to identify wetlands for acquisition, protection, development, or restoration. Landscape level or ecosystem level assessment procedures, or both, may be used. At least two states have developed and are testing new landscape-level procedures that use Geographic Information System (GIS) data (for example, Refs **(5)** and **(15)**). The assessment of landscape level functions is limited by the data available in the GIS format. Greater accuracy may be obtained through the application of ecosystem-level assessment procedures; however, assessing all or most of the wetlands within a designated area is more time-consuming. The New Hampshire Method **(16)** and Indicator Value Assessment **(17)** were developed for this purpose, but other procedures may also be suitable. The EPA has developed a Synoptic Approach as a proposed method for assessing cumulative impacts and making comparisons between landscape subunits, such as watersheds, ecoregions, or counties **(3)(4)**.

4.3.3.5 *Swampbuster Conversion of Wetlands*—Wetlands are managed under the Wetland Conservation (Swampbuster) Provisions of the 1985 Food Security Act as amended by the 1996 Farm Bill. The Farm Bill allows exemptions to be granted for conversion of wetlands where such conversions have minimal effect on wetland functions and values, or where impacts are compensated through mitigation actions. Wetland assessment procedures can be used to measure the effects of proposed conversions or mitigation actions on wetland functions, or both.

5. Function of Wetlands

5.1 Wetlands perform a variety of functions at different scales of complexity. These functions are difficult to characterize because they represent a wide range of scales from microscopic chemical reactions to landscape size changes in climate or environment. By compartmentalizing the activities that take place in a wetland into individual functions, one actually makes value judgments about the important processes in wetlands. For example, nitrogen removal is a function which can be considered a subset of more complex functions such as nitrogen cycling and nutrient cycling. A wetland would probably have a different functional capacity index if the assessment model was designed to assess general wildlife habitat rather than if the model was designed to assess anadromous fish habitat or habitat for amphibians. However, it is not practicable to assess all wetland functions at all levels of complexity. The functions that are assessed should be selected on the basis of wetland type and assessment objectives. The following list of general functions is a starting point for identifying what kinds of functions a wetland performs. This list and definitions are taken or modified or both, from Refs **(9)** and **(18)**. Other lists are available in individual wetland assessment procedures (refer to Section 7) and other publications (for example Ref **(19)** and **(20)**).

5.1.1 *Functions Related to Hydrologic Processes*:

5.1.1.1 *Short-Term Storage of Surface Water*—The capability of a wetland to detain or slow surface water or both for short periods of time. When water is detained in the wetland, downstream peak discharge and flood volume are reduced.

5.1.1.2 *Long-Term Storage of Surface Water*—The capability of a wetland to temporarily store surface water for long periods of time (for example, one week or longer). When water is retained in a wetland, the volume of flood water transported downstream is decreased. The retained water supports aquatic vertebrates and invertebrates and contributes to other ecological processes within the wetland.

5.1.1.3 *Storage of Subsurface Water*—The availability of storage for water beneath the wetland surface. The storage, that becomes available with periodic drawdown of the water table, may be the result of vertical and lateral drainage or evapotranspiration, or both. This storage helps to recharge surficial aquifers and maintain base flow and seasonal flow in streams. The periodic drainage results in a fluctuation between aerobic and anaerobic conditions. This fluctuation benefits the recruitment, survival, and competitiveness of wetland plant species and sustains conditions necessary for microbially mediated biogeochemical cycling.

5.1.1.4 *Moderation of Ground Water Flow or Discharge*—The capability of wetland to moderate the rate of ground water flow or discharge from upgradient sources or from ground water discharge within the wetland. This moderation in flow maintains ground water storage, base flow, seasonal flows, and surface water temperatures. Flows of subsurface water into the wetland in late fall or early spring sustain warmer soil temperatures resulting in a longer growing season for biological activity and other wetland functions.

5.1.1.5 *Dissipation of Energy*—The capability of a wetland to reduce the energy of water as it moves through, into, or out of the wetland. The reduction in the energy of moving water may result in reduced shoreline and floodplain erosion, improved surface water quality, and decreased downstream peak discharge.

5.1.2 *Functions Related to Biogeochemical Processes*:

5.1.2.1 *Cycling of Nutrients*—The conversion of elements from one form to another through abiotic and biotic processes. Nutrient cycling is accomplished through plant uptake and release, a process by which nutrients are adsorbed and assimilated into living plant tissue and released with litter production. By cycling nutrients, wetlands maintain sufficient nutrients to support living biomass and detrital stocks. Nutrient cycling also reduces downstream particulate loading which helps to maintain or improve surface water quality.

5.1.2.2 *Removal of Elements and Compounds*—The removal of nutrients, contaminants, or other elements and compounds on a short- or long-term basis through burial, incorporation into biomass, or biochemical reactions. In addition to providing benefits on-site, this removal also reduces downstream loading which helps to maintain or improve surface water quality.

5.1.2.3 *Retention of Particulates*—The deposition and retention of organic and inorganic particulates from the water column, primarily through physical processes such as sedimentation. When particulates are retained in the wetland, downstream loading is reduced; this helps to maintain or improve surface water quality.

5.1.2.4 *Export of Organic Carbon*—The export of dissolved and particulate organic carbon from the wetland through leaching, flushing, displacement, erosion, and other mechanisms. The removal of organic carbon from living biomass, detritus, and soil organic matter contributes to the decomposition and mobilization of metals within the wetland. The exported organic carbon also provides support for aquatic food webs and biogeochemical processing downstream from the wetland.

5.1.3 *Functions Related to Habitat*:

5.1.3.1 *Maintain Characteristic Plant Community*—The maintenance of a plant community that is characteristic with respect to species composition and physical characteristics of the vegetation. Plant communities provide energy to drive food webs; provide habitat for nesting, resting, refuge; provide escape cover for animals; create roughness that reduces velocity of flood waters; and provide organic matter for nutrient cycling within the wetland. Plant communities also provide a source of propagules to help maintain species composition of adjacent areas and migratory pathways between habitats.

5.1.3.2 *Maintain Spatial Structures of Habitat*—The capacity of a wetland to support animal populations and guilds by providing a heterogeneous habitat. Structure provides potential feeding, resting, and nesting sites for vertebrates and invertebrates within the wetland. The structure of the wetland also provides habitat for wide-ranging and migratory animals and a corridor for gene flow between separated populations.

5.2 Wetlands provide benefits, goods, and services that are considered values, but sometimes referred to as functions. While these are not functions, wetland managers may choose to evaluate these aspects of the wetland. Examples include the following:

5.2.1 *Recreation*—Providing recreation sites for fishing, hunting, and observing wildlife,

5.2.2 *Open Space and Aesthetic Values*—Providing open space for visual enjoyment,

5.2.3 *Education and Research*—Providing educational opportunities for nature observation and scientific study,

5.2.4 *Historical or Archeological Significance*—Containing properties of historical or archeological significance, and

5.2.5 *Timber Production*—Providing timber resources for private or commercial uses.

5.3 The preceding list (5.1.1 through 5.2.5) is not all inclusive. Not all wetlands perform these functions and values; additional functions may be appropriate given a specific wetland type and other factors.

6. Steps for Assessing Wetland Functions

6.1 The phases outlined in 6.2 through 6.5 and discussion in 6.3.2 are modified from the Hydrogeomorphic (HGM) Approach **(9)**, **(21)**. Changes have been made in order to increase flexibility and incorporate concepts from other approaches. Many steps, particularly the identification of the assessment approach, require critical decisions. These decisions should be made by a team of experts. The term will differ in each case, but may include wetland scientists from appropriate federal, state, and local agencies as well as from the private sector and academia. The decisions and assumptions may affect the final ouctome of the assessment. For this reason, these decisions should be agreed upon between the assessors and users of the results (for example, regulator) and also be documented throughout the process.

6.2 *Characterization Phase*—The following baseline information must be gathered during the characterization phase before proceeding with the assessment.

6.2.1 *Define Objectives of the Assessment*—Describe the proposed project, purpose, and objectives. Decide which wetland assessment area(s) are to be compared and the number of comparisons required. Predictions regarding future conditions may also be necessary. Therefore, it is important to define the time period for which the wetlands are being assessed (for example, predicted future conditions of planned wetland two years after construction). The three categories of objectives include documenting existing conditions, comparing different wetlands at the same point in time, or comparing wetland(s) at different points in time. For example, a simple objective for an alternative analysis may be to compare two wetland assessment areas (WAAs) in order to determine which project location will have the least impact. A more complex objective would be to compare a restored or enhanced wetland site. In this case, the impact area would be assessed for both future with-project and future without-project conditions. An independent assessment would then be performed for the enhancement area and its predicted future conditions, both with and without the enhancement project. Finally the gains from the enhancement project would be compared to the losses associated with the impact. As projects become more complicated and involve several wetlands, it is important that the objectives be described in specific terms to avoid any misunderstanding and unnecessary work.

6.2.2 *Select Functions*—Select the functions to be assessed on the basis of wetland type, the assessment objectives, the nature of the project, and expected impacts.

6.2.2.1 There is no standard set of wetland functions that are applicable to all wetland types. Applicable functions can be selected from existing assessment models or redefined, or both. In general, a suite of representative wetland functions should be assessed in order to provide a more complete description of a wetland area. Depending upon the assessment objectives, however, a limited number or even one function may be selected. For example, if the sole purpose of a wetland restoration project is to provide wildlife habitat, assessment may be limited to that single function.

6.2.3 Each function should be assessed and considered separately in the decision-making process. However, in more complex projects, decision makers may choose to use of a grand score that combines the measures of each function for a wetland. If functions are to be combined, pertinent regulatory agencies and other decision makers should agree upon which functions will be combined and how. Caution is advised (particularly for options 6.2.3.3 and 6.2.3.4) since no guidance is available, and the combined results could be subject to question. In summary, the possible options include:

6.2.3.1 Consider each function separately.

6.2.3.2 Develop scores for the major function categories (for example, hydrologic processes, biogeochemical processes, and habitat) which are derived from the weighted or non-weighted totals of FCs for functions in each category.

6.2.3.3 Develop a grand score that represents a total number of functional capacity units. (See definition in 6.3.2.3.)

6.2.3.4 Develop a grand total that represents a weighted total of functional capacity units, where multiplying factors are used to emphasize the more important functions.

6.2.4 *Describe the Project Area*—Describe the project area and surrounding landscape with a narrative and map(s). The narrative should include:

6.2.4.1 Project name and location,

6.2.4.2 Nature of the proposed project,

6.2.4.3 Assessment objectives,

6.2.4.4 Classification of wetlands (use National Wetland Inventory (NWI) **(11)** and hydrogeomorphic **(12)** classification, or other classifications as needed), and

6.2.4.5 Description of characteristics of the wetland ecosystem and landscape context that may be relevant to the assessment, (for example, climate, landform and geomorphic setting, hydrology, vegetation, soils, land use, ground water features, surficial geology, urban areas, potential impacts, and red-flag features (see 6.2.7)).

6.2.5 The map(s) shall be prepared to a scale suitable for illustrating the following information, as appropriate:

6.2.5.1 Project area boundaries, property lines, and other relevant political boundaries,

6.2.5.2 Topographic contour lines in the project area and surrounding landscape,

6.2.5.3 Infrastructure (for example, roads, fences, buildings, railroad grades, and bridges),

6.2.5.4 Surface water features (for example, streams, rivers, lakes, ponds, and springs),

6.2.5.5 Hydraulic structures (for example, weirs, culverts, gates, pumps, and levees),

6.2.5.6 Seasonal water table elevations,

6.2.5.7 Soil type(s),

6.2.5.8 Plant communities,

6.2.5.9 Jurisdictional wetlands,

6.2.5.10 Location of wetland impacts (potential and relevant prior impacts),

6.2.5.11 Wetland assessment area(s),

6.2.5.12 North arrow (true north), legend or key, and distance scale,

6.2.5.13 Title block with the project name, investigators, dates, and sources of information, and,

6.2.5.14 Keep time for map preparation to a minimum by using existing maps or modifying as needed, or both. Multiple maps, or overlaps keyed to a base map, may be practical (examples provided in Ref **(16)**.)

6.2.6 *Identify Wetland Assessment Area(s)*—Identify wetlands within the project area using a chosen wetland definition, for example, the jurisdictional wetlands in a regulatory situation. The project area may contain one WAA; however, in some cases, it may be large and encompass several wetland areas that function differently. These WAAs are identified on the basis of wetland classification, physical separation, and potential project impacts. The criteria for identifying WAAs will differ depending upon the selected assessment procedure (refer to Section 7) and local policy. Possible criteria for distinguishing WAAs are difference in wetland classification, physical separation, and differences in predicted project impacts.

6.2.7 *Screen for Red Flags*—Red flags are features of a wetland or the surrounding landscape to which special recognition or protection is assigned on the basis of objective criteria. The recognition or protection may occur at a federal, state, regional, or local level, and may be official or unofficial **(21)** (refer to Table 2). These features are identified to determine whether the area will require special consideration prior to or during the assessment of wetland functions.

6.3 *Identification of Assessment Approach*:

6.3.1 *Identify, Modify, or Develop Assessment Models*—There are a variety of assessment models from which to choose that are contained in existing procedures (see Section 7). Identify the purpose or objective for which the assessment is needed. The objective will dictate what method may be appropriate and which ones will provide the needed information. Review these to determine which are most appropriate. Criteria to be considered are listed in Table 3. Users of this guide should note that some of the procedures cited are no longer acceptable to all resource agencies. It is critical to determine in advance which procedures are acceptable.

6.3.1.1 Decide whether to use the assessment models without change, modify and then use the assessment models, or

TABLE 2 Red Flag Features (9)

Areas protected under American Indian Religious Freedom Act
Hazardous waste sites identified under CERCLA or RCRA
Areas protected by a Coastal Zone Management Plan
Areas providing critical habitat for species of special concern
Areas covered under the Farmland Protection Act
Floodplains, floodways, or floodprone areas
Areas of high public use
Areas with structure/artifacts of historic or archeological significance
Areas protected under the Land and Water Conservation Fund Act
Areas protected by the Marine Protection Research and Sanctuaries Act
National Wildlife Refuges
Native lands
Areas identified in the North American Waterfowl Management Plan
Areas identified as significant under the RAMSAR Treaty
Areas supporting rare or unique plant communities
Areas designated as sole source groundwater aquifers
Areas protected by the Safe Drinking Water Act
Special management areas
State or national parks
Areas supporting threatened or endangered species
Areas with unique geological features
Areas protected by the Wild and Scenic Rivers Act
Areas protected by the Wilderness Act
Wetlands that have been restored, created, or converted

TABLE 3 Criteria to Consider When Identifying Modifying, or Developing Assessment Models,

Criteria	Specific Considerations
Wetland type	Is the model applicable to the wetland type(s)? An existing model describing one wetland type may be suitable, require minor modifications, or be unsuitable.
Functions	Is there a model for each of the pertinent functions?
Geographic area	Is the model applicable to the geographic area (for example, ecoregion, state, watershed)? Define the geographic region or context, and determine whether the model is appropriate. Minor or major modification may be required to ensure that the model is calibrated to the defined region.
Assessment situation	Is the model applicable to the assessment situation, (for example, watershed planning, regulatory action, management, use as guide to wetland design)?
Comparison of different wetland types	Is there a need to compare different wetland types? Note that when models are calibrated to describe particular wetland types within a region, it is inappropriate and meaningless to compare different wetland types. Choose models that will facilitate a comparison, if needed, or decide on how comparisons can be made.
Acreage	How does the model consider wetland acreage? Does or can the resulting measure of functional capacity incorporate acreage? Note that the assessment results are often used to make decisions regarding wetland function and acreage. For example, in permit actions it is necessary to define not only the functional capacity of the mitigation wetland, but also the acreage required to compensate for wetland impacts.

develop new assessment models. Models may be developed using available information including best professional judgment, expert opinion, published literature, empirical data, or a combination thereof. The rationale for the assessment models should be supported by the available information, particularly if models from an established assessment procedure are not being used. For guidance on developing, adapting, and calibrating assessment models, refer to **(9)** and **(17)**.

6.3.1.2 Select or develop the assessment models to adequately address the concerns of the decision makers. For example, the U.S. Fish and Wildlife Service would likely be concerned that the habitat function models adequately address fish and wildlife resource needs. The Service may specify that habitat function models be consistent with HEP **(22)** and thoroughly address the necessary food, cover, water and breeding requirements of all terrestrial and aquatic species expected to utilize a particular habitat type.

6.3.2 *Select the Units of Measure*—Wetland functions can be measured and expressed using quantitative (that is, interval or ratio) or qualitative (that is, nominal or ordinal) scales **(23)**. This guide recommends that the assessment models be used to express functions in terms of functional capacity index (FCI) and functional capacity units (FCs) to be consistent with the HGM Approach developed by the U.S. Army Corps of Engineers **(9)** (and similar indices used in the New Hampshire Method **(16)**, Evaluation for Planned Wetlands **(10)**, Indicator Value Assessment **(17)**, Index of Biological Integrity **(24)**, Water Quality Index **(25)**, Wetland Rapid Assessment Method **(26)**, and Habitat Evaluation Procedure **(22)**.

6.3.2.1 A functional capacity index (FCI) is an index of the capacity of a wetland to perform a function relative to other wetlands within a defined region or wetland class, or both. The index of 0.0 indicates that the wetland does not perform the function. An index of 1.0 indicates that the wetland is performing a function at maximum functional capacity. It is possible for an FCI to exceed 1.0.

$$FCI = \frac{\textit{functional capacity of a wetland assessment area}}{\text{max}\textit{imum functional capacity}} \quad (1)$$

The meaning of maximum functional capacity varies depending upon the assessment model, and whether it defines a standard of comparison (reference). Many assessment models simply define a maximum for wetlands, in general, and the standard of comparison is implied but not defined. In contrast, models being developed following the HGM Approach produce an FCI that measures the capacity of a wetland relative to reference standards. Reference standards are the conditions exhibited by a group of reference wetlands that corresponds to the highest level of functioning (highest sustainable functional capacity) across the suite of functions performed by the regional wetland subclass **(9)**. These reference standards are established for wetlands within a defined geographic region that belong to a single hydrogeomorphic subclass. The highest level of functional capacity is assigned an index score of 1.0 by definition. Guidance for establishing the standard of comparison (reference) following the HGM Approach is provided in **(9)** and **21)**.

6.3.2.2 The FCI is measured by using an assessment model. Existing assessment models may be used and their results converted easily to FCIs. For example, an index of 1.0 may be considered equivalent to the" high" of a model that rates wetland functions as low, moderate, or high, Numeric results of models using other scales (that is, 0 to 100) can also be converted to the 0 to 1.0 scale.

6.3.2.3 The functional capacity unit (FC) is measured as follows:

$$FCs = \text{FCI of } \textit{a wetland area multiplied by size of wetland area} \quad (2)$$

This measurement facilitates the comparison of different size wetlands. For example, the results of an assessment may show that two wetlands have the same functional capacity index (for example, FCI = 0.7), suggesting that there is no difference between them. A decision based solely on the FCI for these two wetlands could lead to erroneous conclusions, particularly if the wetlands are different sizes (that is, Wetland A = one acre and Wetland B = five acres). The index of the two wetlands may be the same, but because of the size difference, the FCs will differ (see explanation in 6.4.1.1).[5]

6.4 *Assessment Place*—Apply the assessment models to each wetland assessment area. Calculate and record the functional capacity indices (FCIs) and functional capacity units (FCs) for each function. Use care when predicting past or future conditions. To ensure the most accurate predictions possible, refer to several sources including personal experience, expert opinion, and the literature. Record assessment results for each wetland assessment in a standardized data sheet such as the one shown in Fig. 1. Comparisons of WAAs can be recorded in standardized data sheets such as those shown in Figs. 2 and 3.

6.4.1 *Units of Comparison*—The differences between wetlands are expressed in terms of functional capacity indices (FCIs), functional capacity units (FCs), and variable scores.

6.4.1.1 Simplified, a comparison of FCIs will provide information regarding the quality of the wetland's functional capacity, whereas the FCs will describe the quantity of functional capacity (see 6.3.2). Thus, a comparison made using FCIs indicates which wetland assessment areas (WAAs) have a greater capacity to perform a function on a unit area basis. The higher the FCI the greater the capacity per unit area. While this information is useful, it is important to remember that the size of the WAA is not considered in the FCI. It is equally important to consider FCs in any comparison because FCs represent the functional capacity of the WAA as a whole based on its FCI and spatial extent. Consider the following example of an alternatives analysis. The first alternative involves the loss of a two-acre WAA with an FCI of 0.9 and FCs of 1.8, and the other alternative involves the loss of a 20-acre WAA with an FCI of 0.4 and FCs of 8.0. If the decision to select the last damaging alternative is based strictly on FCI, the second alternative with the lowest FCI (lower quality) may be selected. However, if the decision is based on FCs so that size is considered, the first alternative with the least number of FCs is the least damaging.

6.4.1.2 Comparisons are also made at the most basic level of the assessment model, the variable. Variable conditions will vary in the wetland and, at extremes, may diminish or maximize functional capacity. The conditions for each variable are assigned different scores in the assessment models based upon their contribution to the functional capacity, that is, a condition that increases the capacity of a wetland to perform a function is assigned a higher score. These data are then used in the models to derive FCIs. The scores for each variable are compared after the assessment has been completed (see Fig. 3). The information on the variables is important because it provides an explanation of why the wetlands' functional capacities differ. This may be important, for example, in the identification of specific conditions that can be improved on in a planned wetland design.

6.5 *Analysis Phase*

6.5.1 *Types of Comparisons*—Once the functional capacities of each wetland assessment area (WAA) are documented, three types of comparison can be made. These are:

6.5.1.1 Comparison of the same WAA at different points in time,

6.5.1.2 Comparison of two or more WAAs at the same point in time, and

6.5.1.3 Comparison of WAAs at different points in time.

6.5.2 *Comparison of the Same WAA at Different Points of Time*—This represents the most common type of comparison of regulatory projects, that is, the comparison between pre-project and post-project impact conditions of the same WAA.

[5] It should be noted that the use of quantitative indices (such as FCI) carries a proportionality assumption which may not be valid. For example, a wetland which has a FCI of 0.5 is not necessarily performing the function at twice the level as a wetland with a FCI of 0.25, even though the numbers imply this relationship. Similarly, there may be a scaling factor which is lost by simply multiplying the FCI by acreage to derive FCs. The use of quantitative units of measure is still recommended to be consistent with current practice (refer to approaches listed in 6.3.2).

Summary of Functional Capacities Under Existing or Predicted Conditions			
Date:			
Project:			
Wetland Assessment Area:			
Assessors:			
FUNCTION	**FCI**	**SIZE OF WAA IN ACRES**	**FCs**

FIG. 1 Data Sheet for Recording Assessment Results for One Wetland Assessment Area

Date:
Project:
Comparison between WAA # ____ and WAA # ____
Assessors:

	WAA # ____			WAA # ____			Net Difference
FUNCTION	FCI	SIZE IN ACRES	FCs	FCI	SIZE IN ACRES	FCs	FC +/-

FIG. 2 Data Sheet for Comparing FCIs and FCs of Wetland Assessment Areas

Date:
Project:
Comparison between WAA # _____ and WAA # _____
Assessors:

	FCI		Difference in model variables and condition(s) with explanatory comments
FUNCTION	WAA # ____	WAA # ____	

FIG. 3 Data Sheet for Comparing the FCIs and Assessment Model Variables of Two Wetland Assessment Areas

This type of comparison is also common with planned wetlands, particularly those involving restoration or enhancement. In either situation, a simple direct comparison can be made between a single WAA assessed at two points of time. The results can be recorded in standardized data sheets such as those shown in Figs. 2 and 3. Some situations may require the comparison of the same wetland area at several different points of time, especially when there is a concern regarding the cumulative loss of functional capacity as a result of a time lag or delays. For example, a developing planned wetland may take several years to achieve the desired levels of functional capacity. Compensation may be required if the loss of functional capacity during a time lag is substantial. The basic steps to making this type of comparison include:

6.5.2.1 Select target years for future prediction,

6.5.2.2 Predict area of WAA that will perform the function in future years,

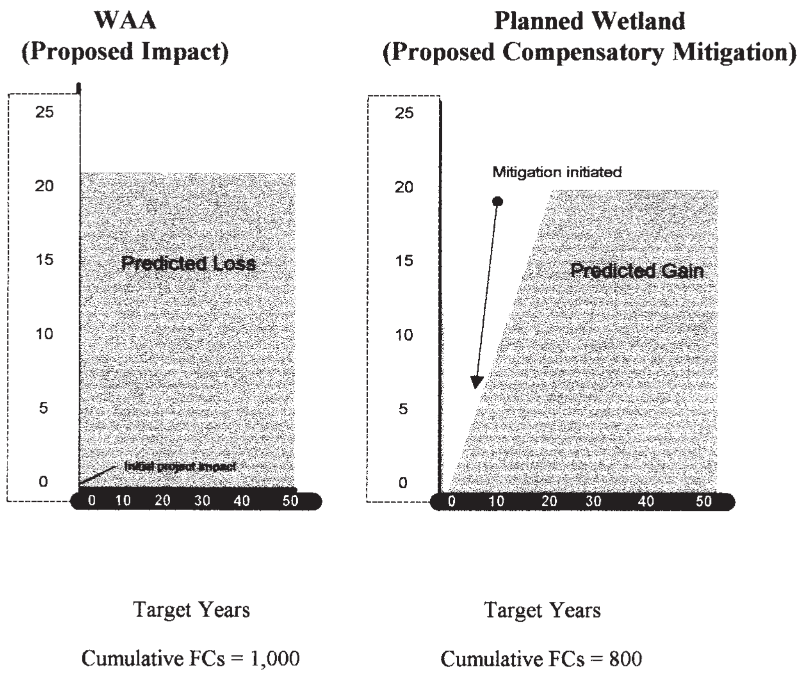
6.5.2.3 Predict FCIs and FCs for future years,

6.5.2.4 Calculate cumulative FCs, and

6.5.2.5 Calculate difference between cumulative FCs for WAAs being compared.

6.5.2.6 Several methods can be used for calculating cumulative FCs. The easiest is to graph the assumed linear relationship between broadly spaced target years, estimate the area under the curve, and then calculate the difference between FCs lost and FCs gained (see Fig. 4). Better estimates of FC loss can be made by using more narrowly spaced target years, or known nonlinear relationships.

6.5.3 *Comparison of Two or More WAAs at the Same Point in Time*—Examples of situations when two or more WAAs may be compared include an alternative analysis for regulatory actions (see 6.4.1.1) or a wetland inventory for watershed planning.



NOTE 1—Difference in cumulative FCs = 200; therefore, the planned wetland provides 200 less FCs than predicted loss from proposed impact.

FIG. 4 Example Illustrating Comparison of Cumulative FCs Through Graphing Predicted FCs

6.5.4 *Comparison of WAAs at Different Points in Time*—Comparing WAAs at different points in time is common with regulatory projects that require compensatory mitigation. The comparison is made between existing conditions of a wetland prior to impact and the predicted future conditions of the planned wetland.

6.5.5 *Other Criteria to Consider When Comparing Wetland Assessment Areas*—The assessment models provide information on functional capacity expressed in terms of FCIs and FCs and individual variables (see 6.4.1). Several other criteria are considered in comparing wetlands. These include wetland class, red flags, wetland vulnerability, wetland rarity, and feasibility of mitigation. With the exception of functional capacity, all other criteria involve a subjective value judgment and need to be thoroughly justified and documented.

6.5.5.1 *Wetland Class*—Caution must be taken when comparing WAAs of different wetland types of class. The assessment models of some procedures allow the comparison of different wetland types, but many do not. According to **(9)**, wetlands in different hydrogeomorphic classes cannot be compared directly because their functional capacity indices are calibrated based on different reference wetlands. The comparison of wildlife habitat functional capacity for different wetlands such as an ombotrophic peatland and a salt marsh would be considered meaningless. Although direct comparisons cannot be made, the measures of functional capacity (FCIs and FCs) may still be useful because they provide information regarding the WAA relative to wetlands within the same regional subclass. Consider the following example involving the choice between impacting 10 acres of riverine bottomland hardwood forest or in ten acres of depressional marsh. The riverine wetland has a wildlife habitat FCI of 0.9 and the depressional wetland FCI is 0.4. The higher FCI for the riverine wetland indicates that it is closer to the reference condition for the wildlife function then the depressional wetland. It may be reasonable to conclude that the wildlife habitat function provided by the riverine forested wetland is more valuable because it provides nesting habitat for neotropical migrant birds, a group currently considered to be in decline.

6.5.5.2 *Functions*—A comparison of wetlands often shows that no one WAA has the highest functional capacities for all functions. For example, one WAA may have the greater wildlife habitat functional capacity and the other WAA may have the greater water quality functional capacity. Some situations, such as a regulatory project, may require a choice between wetlands. The choice between wetlands may come down to a choice between which function is considered less valuable in the specific context.

6.5.5.3 *Red Flags*—The occurrence of a red flag feature may provide sufficient justification to remove a WAA from consideration. For example, a wetland which has endangered species, is rare, or contains historic properties may be considered more valuable and thus removed from a list of potential alternative project sites.

6.5.5.4 *Wetland Vulnerability*—Some wetland types are inherently more vulnerable to impacts than others due to their hydrogeomorphology or location. For example, a given length of fill could have a profound impact by blocking tidal flow to a salt marsh. The same length of fill might only have a minimal impact on a depressional wetland with no outlet. Also, wetlands located more closely to populated areas may be more vulnerable to impacts associated with development. The choice between such wetlands may be decided solely on the basis of which one is more vulnerable in a specific context.

6.5.5.5 *Feasibility of Mitigation*—Some wetland types and their functions are more easily compensated for than others. A choice between wetland impacts may come down to a selection of the wetland type which is easier to replace.

7. Assessment Procedures

7.1 Assessment models are available within a variety of procedures. Table 4 provides a current listing and additional information which can be used in selecting appropriate models. Detailed review of some of these procedures are contained in Refs **(27-29** and **63)**.

7.2 *Properties to Consider When Selecting Procedure or Models*:

7.2.1 *General Principles*—The choice of an assessment procedure or model depends on many factors, especially assumptions that decision makers are willing to accept. Reference **(23)** suggest the following general principles be used to guide the choice of a procedure. The procedure should:

7.2.1.1 Be biased on principles and assumptions that are valued (if feasible) and easily illustrated,

7.2.1.2 Yield results understandable to decision makers and the public,

7.2.1.3 Make explicit subjective values and judgments,

7.2.1.4 Yield results that are repeatable given certain explicit assumptions,

7.2.1.5 Allow use of qualitative and quantitative information in a methodologically sound way,

7.2.1.6 Stimulate the imagination of decision makers and increase insight into the choice to be made,

7.2.1.7 Enable the use of information at different spatial scales, and

7.2.1.8 Allow consideration of alternatives both separately and in combination.

7.2.2 *Section 404*[3] *Regulatory Actions*—Reference **9** indicates that the assessment procedure must satisfy one or more of the basic programmatic or technical requirements to receive widespread acceptance or utilization in the Section 404 program at a national level. These requirements included the following:

7.2.2.1 Standardized and documented approach,

7.2.2.2 Applicability throughout the public interest review sequence,

7.2.2.3 Applicability across the geographic extent of the U.S. Army Corps of Engineers regulatory jurisdiction,

7.2.2.4 Applicability to a variety of wetland types,

7.2.2.5 Applicability to a variety of wetland functions,

7.2.2.6 Compatibility with the time and resources available for the public interest review process,

7.2.2.7 Accuracy and precision that is consistent with the time and resources available,

7.2.2.8 Sensitivity to different types of impacts at levels at which wetland functions are affected,

7.2.2.9 Adaptability to a variety of regulatory, management, and planning applications,

7.2.2.10 Defined standards of comparison,

7.2.2.11 Capability to incorporate new technical information as it becomes available, and

7.2.2.12 Capability to incorporate new or changing programmatic requirements.

7.2.3 *Appropriate for Planned Wetland Design*—Some assessment procedures are not suitable for the mitigation process and can lead to unfounded planned wetland design criteria. An assessment procedure must have the following properties to be suitable, particularly if it will be used as a guide to design **(10)**:

7.2.3.1 Document both the procedure and results. This will facilitate the design and review of the planned wetland. The format should allow the designer and decision maker to readily identify elements that are important to each function. It should provide for easy extraction to improve the functional capacity in the planned wetland.

7.2.3.2 Provide validated threshold values for design elements. Threshold values should not be used, unless they can be literature-validated or validated through consultation with experts. Threshold values are cutoff values used in the assessment model, above or below which it is believed that a wetland's capacity to perform a function changes substantially. For example, the model may assume that a $\geq$ to 20-ft wide wetland will effectively provide the shoreline erosion control function; anything less would be considered ineffective. Different assessment models use different threshold widths (for example, 8, 10, 20, 600 m). If the assessment model is used as a guide to design, then substantially different design criteria could be obtained depending upon the model used. Based upon the example given, the recommended minimum width could vary from 8 to 600 m.

7.2.3.3 Include variables applicable to planned wetland design. Models from rapid assessment procedures often use a minimum number (for example three to five) of variables to assess each function. Although it lengthens the assessment time, it is important that variables critical to wetland design be included.

7.2.3.4 Avoid using variables that describe opportunity in models designed to measure functional capacity. Opportunity variables are those characteristics of a wetland or its surroundings that determine if the opportunity is available for that wetland to perform a function. Opportunity variables are used with other structural variables to describe functional capacity in most models. The rationale is that the wetland is more valuable when the opportunity for performing the function is present. Many of the opportunity variables describe conditions that, if excessive, could change a wetland's functional capacity. For example it is often assumed that greater pollutant input makes a wetland more valuable for the water quality function. This assumption may be invalid. Studies on the use of wetlands for wastewater treatment have demonstrated that, after several years, some wetlands that initially served as nutrient sinks reach their assimilatory capacity for certain chemical constituents. Many assessment models do not set an upper limit on opportunity variables. Without an upper limit, the model may assign a high rating erroneously when the capacity of the wetland to perform a function may be minimal or exceeded due to excessive pollutant input. Opportunity variables should only be used in the models to note conditions which could reduce the planned wetland's functional capacity.

7.2.3.5 Be sensitive to detect differences between wetlands. The assessment model must be sensitive enough to detect planned wetland improvements.

TABLE 4 Summary of Some Wetland Assessment Procedures

Procedure Title: Citation	Units of Measure	Application		Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
		Wetland Types	Geographic Area				
Approach for assessing wetland functions based on hydrogeomorphic (HGM) classification, reference wetlands, and functional indices **(9), (18), (21)**	Functional capacity indices (FCI) (scale 0 to 1.0) and functional capacity units (FCs). Functions separate.	Conceptually applicable to all wetland types; but not all assessment models are developed.	Widespread application: assessment models calibrated to regional wetland subclass using reference wetlands.	Regulatory actions Impact assessment Management Planning Mitigation	Relatively rapid, after initial development and scaling of models.	Yes	Requires scaling models to wetlands in defined region. Cannot use FCIs and FCs to directly compare wetlands in different hydrogeomorphic classes, but can use information to aid in decision. Provides measure of function that accounts for size (FCs).
Wetland rapid assessment procedure (WRAP) **(26)**	Ecological integrity index (scale 0 to 1.0). Functions assessed separately, but scores for each function pooled to obtain one index for a wetland.	Depressional wetlands	South and Central Florida (can be modified for North Florida)	Regulatory actions Mitigation	Relatively rapid	Yes	Index not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.
North Carolina Coastal Region Evaluation of Wetland Significance (NC-CREWS) **(5)**	Overall ecological significance (high, medium, or low) and function ratings (H, M, or L). Functions separate, but also combined to derive overall rating of ecological significance.	All wetland types	North Carolina coastal area	Planning Management To predict ecological relative significance of wetlands within watershed or region	Relatively rapid	Yes	GIS-based landscape scale procedure; thus, does not provide the site-specific detail which is desired for many applications. Rankings and indices not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.

TABLE 4 *Continued*

Procedure Title: Citation	Units of Measure	Application		Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
		Wetland Types	Geographic Area				
Minnesota routine assessment method for evaluating wetland functions (MinRAM) **(30)**	Low, medium, high, exceptional and not applicable functional level ratings. Functions separate.	Freshwater wetlands	Minnesota	Regulatory actions	Relatively rapid	No: There are no models. Evaluator answers questions that are used to guide the evaluation. Best professional judgment (BPJ) then used to rate significance. BPJ may be used to estimate functional capacity, but modifications required to ensure this.	Cannot use rankings or ratings to directly compare wetlands in different wetland class, but can use information to aid in decision. Rating not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.
Wetland functions and values: A Descriptive Approach **(31)**	Yes or no answer indicating whether function/value occurs. Functions separate.	Applicable to all wetland types.	New England area	Regulatory actions	Relatively rapid	No. There are no models. Evaluator provided lists of functions, values, and considerations that are used to guide the evaluation. Best professional judgment (BPJ) is then used to determine whether a function occurs.	Results not multiplied by acres, thus does not prove measure of functional capacity that accounts for size. Comparison of different wetland types possible.
Wildlife Habitat Appraisal Procedure (WHAP) **(32)**	Average habitat quality score (scale 0 to 1.0) and habitat units (HUs) for biological component. Functions and values assessed separately.	All wetland types	Texas	Impact assessment Inventory Mitigation Management Wetland acquisition	Relatively rapid	Yes. The biological habitat component model does. No. Other models combine function and value. Modifications required to achieve measure of functional capacity.	Provides measure of functional capacity that accounts for size (HUs), but only for biological component. Comparison of different wetland types possible

TABLE 4 *Continued*

Procedure Title: Citation	Units of Measure	Application		Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
		Wetland Types	Geographic Area				
Semantic Categorization Method for Assessment of Wetland Impacts **(33)**	Impact score (scale −4 to +4). Functions separate.	Riverine wetlands, but conceptually applicable to other types with the development of appropriate functions and reference standards.	Southern California	Regulatory actions Impact assessment Mitigation	Relatively rapid	No. Provides measure of change in functional capacity.	A comparative evaluation of functions before and after project implementation. Score not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.
A Method for the Assessment of Wetland Function **(34)**	Functional capacity index (FCI) (scale 0 to 1.0), functional capacity units (FCU), and total functional capacity units. Functions separate but FCUs also added to derive total FCUs for a wetland.	Non-tidal palustrine vegetated wetlands.	Maryland piedmont and eastern shore (coastal plain).	Broad area planning (e.g., watershed) Mitigation	Relatively rapid	Yes	Contains 2 models types: (1) GIS-based landscape scale desk top models and (2) a field method, that requires a site visit. The desk top does not provide the site specific detail which is desired for many applications. Provides measure of function that accounts for acreage (FCU). Comparison of different wetland types possible.
Wetland quality index (WOI) **25**	Wetland quality index (WQI) (scale 0 to 1.0) and wetland functional value (WFV). Function categories combined to derive one index for a wetland.	Freshwater wetlands.	Everglades in Florida	Mitigation	Relatively rapid	Yes	Provides measure of function that accounts for size (WFV).

TABLE 4 *Continued*

Procedure Title: Citation	Units of Measure	Application		Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
		Wetland Types	Geographic Area				
Evaluation for Planned Wetlands (EPW). **(10)**	Functional capacity indices FCI (scale 0 to 1.0) and Functional capacity units (FCUs). Functions separate.	Applicable to all wetland types.	Widespread application	Regulatory actions Impact assessment Management Mitigation Planned wetlands	Relatively rapid	Yes	Procedure recommends modification of models, where needed, to ensure applicability to region. Provides measure of function that accounts for size (FCUs). Cannot use FCIs and FCUs to directly compare wetlands in different wetland classes, but can use information to aid in decisions.
Guidance for rating the values of wetlands in North Carolina **(35)**	Ratings for each function (scale 0 to 5). Wetland score based upon the combined weighted ratings for each function (scale 1 to 100). Functions combined.	Freshwater wetlands	North Carolina	Regulatory actions (401 water quality certifications) Inventory Restoration Mitigation banks Acquisition	Relatively rapid	No: Models combine function and value; modifications required to achieve measure of functional capacity.	Designed to evaluate values. Rating not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.
Indicator value assessment (IVA) **(17)**	Performance score and value score (scale 0 to 100). Functions separate.	Conceptually applicable to all wetland types, but not all assessment models are developed.	Widespread application. Assessment models calibrated to regional wetlands using reference wetlands.	Regional planning Impact assessment Identify potential wetland enhancement areas	Relatively rapid, after initial development and scaling of models.	Yes	Models for each function for wetland within planning region or watershed (total number variable). Score not multiplied by acres, thus does not provide measure of functional capacity that accounts for size. Requires scaling models to wetlands in region. Comparison of different wetland types possible.

TABLE 4 *Continued*

Procedure Title: Citation	Units of Measure	Application		Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
		Wetland Types	Geographic Area				
Buffalo District wetland evaluation method **(36)**	Function score (scale 7 to 30, depending on function). Functions separate.	Depressional wetlands (Draft versions for riverine and lake-fringe wetlands).	Ohio	Regulatory actions Mitigation	Relatively rapid	No: Document states that evaluations are not considered models; modifications required to achieve measure of functional capacity.	Score not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.
Wetland Value Assessment Methodology and Community Models (WVA) **(37)**	Habitat suitability index (HSI) (scale 0 to 1.0) and habitat units (HUs). Wetland type separate; pool index for each type to obtain one score (total HUs) for a wetland.	Coastal wetlands: fresh (intermediate) marsh, brackish marsh, saline marsh, and cypress-tupelo swamp.	Louisiana	Wetland enhancement projects	Relatively rapid	Yes	Modification of the Habitat Evaluation Procedure (HEP). Only habitat function. Provides measure of function that accounts for size (HUs).
Wildlife Habitat Assessment and Management System (WHAMS) **(38)**	Habitat suitability index (HSI) (scale 0 to 1.0 and Habitat Units (HUs). Species separate. Pool index for each species to obtain one score (total HUs) for a wetland.	Freshwater wetlands and terrestrial habitats.	Pennsylvania and possibly other areas.	Wildlife management planning	Relatively rapid	Yes	Modification of the Habitat Evaluation Procedure (HEP) and PAM HEP; simplified to reduce time requirement. Modified for use as a wildlife management planning tool. (Remarks same as for HEP).
Oregon freshwater wetland assessment methodology **(39)**	Wetland descriptor indicating whether the wetland provides, has the potential to provide, or does not provide a function. Functions separate.	Freshwater wetlands	Oregon	Inventory Planning Education	Relatively rapid	No. Models produce probability ratings (that is, an estimate of the probability that a function will occur to an unspecified magnitude); not a measure of functional capacity.	Tool for those with some knowledge of wetlands (for example, town commissions), but not necessarily wetland ecologists. Descriptor not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.

TABLE 4 *Continued*

Procedure Title: Citation	Units of Measure	Application		Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
		Wetland Types	Geographic Area				
Ontario wetland evaluation system **(40), (41)**	Score for each function (scale 0 to 250). Functions separate, but scores combined to achieve total wetland score.	Freshwater wetlands	Northern and Southern Ontario, Canada	Planning	Relatively rapid	Yes	Score not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.
Coastal Method **(42)**	Average functional indexes (AFI) (scale 0 to 1.0). Functions separate.	Coastal wetlands	New Hampshire	Inventory Planning Education	Relatively rapid	Yes	Tool for those with some knowledge of wetlands (for example, town commission), but not necessarily wetland ecologists. Index not multiplied by acres, thus does not provide measure of functional capacity that accounts for size for comparison of different marsh systems. However, relative size considered for comparisons of ecological units within a marsh system.
Synoptic Approach to Cumulative Impact Assessment **(3), (4)**	Four general synoptic indices that are refined based upon project objectives: function, value, functional loss, and replacement potential. Functions separate.	Conceptually applicable to all wetland types; however, requires collection and analysis of available maps and tabular data.	Widespread application	Cumulative effects analysis	Relatively rapid, after initial collection of data for landscape unit (for example, watershed).	Yes. Function indices do. No. Models for other indices (value, functional loss, and replacement potential) do not.	Landscape scale procedure; thus, does not provide the site specific detail which is desired for many applications. Requires collection and analysis of data for wetlands within defined region. Indices not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.

TABLE 4 *Continued*

Procedure Title: Citation	Units of Measure	Application		Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
		Wetland Types	Geographic Area				
Wisconsin Rapid Assessment Methodology **(43)**	Low, medium, high, exceptional and not applicable significance rating. Functions separate.	Freshwater wetlands	Wisconsin	Regulatory actions	Relatively rapid	No. There are no models. Evaluator answers questions that are used to guide the evaluation. Best professional judgment (BPJ) then used to rate significance. The BPJ may be used to estimate functional capacity, but modifications required to ensure this.	Rating not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.
New Hampshire Method **(16)**	Functional Value Indexes (FVI) (scale 0 to 1.0) and Wetland Value Units (WVU). Functions separate.	Nontidal wetlands	New Hampshire	Inventory Planning Education	Relatively rapid	No. Some models combine function and value. Modifications required to achieve measure of functional capacity.	Tool for those with some knowledge of wetlands (for example, town commission), but not necessarily wetland ecologists. Provides measure of function that accounts for size (WVU).
A technique for the functional assessment of nontidal wetlands in the coastal plain of Virginia **(44)**	Low, moderate, or high probability rating of opportunity and effectiveness at performing function. Functions separate.	Nontidal wetlands	Coastal plain of Virginia	Inventory	Relatively rapid	No. Some models produce probability ratings (that is, an estimate of the probability that a function will occur to an unspecified magnitude); not a measure of functional capacity. Also, some models combine function and value. Modifications required to achieve measure of functional capacity.	Rating not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.

TABLE 4 *Continued*

Procedure Title: Citation	Units of Measure	Application: Wetland Types	Application: Geographic Area	Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
Wildlife Habitat Appraisal Guide for Missouri **(45)**	Farm habitat index (scale 0.1 to 1.0) and habitat quality rating (excellent, good, fair, or poor). Species separate. Habitat type separate. Pool index for each habitat type to obtain farm habitat index and habitat quality rating for each species.	Freshwater wetlands and terrestrial habitats	Missouri	Management	Relatively rapid	Yes	Only habitat function. Acreage used in calculation of farm habitat index; however, only as a weighting factor. Index not multiplied by acres, thus does not provide measure of functional capacity that accounts for size. Comparison of different wetland types possible.
Habitat Assessment Technique (HAT) **(46)**	Faunal index (scale 0 to 360+ depending on wetland size). Bird species separate, pool scores for each bird species to obtain one faunal index for a wetland.	All wetland types	Widespread application	Regulatory actions Acquisition	Not rapid	Yes	Only habitat function. Requires bird inventory during breeding season in study wetland. Provides measure of function that accounts for size (faunal index). Requires scaling model to wetlands in defined region, that is, species must be assigned points based on breeding population in region.
Minnesota Wetland Evaluation Methodology (WEM) **(47)**	High, moderate, or low probability rating. Functions separate, but option to combine ratings is provided.	Freshwater wetlands	North Central United States	Regulatory actions	Relatively rapid	No. Some models produce probability ratings (that is, an estimate of the probability that a function will occur to an unspecified magnitude); not a measure of functional capacity. Also, some models combine function and value. Modifications required to achieve measure of functional capacity.	Rating not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.

TABLE 4 *Continued*

Procedure Title: Citation	Units of Measure	Application: Wetland Types	Application: Geographic Area	Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
Wetland Evaluation Technique (WET) **(48), (49)**	High, moderate, or low probability rating of social significance, opportunity, and effectiveness. Functions separate.	Applicable to all wetland types of contiguous U.S.	Widespread application	Regulatory actions Impact assessment Management Planning	Relatively rapid	No. Some models produce probability ratings (that is, an estimate of the probability that a function will occur to an unspecified magnitude); not a measure of functional capacity. Also, some models combine function and value. Modifications required to achieve measure of functional capacity.	Rating not multiplied by acres; thus does not provide measure of functional capacity that accounts for size.
Connecticut Method **(50)**	Functional Value Indices (FVI) (scale 0 to 1.0) and Wetland Value Units (WVUs). Functions separate.	Nontidal wetlands	Connecticut	Inventory Education Planning	Relatively rapid	No. Some models combine function and value. Modifications required to achieve measure of functional capacity.	Tool for those with some knowledge of wetlands (for example, town commission), but not necessarily wetland ecologists. Provides measure of functional capacity that accounts for size.
Index of Biotic Integrity **(24), (51), (52)**	Index of biotic integrity (IBI). One function.	All freshwater wetlands that provide fish habitat.	Widespread application	Inventory	Not rapid	Yes	Requires collection of fish samples. One function. IBI not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.
A method for assessing the functions of wetlands **(53)**	Scores (scale differs for each function; range from 3 to 158). Functions separate, then assigned weights/ranked and wetland assigned one decile score (0-10).	Nontidal wetlands	New England states. Some midwestern states, and possibly other areas.	Regulatory actions Management Planning	Relatively rapid	No. Some models combine function and value. Modifications required to achieve measure of functional capacity.	Score not multiplied by acres, thus does not provide measure of functional capacity that accounts for size.

TABLE 4 *Continued*

Procedure Title: Citation	Units of Measure	Application		Use	Time Required	Do Models Provide Measures of Functional Capacity?	Remarks
		Wetland Types	Geographic Area				
Habitat Evaluation Procedure (HEP) **(22)**	Habitat suitability indices (HSI) (scale 0 to 1.0) and Habitat Units (HUs). Species separate. Pool index for each species to obtain one score (total HUs) for a wetland.	Nontidal wetlands, tidal wetlands, and terrestrial habitats.	Widespread application; regionalized by selection of indicator species assessment models which are applicable to region.	Regulatory actions Impact assessment Management Mitigation	Not rapid	Yes	Models describe habitats of selected fish, wildlife, or invertebrates: pool index for each selected species to give one score for wetland. Provides measure of function that accounts for size (HUs). Only habitat function. Comparison of different wetland types possible
Pennsylvania Habitat Evaluation Procedure (PAM HEP) **(54), (55)**	Habitat suitability index (HSI) (scale 0 to 1.0) and Habitat Units (HUs). Species separate. Pool index for each species to obtain one score (total HUs) for a wetland.	Freshwater wetlands and terrestrial habitats.	Developed for Pennsylvania but has been applied in other states.	Wildlife habitat assessment Regulatory actions Impact assessment Mitigation.	Relatively rapid	Yes	Modification of the Habitat Evaluation Procedure (HEP); simplified to reduce time requirement. (Remarks same as for HEP).
Wildlife wetland evaluation model **(56)**	Wetland score (scale 36 to 108). (One functional).	Freshwater wetlands	Massachusetts and possibly other northeastern states.	Regulatory actions Management Planning	Relatively rapid	Yes	Score not multiplied by acres, thus does not provide measure of functional capacity that accounts for size. Only habitat function.

8. Keywords

8.1 assessment; design; ecology; function; functional capacity; index; mitigation; planned wetland; variables; wetland

APPENDIX

(Nonmandatory Information)

X1. WETLAND CREATION, ENHANCEMENT, RESTORATION, OR CONSTRUCTION

X1.1 A specific situation when wetland functions are assessed is during the development of planned wetlands. Planned wetlands encompass a variety of activities such as wetland creation, enhancement, restoration, or construction. Planned wetlands may be designed to compensate for the loss of functions resulting from project impacts, or be associated with a non-permit restoration effort. In either case, if information on the adequacy of the planned wetland with regard to function is desired, an assessment may be performed and the results compared to some baseline condition. Assessment models may be used during one or more steps in the planned wetland process that include defining goals, site selection, design, and assessment. The following steps follow those prescribed in Bartoldus et al **(10)**. The use of assessment models may not be deemed necessary such as with small planned wetlands. In other situations, the collection of additional data may be required. A decision as to what is needed must be made on a case-by-case basis.

X1.2 *Define Goods for Planned Wetland*—The goals should be defined based on the results of the comparison of WAAs and recommendations of participating federal, state, or local agencies. If the goals are established for a permit action, they become part of the mitigation requirements.

X1.2.1 Potential goals could include:

X1.2.1.1 Providing the same functions at the same level of functional capacity (that is, equal FCIs and FCs),

X1.2.1.2 Providing the same functions at a different level of functional capacity (that is, greater or less FCIs and FCs),

X1.2.1.3 Maximizing functional capacity of one or several functions that are not or poorly provided in the WAA,

X1.2.1.4 Establishing the same wetland class with same the vegetative cover types,

X1.2.1.5 Establishing the same wetland class with different vegetative cover types, and

X1.2.1.6 Establishing a different wetland class.

X1.2.2 Planned wetland goals can be defined in a variety of ways depending upon the project. However, they should ultimately be expressed in terms of Target FCIs and Target FCs. For example, the goals for FCIs in the planned wetland can be expressed as a simple statement such as the planned wetland FCIs must meet or exceed the FCI for each function in the WAA. If the comparison involves more than one baseline WAA with a broad range of FCIs (for example, from 0.1 to 0.6), then the goal may be to achieve the highest FCI (for example, FCI equal to 0.6). Target FCs for each function are calculated as follows:

$$\text{Target } FCs = FCs \times R \quad \text{(X1.1)}$$

where:

Target FCs = target functional capacity units,
FCs = total functional capacity units for the WAA, and
R = multiplying factor used to generally increase the amount of compensation

If the goal is to provide equal compensation, then the Target FCs will equal the FCs for the WAA, and no multiplying factor is used. If the goal is to provide greater compensation (for example, 2:1 mitigation ratio), then the Target FCs are calculated by multiplying the FCs by the appropriate factor (for example, $R = 2$). Ratios described here are included for purposes of illustration and do not represent a standard ratio. Experience indicates that each wetland mitigation scenario yields a unique mitigation ratio based upon factors specific to each project. Target FCIs and Target FCs can be recorded in standardized data sheets such as those shown in Table X1.1. Reasons for requiring greater than/equal to 1 to 1 compensation include the following.

X1.2.2.1 *Mitigation Ratios*—Some federal, state, and local agencies have instituted regulations or policies that stipulate mitigation ratios. The ratios have often been set in response to unsuccessful planned wetlands. Since planned wetlands are frequently perceived as being unsuccessful, or not totally successful, ratios are established to provide compensation for the anticipated failure of some portion of a project. The hope is that a larger planned wetland will provide some guaranteed compensation for the losses. In some cases, standard ratios are stipulated in regulations or guidelines, or both, that are required for mitigation projects. The ratio may be the same for all wetland types (that is, 3:1) or different depending upon the WAA (that is, 1:1 for emergent wetland replacing emergent wetland or 3:1 for emergent wetland replacing forested wetland). In other cases, standard ratios are required for the planned wetland when it involves mitigation for a rare wetland type.

X1.2.2.2 *Out-of-Kind Mitigation*—Depending upon the wetland type involved, decision makers may recommend the construction of a relatively larger or smaller planned wetland of another wetland type.

TABLE X1.1 Comparison of WAA and Planned Wetland: Calculations of FCIs and FCs (Modified from (10))

Project Title: Marley Creek

Comparison between WAA #1 and Planned Wetland #1

	WAA			Goals for Planned Wetland					Planned Wetland			
Function	FCI	Size, Acres	FCs[A]	Target FCI[B]	R[C]	Target FCs[D]	Predicted FCI[E]	Minimum Size[F]	FCI	Size, Acres	FCs	Check if Goals Met
Shoreline Bank Erosion Control	0.7	0.5	0.4	> 0.7	1	0.4	0.7	0.5	0.97	2	1.9	√
Sediment Stabilization	0.83	1.5	1.2	> 0.8	1	1.2	0.8	1.5	0.90	2	1.8	√
Water Quality	0.92	1.5	1.4	> 0.9	1	1.4	0.9	1.6	0.83	2	1.7	NO
Wildlife	0.54	1.5	0.8	> 0.06	1	0.8	0.6	1.3	0.35	2	0.7	NO

[A] FCs = FCI × area.
[B] Target FCI = goal established by decision makers.
[C] R = multiplying factor established by decision makers.
[D] Target FCs = FC of the WAA multiplied by R (that is, the planned wetland goal).
[E] Predicted FCI = FCIs that designers presume planned wetland may achieve at a particular site. (Note—this may be greater than Target FCI.)
[F] Minimum area = target FCs/predicted FCI.

X1.2.2.3 *Off-Site Mitigation*—If a nearby site is not available, the planned wetland may be located in a different locale (for example, out of watershed) far from the WAA. Since compensation is not provided in the same area, decision makers may recommend construction of a larger planned wetland.

X1.2.2.4 *Time Lag*—This refers to the loss in functional capacity during the period of time it takes the planned wetland to reach long-term functional capacity goals. It may not be feasible to construct a wetland that will immediately provide all of the desired functions. For example, a planned wetland planted with saplings may be designed for the long-term goal of a forested wetland. Decision makers may choose to estimate these losses by comparing the same wetland at different points in time which is time consuming, or simply require additional acreage to offset the anticipated loss of function during the period while the planned wetland is maturing.

X1.2.2.5 *Anticipated Failure in the Development of Some Portion of the Planned Wetland*—With the construction of wetlands, it is possible that some portion will not become established as planned. Possible causes of the failure may include plant die off from waterfowl grazing, muskrat eatouts, drought, or vandalism. It is common practice for decision makers to require a larger planned wetland with the hope of providing some guaranteed compensation for the total losses associated with the WAA.

X1.2.3 *Estimate Minimum Area Required to Meet Goals*—Before initiating the search for a planned wetland site, estimate the minimum area required to achieve the Target FCs. This exercise can save time by restricting the search to the sites with the potential to achieve the desired goals. Predicted FCIs must be defined before an estimate of minimum area can be made. Predicted FCIs are the FCs that the planned wetland is predicted to achieve. Define predicted FCIs based on a realistic assessment of the functional capacity of similar wetlands in the region. Note that the predicted FCIs are just estimates, and the FCIs achieved in the planned wetland design can differ from the predicted FCIs. Predicted FCIs should be recorded on standardized data sheets such as shown in Table X1.1. The minimum area is the minimum acreage required to satisfy the Target FCs for each function being considered in the planned wetland. Calculate minimum area as follows:

$$Minimum\ area = Target\ FCs/Predicted\ FCI \quad (X1.2)$$

For example, it may be determined that the planned wetland has the potential to provide relatively high-quality wildlife habitat, and thus the Predicted FCI is set at 0.8. If the wildlife habitat function Target FCs = 6.6 units, then the minimum area would be 8.25 acres.

X1.2.3.1 The steps to determining Target FCs and minimum areas are illustrated in Table X1.1. In the example, the minimum acreage required for the planned wetland is less than the acreage of the WAA. The smaller acreage can be attributed to the predicted FCIs of the planned wetland which are equal to or higher than the FCIs in the WAA. This demonstrates the importance of FCIs in determining the planned wetland acreage. If FCIs in the planned wetland are greater than the FCIs in the WAA, the planned wetland goals can be achieved with a smaller planned wetland. The planned wetland must be larger if the FCIs in the planned wetland are less than those in the WAA.

X1.3 *Select Planned Wetland Site*—Potential sites are screened to eliminate the unacceptable ones and the final selection is made based upon a more detailed examination. Basic criteria such as minimum area and availability are initially used to identify potential sites. Other factors in addition to wetland function are also considered including economic feasibility, presence of red flags, and construction constraints. The assessment models are used as a guide to determine which site(s) can provide or can be modified to provide the conditions necessary to attain the Target FCIs and FCs. A simple comparison of site characteristics to assessment model variables will suffice in most cases. The FCI calculations may also be conducted if there are questions regarding the attainment of FCIs and FCs for the planned wetland. The extent to which model variables are examined during site selection will vary. The evaluation of some variables may only require cursory office windshield evaluations, whereas other variables may require a set procedure with frequent field monitoring. For example, the site hydrology usually requires a thorough evaluation because it is crucial to the success of a planned wetland. The hydrologic analysis not only verifies the planned wetland feasibility, but also verifies the conditions needed to achieve the function goals.

X1.4 *Design Planned Wetland*—Refer to the Target FCIs and FCs and the assessment models to determine which conditions are necessary to meet the goals. Appropriate conditions can be incorporated as the planned wetland design is developed. Periodically refer to the models to identify the best conditions for maximizing the functional capacity level. Include these conditions and avoid or minimize unsuitable conditions in the planned wetland design.

X1.4.1 The planned wetland design is prepared for the selected site(s) at a scale necessary to establish site-specific design considerations. The design must also provide sufficient detail to perform the assessment. Designs are usually prepared in two stages beginning with a conceptual design, and followed by the development of construction plans and specifications. A conceptual plan provides a brief description of the planned wetland through drawings and text that confirms feasibility and facilitates early review by decision makers. Construction plans and specifications provide sufficiently detailed site-specific information for the general contractor to ensure that the planned wetland is constructed as planned. It is better to assess a conceptual design since the more detailed information (for example, specific grading and landscaping requirements) are not required to perform the assessment. A decision to delay and to assess the construction plans and specifications may result in undue costs if the assessment reveals the need for revisions.

X1.5 *Assess Planned Wetland*—Define the stage at which the planned wetland is to be assessed (for example, design, predicted future conditions) and proceed with the assessment. The results are compared to the Target FCIs and Target FCs to determine whether the goals are met (refer to Table X1.1). If the planned wetland design does not meet the goals, the design should be revised and reassessed again. If the Target FCs are not met, the FCs can be increased by increasing the size of the wetland area or redesigning the planned wetland to increase the FCI for the applicable function(s), or both. The comparison of model variables should also be recorded on standardized data sheets such as shown in Fig. 3. This information can be used to explain how specific difference in wetland features have resulted in a difference in the functional capacity indices. If the planned wetland is compared to several WAAs of the same class, then a direct comparison can be made between the planned wetland and goals (Target FCIs and Target FCs). The comparison of variable scores is more difficult. Users and decision makers must agree upon the format and extent of comparison, depending upon the individual project.

X1.6 *Monitoring*—The monitoring of planned wetlands is required for a variety of purposes including mitigation, but is generally done to determine success or failure. Monitoring can be approached from two perspectives: design goals and function-based goals. At the very least, the planned wetland should be evaluated to determine whether the design goals have been met in order to ensure continued development of the planned wetland. A decision must be made regarding the need for and type of additional monitoring to determine if the goals for functional capacity have been met.

X1.6.1 *Design Goals*—One approach to monitoring is to compare the as-built planned wetland at the completion of the construction phase and, over time, with the original or modified plans. Relatively short-term monitoring is used to identify corrective action, if needed, to ensure establishment of the wetland. Following Ref **(57)**, the planned wetland would be considered a success if it persisted in comparing favorably with the conceptual plans during the monitoring period. Modified plans are original ones that were changed prior to or during construction due to unexpected site conditions, errors in the original plan, and so forth. Comparing favorably means that the specified hydrology is present, specified emergent or woody vegetation, or both, are present or both at the designed locations, and open water and other structural features are present at the design locations.

X1.6.2 *Function Goals*—Function-based goals in the planned wetland can be assessed using the steps described in X1.2-X1.6. However, in some situations more detailed field studies may be required. For additional information on sampling strategies and data collection techniques refer to Refs **(58-62)**. It should be noted that monitoring for function goals may not detect all of the information necessary to ensure continued development of the planned wetland. For that reason, the design goals must be looked at separately.

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