Classifying wetlands and assessing their functions: Using the NC Wetlands Assessment Method (NC WAM) to analyze wetland mitigation sites in the coastal plain region.

Emily R. Burton
Environmental Studies Graduate Student
University of North Carolina, Wilmington
May 5, 2008

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Acknowledgements:

I would like to extend my appreciation to the following people who have provided valuable comments and insights during the course of this study: Sandy Smith of EcoScience Corporation/BPS&J, John Dorney of NCDWQ-DENR, Tammy Hill Environmental Specialist, NCDENR-DWQ, Rick Savage, Technology Support Analyst, NCDENR-DWQ, Randy Griffin of NCDOT, Dave Lekson of the Washington Regulatory Field Office, and Mickey Sugg of the Wilmington Regulatory Field Office.

I am especially grateful for the time, effort and patience of Scott McLendon, Deputy Chief of the USACE Wilmington District (and my chosen project advisor), who accompanied me in the field and spent long hours providing feedback on this paper. Thank you.

Executive Summary:

Wetlands are vitally important ecological systems, especially within North Carolina's coastal plain. For over one hundred years, thousands of acres of wetlands have been lost throughout this region by means of ditching and draining practices for agricultural purposes without any regulatory restraints. As developmental pressures rose and watershed functions declined, there became an alarmingly high need to restore and preserve the State's remaining wetlands. In 1989, President George Bush Sr. spearheaded the national "No Net-Loss of Wetlands" campaign, which ignited future litigation that required compensatory wetland mitigation plans with permitted impacts.

Today, the U.S. Army Corps of Engineers (Corps) tracks the national acreage of permitted wetland fill and mitigation required. From 1993 to 2000, approximately 23,500 acres of wetlands were filled and 40,700 acres were restored or created in mitigation nationally (National Research Council, 2001). Despite the rapid growth of mitigation banks and their use during this time, questions remain as to whether functional performance has matched expectations. Are restored wetlands functioning as well as they should be? Has wetlands mitigation led to the conservation and "no net loss" of wetlands?

In the state of North Carolina, a newly developed method of wetland classification and evaluation has been developed, and will soon be adopted by NC state and federal agencies. The North Carolina Wetlands Assessment Method (NC WAM) is a referenced-based, wetland functional assessment tool that would be useful for mitigation planning and tracking functional replacement across the state. The purpose of this study was to utilize NC WAM to evaluate twelve prior-converted mitigation sites in the coastal plain to determine whether past methods of wetland mitigation have been successful in restoring target or expected wetland functions.

Since there was no way to assess the lost functions of the impacted wetlands (permitted unavoidable impacts that required compensatory mitigation), this study was unable to determine if functional replacement through mitigation had actually occurred. Instead, it's focus was to assess the mitigation sites in a qualitative format for three main purposes: (1) to determine how well restored wetlands were functioning, according to NC WAM, based on a reference wetland; (2) to determine if

there is a most favorable method of restoration by comparing each site's mitigation plans with NC WAM's results; (3) and to see if NC WAM is an accurate and useful tool in validating success criteria for mitigation sites.

I. Geography

The Coastal Plain of North Carolina is a very unique and important ecological region. It includes the inner and outer coastal plain ecoregions, stretching from South Carolina to Virginia, and extending inward almost to Raleigh. The inner coastal plain consists of irregular plains and broad interstream divides, with the outer coastal plain having a low elevation (below 25 feet mean sea level) and flat plains with numerous swamps, marshes and estuaries. This entire area encompasses approximately 25,000 square miles of land that drains into the Atlantic Ocean (Figure 1).

The region's numerous rivers, streams and wetlands are the lifeblood of the coastal plain, providing a variety of functions to support a range of plant and animal species, while soaking up floodwaters and feeding North Carolina's sounds and bays. The gentle-sloping plain is divided by many rivers, including such navigable waterways as the Cape Fear, White Oak, Neuse, Tar, and Roanoke rivers. Soils are mineral-based and rich in organics, often somewhat to very poorly drained, with the largest of these areas located on interstream divides.

II. Land Use

The Coastal Plain once contained approximately 95% of the state's 6 million acres of wetlands (Wilson, 1962). In 1992, a study by Cashin et al. estimated that about 51% of the original wetlands in North Carolina had been lost or altered in some way. It revealed that between 1950 – 1980, approximately 42.2% of this loss was caused by agricultural activities. Landowners discovered that the moist, nutrient-rich soils were ideal for growing leaf tobacco, peanuts, soybeans, and sweet potatoes.

Typical practices for conversion of wetlands to agriculture consisted of extensive drainage and site preparation. Wetland alteration involved the removal of all vegetation and debris from the soil surface, then cutting parallel open drainage ditches from 24-48 inches deep at regular intervals across the field. Land was often graded to produce a "crown" in the center of the fields between adjacent drainage ditches so that rainwater would flow to the ditches, thereby preventing ponding on the surface. Additionally, after years of intensive management with heavy farming equipment, a thick layer of compacted soils known as a "plow-pan" was created about 8-10 inches below the surface. As these shallow aquifers were drained, many of the aquatic functions that were formerly present were eliminated.

According to the Natural Resources Conservation Service (NRCS), wetlands that were drained, dredged, filled, leveled, or otherwise manipulated, including the removal of woody vegetation, before December 23, 1985, are considered prior converted (PC) cropland. These sites must qualify to make production of an agricultural commodity possible, and that (1) do not meet specific hydrologic criteria (i.e. the land does not flood or pond for more than 14 days during the growing season), (2) have had an agricultural commodity planted or produced at least once prior to December 23, 1985, and (3) have not since been abandoned (NRCS website). Such lands, as designated by the NRCS, are exempt from wetland regulations administered by the Army Corps of Engineers under Section 404 of the Clean Water Act, and often the presence of relic hydric soils may offer the only historical baseline in determining where wetlands were once present (and thus can be an important mechanism for mitigation planning).

III. Wetlands and their Importance

Jurisdictional wetlands, those subject to the permit requirements of Section 404 of the Clean Water Act, are defined by the presence of three wetland parameters: hydrology, hydrophytic vegetation and hydric soils (U.S. Army Corps of Engineers Wetland Delineation Manual, 1987). The prolonged presence of water creates conditions that favor the growth of specially adapted plant (hydrophytes) and promote the development of characteristic wetland (anaerobic) soils. The Corps defines wetlands in the 1987 Delineation Manual as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils conditions" (p. 9) For a site to meet the standards for the definition of a wetland, water must be present within the upper 12 inches of the surface for at least 5% of the growing season (which is typically March – November in North Carolina), and indicators of hydric soils as well as a 50% or greater presence of wetland species must be present.

Only relatively recently have humans begun to understand the many ecological functions associated with wetlands and their significance. They are a valuable natural resource that provides a vital link between water and land and generally include swamps, marshes, bogs and floodplains. Wetlands provide natural water quality improvement, flood storage, groundwater recharge, shoreline erosion protection, and protect human health and safety by reducing flood and storm damage and preserving water quality. They can receive, store and release water in various ways – physically through ground water and surface water, as well as biologically through transpiration by vegetation – thereby trapping and filtering nutrients, sediments and toxic pollutants from water that flows across them. Wetlands also provide habitat for fish and wildlife, including many endangered and state listed species, as well as opportunities for recreation and aesthetic appreciation.

IV. Regulatory Protections

The primary law conserving and protecting wetlands in the United States is the Clean Water Act passed in 1972. Under Section 404, the Secretary of the Army has delegated authority to issue permits for the discharge of dredged or fill material into wetlands and waters of the U.S. These permits, administered by the Corps under the 404(b)(1) Guidelines, call for a sequencing approach to (1) avoid filling wetland resources, (2) minimize adverse impacts to those wetlands that cannot be avoided, and (3) provide compensatory mitigation to off-set unavoidable adverse impacts. Wetland loss is compensated through means of on-site and off-site preservation, restoration, enhancement and creation.

In 1989, President George H. W. Bush launched a "No Net Loss of Wetlands" campaign, pledging to reduce the amount of wetlands impacted while restoring and creating new wetlands to compensate for those lost. The Environmental Protection Agency (EPA) and Corps of Engineers were called upon to employ a range of new policy instruments to slow and reverse wetlands conversion while responding to development pressures.

Three options of mitigation were made available for a permittee to provide mitigation through the regulatory process: mitigation banking, in-lieu fee (ILF), or on-site restoration, enhancement, creation and/or preservation. Mitigation banking provides the means of purchasing wetland credits from an approved wetland mitigation bank. The ILF process allows a permittee to provide funds to an in-lieu-fee sponsor who is responsible for providing wetland mitigation under guidance. The permittee process involves completing project-specific mitigation on-site of a project to compensate for wetlands lost. In general, the regulatory agencies require a 2:1 ratio (acres of mitigation to impacts) to help ensure that any temporal and spatial losses are accounted for.

V. Mitigation Banking

In the early 1990s, resource and regulatory agencies and state governments promoted a market-based instrument known as wetlands mitigation banking. This process entails the development of a "bank" of wetlands that have been created, restored, or preserved and that are then made available to developers to "buy" into as credit for their proposed impacts. A mitigation bank is defined as "a site where wetlands and/or other aquatic resources are restored, created, enhanced, or in exceptional circumstances, preserved expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources" (Federal Guidance for the Establishment, Use and Operation of Mitigation Banks, 1995, p.3).

The Corps Regulatory Division attempts to utilize a watershed-based approach when determining compensatory mitigation requirements, thus the Geographic Service Area (GSA) of a bank is one of the most important aspects in determining site selection approval. In North Carolina, the GSA has generally been confined to the 8-digit USGS Hydrological Unit Code (HUC) within which the bank property and the proposed project impacts are located, including any area outside the watershed considered appropriate by the Corps or other permitting agency.

In order to develop a bank, a sponsor first must submit a prospectus describing the bank property to the Corps and the Inter-agency Review Team (IRT) who will review the information to determine if the bank site can successfully support the goals of the project. If agreed upon by the IRT, the sponsor can begin detailed planning of the bank site including the methods of wetland (and/or stream) restoration/enhancement. A critical component of this plan is the development of detailed success criteria upon which the success of the bank will be evaluated. The IRT also negotiates the details of objectives, ownership, operation, and enforcement before the proposed bank is submitted for public notice and comment.

The Mitigation Banking Instrument (MBI) provides the legal framework around which the bank will be operated and includes such items as the credit release schedule, Geographic Service Area, preservation mechanism, etc. and allows the bank sponsor to assume responsibility for providing the mitigation required from Department of the Army (Section 404) permits, as well as long-term management and ecological success of the site.

Mitigation banking is typically implemented and functioning in advance of project impacts, thereby reducing temporal loss of aquatic functions and uncertainty of whether the mitigation will be successful in offsetting the project impacts. Its goal is to provide for greater selection of hydrologically and ecologically favorable locations, thus increasing the opportunity for a well-functioning, self-sustaining replacement (Federal Guidance for the Establishment, Use and Operation of Mitigation Banks, 1995). It is believed that an increase in existence of mitigation banks could contribute towards attainment of the goal of no net loss of the nation's wetlands.

VI. The North Carolina Department of Transportation

In the early 1990s, the North Carolina Department of Transportation (NCDOT), with support of the governor and state legislature, began an ambitious road-building initiative. As a result, NCDOT became responsible for compensating for an increasing amount of wetland losses resulting from the construction of many miles of new roads. During the mid-1990s, the NCDOT began to experience increased project delays because they lacked the required mitigation at the time they needed authorization to build. The few mitigation banks developed in North Carolina that did exist already sold all or most of their credits to the NCDOT, thus leaving none available for the private landowner. It became evident to state and federal agencies that methods for wetland mitigation needed to expand and become more pro-active for highway projects.

VII. In-Lieu Fee Process

NC Wetland Restoration Program

In 1997, the NC Department of Environment and Natural Resources (DENR) established a state-supported ILF Program known as the North Carolina Wetlands Restoration Program (NCWRP) to off-set impacts caused by a boom in road building and demand for infrastructure. Its purpose was to restore and replace wetland functions lost through historic conversion and through current and future permitting activities, as well as increase ecological effectiveness of wetland compensatory mitigation (NCWRP General Statutes Summary, 1997). It also emphasized the importance of mitigating within the same river basin that impacts had or would occur.

Amongst other initiatives, the program allowed permittees to pay into the NCWRP Fund based on the costs to restore or create the streams and wetlands, to include a restoration plan, long-term monitoring, and maintenance of the restored wetland. Funds were distributed to state or federal agencies, local governments, or private, non-profit conservation organizations, to acquire, develop, manage and maintain the property in accordance with Corps requirements (NCWRP General Statutes Summary, 1997). This program was an alternative to banking and allowed property owners/developers and DOT to pay funds and thus transfer responsibility for wetland mitigation to the NCWRP.

The NCWRP soon became an important component of mitigation in North Carolina by providing the first method of developing a per-acre cost of wetland (and stream) restoration, as well as reporting and documenting statewide wetland acreage losses and gains. Unfortunately, the NCDOT and NCDENR mitigation programs functioned independently with different operating processes, a situation that failed to meet the satisfaction of either federal and state regulatory agencies, or environmental interest groups (EEP website). As a result, in 2003 a Memorandum of Agreement was signed between the Corps, NCDOT, and NCDENR to provide a consistent and streamlined approach to address compensatory mitigation requirements associated with Section 401 and 404 permits. This action established the Ecosystem Enhancement Program (EEP), a multi-agency partnership that, combined with the existing wetlands restoration initiative, enabled the implementation of large-scale watershed-based restoration efforts with a goal of providing restoration in advance of wetland impacts. The EEP is currently managing previous NCWRP mitigation sites as well as many of its own new sites, and as of August of 2004 it accepted the transfer and responsibility of all of NCDOT's off-site mitigation projects.

VIII. Functional Assessment

Wetland assessment procedures are tools that provide an objective way of evaluating and tracking wetland function. Traditionally, state and federal agencies required wetland mitigation based on acreage, evaluating success by focusing more on quantity rather than quality. Quantity has been measured according to the structure of the mitigation site according to survival numbers and growth rate of vegetation planted and monthly data displaying level of water tables to infer that wetland functions were actually occurring. For mitigation success, the Corps requires on average a survival rate of 260 planted trees per acre at the end of five years, and a the presence of water within the upper 12 inches of the surface for at least 12.5% of the growing season. Quality has been a measurement based on the regulator's best professional judgment (BPJ), which often lends itself to disagreements and inconsistencies. When EEP was developed, there was an expectation that impacts and mitigation would be based more on functional assessment than the purely qualitative BPJ approach that is currently employed. The Corps, Wilmington District and NCDENR realized that they needed a new method of assessing wetland function to make better and more defensible permit decisions.

IX. North Carolina Wetland Assessment Method

In response to a recognized need for a consistent, agency-approved method to assess wetland functional quality, a team of experts gathered in 2003 to analyze approximately forty different existing methodologies of wetland functional assessment to come up with an approach that would answer many of their questions related to wetland function in North Carolina. In December of 2007, the North Carolina Wetland Assessment Method (NC WAM) was developed by an inter-agency team to provide a consistent tool to allow functional assessment information to support the regulatory review process, including requirements for compensatory mitigation.

The purpose of NC WAM is "to provide the public and private sectors with an accurate, consistent, rapid, observational, and scientifically-based field method to determine the level of function of wetlands relative to reference condition for each general wetland type identified" (NC WAM Draft User Manual, 2007, p.2). In North Carolina, wetlands have been grouped into 16 general wetland types that are identified through the use of a dichotomous key. The Dichotomous Key to General North Carolina Wetland Types was created to use specifically with NC WAM to identify the exact community type being assessed (refer to Appendix B). The purpose for specifying general types is to (1) provide a unified list of wetland types for North Carolina, (2) account for impacts by wetland type, and (3) account for the inherent differences in function for each wetland type (NC WAM Draft User Manual, 2007).

NC WAM determines the level of function of wetlands based on ratings of indicators of function rather than their actual measurements. These ratings are generated based on an assessor's evaluation of 22 questions, or metrics, using observation, measurement, and best professional judgment (refer to Appendix C). After the assessor completes the form, the selected descriptors are entered into a computer program known as the NC WAM rating calculator, which converts the data into a functional rating for each metric (refer to Appendix D). Metric descriptors are combined to provide eleven sub-function ratings, which are then combined to provide three function ratings: Hydrology, Water Quality and Habitat. These three ratings are then combined to yield an overall wetland rating. Ratings are provided as "Low," "Medium" and "High" relative only to those functions of the reference wetland type.

Wetland Functions and Sub-functions

Functions vary amongst the 16 different wetland types, and the condition of a wetland can range from having little apparent disturbance to being severely degraded. NC WAM considers chemical, physical and biological functions and assesses the general performance for each wetland type. Three wetland functional conditions are identified: hydrology, water quality and habitat, and each are divided into sub-functions which are represented by on-site indicators and vary for each wetland type. The hydrology function is determined by surface and sub-surface storage and retention, water quality by particulate, soluble, pathogen, physical and pollution change (the last being a combination of the first three), and habitat by physical structure, landscape patch structure, connectivity, vegetation composition, and uniqueness. The water quality function is also rated by wetland opportunity, which is determined by the ability (opportunity) of a wetland to perform a certain function (see metric #7, Appendix C). The state of the surrounding watershed can increase the wetland's opportunity to provide function. For instance, proximity to disturbance areas within the watershed and up to 5 miles from the assessment area may increase the functional rating.

The current method is now in its final review stages, and will soon be made available to state and federal agencies involved in the regulatory review process. NC WAM is expected to be useful tool for project planning, alternatives analysis, compliance/enforcement, mitigation planning and tracking functional replacement. It is also expected that it may be modified for more specific applications, such as mitigation success monitoring, as is relevant to this study (refer to suggestions for modifications in the Conclusions Section in regard to mitigation monitoring).

X. Site Selection for NC WAM Evaluation

Twelve mitigation sites were selected for this study by means of identifying a geographical area, the age of site development, and prior land use (site descriptions and photos found in Appendix E). The geographical area of interest is the North Carolina Coastal Plain, which includes the outer and inner plains to where they meet the Piedmont ecoregion (NC Ecoregion map, Figure 1). Emphasis was placed on selecting older mitigation sites to determine how they have developed functionally over time. Mitigation sites within this region that had completed their required monitoring phase and were "closed out" or approved by regulatory agencies, were then identified (approximately 45 sites total). The time period of when these sites began construction ranged from 1993 to 2002.

From this selection, a common thread that was used to narrow the focus of study was that the site contained some portion of restoration of a prior-converted (PC) cropland. In the history of mitigation, PC sites have been looked upon as having the most "bang for your buck" for conducting wetland restoration, for they historically supported wetlands and were underlain with hydric soils, a critical component of a successful restoration project. They also encompassed larger areas; one site could have the potential to provide tens to hundreds of acres of wetland restoration credits with minimal restoration design work and cost. Twelve mitigation sites in the Coastal Plain containing partially or fully restored PC croplands were identified for the NC WAM evaluation, encompassing a total of 2,176 acres (see Appendix E).

XI. Restoration of Mitigation Sites

Site restoration plans for each of the twelve selected mitigation sites in this study all involved fairly similar methods for re-establishing hydrology and wetland vegetation. On all sites, drainage ditches had been plugged and/or filled to re-establish surface and sub-surface hydrology, and some aspect of site preparation prior to planting occurred. Depending on the severity of soil compaction that resulted from agricultural activity, discing, deep ripping or surface scarification could have occurred. Discing refers to a method of carrying a row of circular blades approximately 16-20 inches in diameter behind a tractor to loosen up the AP horizon, allowing for aeration and filtration within the soil. In the presence of thick plow pans below the AP horizon, deep ripping is necessary for breaking up this hard compacted layer. This is similar method to discing, however the 24-26 inch blades penetrate much deeper. Surface scarification may often be referred to as discing but generally implies a more shallow "raking" of the surface. All three methods help to increase permeability rates, surface roughness, hydrological retention and improve vegetation restoration efforts (plantings).

In general, hydrophytic vegetation was planted shortly after the site was constructed. Trees species were often selected by the type of wetland to be restored. This was often determined by a reference area located nearby the restoration site. Hardwoods or pines were selected based on the desired outcome of the site (e.g. Bottomland Hardwood forest or Pine Flat/Savanna). Saplings were planted in rows that were often times prepared with bedding ploughs. Bedding, although not a recommended activity by the Corps, is a procedure to help ensure survival of young planted saplings, especially if the site becomes quickly inundated after ditch plugging/filling. The rows created between beds, though, can often act as drainage ways for water or pool up for unnecessarily long periods of time. A more acceptable method would call for vegetation planting first, allowing trees to establish themselves for at least a year or two before reintroducing hydrology. This, however, would require additional monitoring time that the permittee often cannot afford to waste.

Following the completion of site construction and planting, monitoring gauges (ground water observation wells) were installed and sites were monitored for hydrology and vegetation success for 4-6 years, respectively. In several cases during this monitoring period, it was also deemed necessary to perform vegetation remediation in the form of herbicide treatment and shearing (tree removal) to eliminate competition from undesirable dominant and invasive species. Monitoring reports were submitted to the Corps and resources agencies on an annual basis and often followed up with routine site visits.

XII. Methodology

Background information on each site was obtained from NCDOT, the Corps and EEP. The majority of mitigation sites (8 out of 12) are owned and operated by NCDOT for roadway projects exclusively. The NCDOT website stores monitoring reports for all of their mitigation sites from 1995 to the present as public information. These reports provided information on site history and progress, with monthly well data, vegetation planting maps and photo documentation of vegetation growth. Site restoration proposals and plans were provided directly from the NCDOT office in Raleigh.

The remaining four sites of this study are privately owned mitigation banks. These banks have gone through the regulatory process of developing approved MBIs as required by the Corps. Information on these sites is also public record, available on the Wilmington Regulatory Division's website. Project site proposals and plans were obtained from the Wilmington and the Washington Regulatory field offices.

Extensive site research was conducted via ArcView/ArcMap Geographical Information Systems (GIS) data during the months of January – February 2008. Site property boundaries, topography, streams and roads were identified on 2005/2006 color aerial photos, 1998 near-infrared images were downloaded to reveal accentuated texture and reflected energy from vegetation and to identify historic structures and land uses, and combined elevation and hillshade data produced Light Detecting and Rating (LIDAR) images enabling a clear two-dimensional view of the site.

Site assessment evaluations were conducted during the months of February – April, 2008. GIS maps, mitigation site plans and NC WAM forms were brought to each assessment site, as well as the necessary tools needed to complete the forms. Field tools included a soil auger, a hand-held Global Position System (GPS) unit, a digital camera, a pocket rod, soil surveys, Munsell Soil Color Charts and a compass. The NC WAM 2007 Draft Manual was also at hand and constantly referenced.

Assessment areas on each mitigation site were first identified with maps showing where hydrology had been restored and wetland vegetation had been planted. Once located in the field, those particular areas were walked and observed for changes in visible hydrology on the surface, survival of trees and introduction of volunteer species, and changes in ground surface and topography. A selected area that showed a favorable, homogenous representation of a particular wetland type was identified using the Dichotomous Key to General North Carolina Wetland Types to identify the exact community type. This was considered to be the Assessment Area (AA) and could encompass tens to hundreds of acres. The final step was then to evaluate the area with NC WAM and properly document it with field notes and digital photographs. The number of wetland community types generally depended on the landscape positioning of each site, determining how many assessments were conducted per mitigation site (2-5 on average).

After completing the NC WAM forms in the field, site information and selected answers to metrics 1-22 were entered into the NC WAM rating calculator for each assessment area (37 total). The form's answers are generated through the rating system in conjunction with the wetland community type selected, and a Wetland Rating Sheet displays the results. Results were then observed and assessed according to wetland community type and "Low," "Medium" and "High" ratings of hydrology, water quality and habitat.

XIII. Results

Eight of the sixteen North Carolina wetland community types were represented within the twelve mitigation sites studied. A total of thirty-seven total assessments were completed, resulting in eleven hardwood flats, nine non-riverine swamp forests, six riverine swamp forests, four bottomland hardwood forests, four pine flats, one pine savanna, one floodplain pool and one non-tidal freshwater marsh.

Results for all four wetland functions (hydrology, water quality condition, water quality opportunity, and habitat), including the overall wetland function, were tabulated showing the percentage of results for “Low,” “Medium” and “High” ratings (see Table 1).

Function	**Functional Rating**		
	Low	**Medium**	**High**
Hydrology -- Condition	11.0%	13.5%	75.5%
Water Quality -- Condition	13.5%	19.0%	67.5%
Water Quality -- Opportunity	11.0%	16.0%	73.0%
Habitat -- Condition	56.5%	30.0%	13.5%
Overall Rating	**16.0%**	**19.0%**	**65.0%**

(Table 1: Functional Results of Wetland Mitigation Sites)

For the thirty-seven NC WAM assessments conducted, overall results show that the majority (65%) of the assessments completed (24 total) received “High” ratings for all four functions, 19% (7 total) rated “Medium” and 16% (6 total) rated “Low”. Hydrology, water quality condition and water quality opportunity received the largest percentage of “High” functional ratings (75.5%, 67.5%, and 73%), whereas the habitat condition rated “High” for only 13.5% of the assessment areas. “Low” ratings for hydrology and water quality functions occurred within 11-14% of the assessment areas, whereas the habitat rating was found to be “Low” for 56.5% (21 out of 37 assessment areas).

The habitat function rated “Low” overall, which was expected due to the young ages of the mitigation sites (as compared to their reference condition). Since all the mitigation sites began as row-crop fields with no existing natural vegetation or woody debris, there was no habitat opportunity such as snags, large living trees and large woody debris present (eliminating metrics 18-20 and thus producing so many “Low” ratings). All of the sites had been planted between 1993 – 2002 respectively, and the majority of trees observed measured 3-5 inch diameter at breast height (DBH), putting them in the category of “saplings” not “canopy” for Vegetation Structure (metric 17).

Ratings dropped as it was indicated that canopy was "sparse or absent," and that the majority of trees were "less than 6-inches or absent" for Diameter Class Distribution (metric 19).

Three out of the five assessment areas that did rate "High" for habitat had an established canopy of trees in which the majority of stems measured greater than 6-inches DBH, with a dense mid-story/sapling layer. Thus, these sites received "High" ratings for Vegetative Structure (metric 17) and Diameter Class Distribution (metric 19). It was noted on another site that large logs (relative to others present in the landscape) were present, thereby increasing the rating for habitat via the Large Woody Debris metric (no. 20).

Table 2 displays the ratings of all wetland functional conditions for each assessment area. Results show that four out of the twelve mitigation sites in this study rated "High" overall for all assessment areas evaluated: Scuppernong River Corridor, Dismal Swamp, Hidden Lake and the Gurley Tract. These sites were observed to have well-established hydrology, effective water quality, and reasonable habitat throughout the entire restored areas. Only one site, ABC, rated "Low" overall. This site was a unique situation in which NC DOT had purchased the property and followed through with its mitigation restoration plan with little input or approval from the Corps (refer to ABC site description in Appendix E).

Three other sites that also received "Low" overall ratings, Bull Farms, Haws Run and Bear Creek-Mill Branch, were all noted to have had either alterations due to beaver activity or lack of wetland functions due to presence of stream channelization, man-made berms or soil compaction. These stressors can have a negative effect on all three wetland functions (NC WAM Draft User Manual, 2007). Stream channelization can reduce both surface and sub-surface retention, reduce treatment time for overbank flows and upland runoff, and degrade wildlife habitat. The presence of berms can prevent overbank and overland flooding, alter surface and sub-surface water storage capacity, decrease opportunity for the wetland to provide water quality, and degrade wildlife habitat. Soil compaction, a result of intensive management, can reduce infiltration and subsurface storage capacity.

Site Name/Assessment Area (AA)	Wetland Community Type	Hydrology Cond.	Water Qual Cond.	Habitat Cond.	Overall Rating
1. Scuppernong River					
AA 1	Non-Riverine Swamp Forest	High	High	Medium	**High**
AA 2	Hardwood Flat	Medium	High	High	**High**
2. Bull Farms					
AA 1	Floodplain Pool	High	High	High	**High**
AA 2	Bottomland Hardwood Forest	High	Low	Low	**Low**
AA 3	Riverine Swamp Forest	Medium	Low	Low	**Low**
AA 4	Bottomland Hardwood Forest	High	Medium	Low	**Medium**
AA 5	Riverine Swamp Forest	High	High	Low	**High**
3. Mildred Woods					
AA 1	Pine Flat	High	High	Medium	**High**
AA 2	Hardwood Flat	Medium	High	Low	**Medium**
AA 3	Non-Riverine Swamp Forest	High	High	Low	**High**
AA 4	Non-Riverine Swamp Forest	High	High	Low	**High**
AA 5	Pine Flat	Medium	Medium	High	**Medium**
AA 6	Pine Flat	High	High	Medium	**High**
4. Dismal Swamp					
AA 1	Riverine Swamp Forest	High	High	High	**High**
AA 2	Non-Riverine Swamp Forest	High	High	Medium	**High**
AA 3	Non-Riverine Swamp Forest	High	High	Medium	**High**
5. Hidden Lake					
AA 1 (Woodward Tract)	Hardwood Flat	High	High	Low	**High**
AA 2 (Morris Tract)	Hardwood Flat	High	High	Low	**High**
6. Gurley Tract					
AA 1	Hardwood Flat	High	High	Medium	**High**
AA 2	Bottomland hardwood Forest	High	High	Medium	**High**
7. Barra Farms (Phase I)					
AA 1	Hardwood Flat	High	Medium	Medium	**Medium**
AA 2	Non-Riverine Swamp Forest	High	High	Medium	**High**
AA 3	Pine Flat	Medium	Medium	Medium	**Medium**
AA 4	Hardwood Flat	High	High	Low	**High**
8. Long Swamp					
AA 1	Hardwood Flat	High	High	Medium	**High**
AA 2	Non-Riverine Swamp Forest	High	Medium	Low	**Medium**
9. Haws Run					
AA 1	Riverine S. Forest (created)	Low	Medium	Low	**Low**
AA 2	Riverine Swamp Forest	High	High	Low	**High**
AA 3	Hardwood Flat	High	High	Low	**High**
AA 4	Pine Savanna	High	High	Low	**High**
10. Dowd Dairy					
AA 1	Non-Riverine Swamp Forest	High	Medium	Low	**Medium**
AA 2	Non-Riverine Swamp Forest	High	High	Low	**High**
AA 3	Hardwood Flat	High	High	Low	**High**
11. ABC Site					
AA 1	Bottomland Hardwood Forest	Low	Low	Low	**Low**
AA 2	Hardwood Flat	Low	Low	Low	**Low**
12. Bear Creek Mill Branch Site					
AA 1	Riverine Swamp Forest	Low	Low	Low	**Low**
AA 2	Non-Tidal Fresh Water Marsh	High	High	High	**High**

(Table 2: Results of Wetland Functions for Individual Assessment Sites)

XIV. Discussion

One challenge to this study was identifying the type of wetland community that was present within an assessment area. Generally, mitigation plans describe the target community wetland type to be achieved, however, site conditions that develop after ditches are plugged, beaver move in, storm events occur, etc., sometimes lead to the development of community types that are different than what was originally planned. Questions arose pertaining to whether the site should be keyed as the type of wetland the restoration plan described (according to the species of trees planted and the projected hydrological data), versus what was actually observed in the field. Several factors were found to have influenced the development of the mitigation sites such as invasive species that had dominated sites, (e.g. sweet gum, red maple or loblolly pine), and beaver activity in particular. It is very difficult to predict post-restoration site conditions, since too much or too little water can significantly affect the vegetation species composition.

NC WAM takes into account whether the site is "intensively managed" or "substantially modified", stating that:

> Wetlands with modifications (man-made or natural) should generally be classified as the original, naturally occurring type if this determination can be made. However, if the full range of stable, existing wetland characteristics (vegetation, hydrology, and soils) better resemble another wetland type because of long-established, permanent alterations, it should be classified as this current, more appropriate type (Dichotomous Key to General North Carolina Wetland Types).

It would be nearly impossible to determine the exact original wetland types that were present prior to agricultural conversion, however, the majority of the restoration plans attempted to recreate what was believed to exist historically by referring to nearby sites that were in a similar landscape positions and had not been substantially altered. These reference sites were used to determine how much hydrology would normally be present during the year and what type of vegetation would best be supported by those conditions. With regards to each mitigation site, however, it was difficult to say that it was undergoing "long established, permanent alterations" (referred to as on-going for 10 or more years in the NC WAM Draft User Manual) since they were all at such early stages of development.

There is also debate as to how beaver activity could affect wetland ratings using NC WAM. The Corps does not require perpetual beaver management for practical reasons, but it is evident from this study that beaver have the potential to alter all three wetland conditions quite substantially by means of (1) modifying the local plant community composition and structure through tree cutting and flooding (vegetation mortality), (2) reducing energy dissipation by removal of vegetation, and (3) changing local habitat for wildlife and aquatic species. For these reasons, the beaver could be considered a natural stressor on the wetland community, depending upon whether the dam(s) are long-established and alterations appear permanent. However, as it is well-known, beaver tend to abandon their dams periodically, allowing them to become unstable until they breech, thus eventually returning the wetland to its original state.

That said, wetland community type identification, being a crucial component to achieving results with NC WAM, needs to be looked at consistently from site to site. Thus it was decided, for purposes of consistency, to key out and identify wetlands as they currently exist, regardless of what the original mitigation plan stated. It is understood that with time, as vegetation succession becomes more established on these mitigation sites, a change of wetland type could result (as could with natural modifications or disturbances due to beaver, hurricanes, droughts, blights, etc.).

XV. Conclusions

<u>Wetland Functionality</u>

From this study, the level of wetland functionality can be determined for each of the twelve restored mitigation sites according to NC WAM's results with regard to hydrology, water quality and habitat. It can be concluded that the hydrology function rated "high" the most (75.5%) since this is often the first function to be replaced after a site is constructed. Once drainage ditches are plugged and/or backfilled, water will back up on a site very quickly. However, if ditches, berms, beaver or soil compaction are present, then hydrology can be substantially altered.

Following hydrology, water quality would be the next function to improve, relative to inundation duration and vegetation structure/buffer (as is noted for over 67% of the assessment areas evaluated that received "High" ratings). This, however, can change quickly depending on (1) surrounding land uses (opportunities) that clear-cut vegetation, increase impervious surfaces and introduce pollutants, (2) heavy storm events, or (3) the introduction of beaver. It has been determined by NC WAM that sites such as Bull Farms that have been impacted by beaver receive a lower water quality rating. However, it is generally believed that increasing water storage capacity can actually improve water quality.

As for habitat function, it is generally understood that this can take from decades to hundreds of years to re-establish all the parameters necessary to support an ideal environment for local wildlife. The oldest site in this study, Scuppernong River Corridor, is only fifteen years old, so it can be assumed that it has not reached habitat functionality at a level that a reference site of the same community type would. However, this site, as well as three others, received "High" ratings for habitat, for the key reason that they provided ideal conditions for tree growth and resulted in the best vegetation composition and structure. Conditions such as inundation duration and soil structure vary according to wetland type, but if the proper species of trees are planted in the appropriate places, they prove to do well. For instance, the presence of large, healthy planted bald cypress in several assessment areas where standing water was present was a good indicator of when these conditions are optimal.

Lack of Opportunity:

In several sites such as Long Swamp, Dismal Swamp and Dowd Dairy, stormwater from surrounding developed and disturbed areas is directed away from the wetland (via ditches or storm drains), thereby prohibiting the opportunity for the restored wetland to perform its functions. This may have been considered during the development of the restoration plans, but determined not to be feasible based on water encroachment issues on neighboring properties. In the case of the ABC and Gurley sites, mitigation plans called for riverine wetland restoration. However the inverts of the nearby stream channels were not raised to historical levels, so that the opportunity for flood events to reach adjacent wetlands was very minimal (which was reflected in the rating results). Unless over-bank flooding can be restored, wetlands will not be able to perform important ecological functions.

Restoration Methods:

The standard method of restoring prior-converted croplands (i.e. ditch plugging/filling, soil discing/scarification and tree planting) appears to have resulted in a desirable outcome of hydrology and water quality functional ratings according to NC WAM. To improve habitat functionality, the introduction of coarse woody debris on a mitigation site (such as logging deck material) would create additional habitat for wildlife. Doing so would increase this rating significantly, as it would trigger the Large Woody Debris (no. 20) metric.

The ABC Mitigation Site rated “Low” overall and according to this study became a good example of what not to do when constructing a wetland restoration site. Site construction techniques, such as topsoil removal, B-horizon contouring and micro-relief treatment created an unnatural ground surface that would not normally be found in an interstream divide. This unnecessary activity most likely contributed to the further compaction of soils, causing a reduction in infiltration and subsurface storage and decline in tree growth. Poor soil structure, no evidence of inundation, and little to no opportunity to improve water quality were observed at this evaluation site. From this it can be concluded that the statement “less is better” is the preferred method with regards to wetland (and stream) restoration planning.

Wetland creation has also been an unfavorable method of mitigation by regulatory agencies, as was evident at the north end of the Haw’s Run Mitigation Site where a 33-acre floodplain was created. The top soil (O and A horizons) in this area was excavated, leaving compacted sandy clay soils exposed at the surface, and the trees planted were not surviving well (less than 2 feet tall after 10 years of growth). Haws Run is an example of wetland creation in which results have been validated by NC WAM: this assessment area received low ratings due to altered ground surface, substantially altered sub-surface storage capacity and poor vegetation structure and composition.

NC WAM: A Validation for Success

NC WAM has taken a leap from assessing wetlands in a simple to broad context: performance measures prior to NC WAM looked at one or more ecological functions related to minimum standards of meeting hydrology or percent cover of hydrophytic vegetation, whereas the NC WAM method examines a range of wetland functions covering a number of observable characteristics. It has been concluded from the results of this study that NC WAM, is a valuable and accurate tool for evaluating the success of mitigated wetlands, and it is suggested that it be used as an alternative method to validate existing success criteria.

NC WAM can be an effective tool for assessing and perhaps tracking the functions of mitigation sites throughout North Carolina. For potential enhancement areas, it is suggested that it be applied to all identified wetland community types present on a potential mitigation site *prior* to restoration, then again after the site has been restored to evaluate functional uplift. For potential restoration areas, it is recommended that the site be evaluated prior to approval for determining restoration goals. NC WAM could then be used again the year after vegetation planting, and the following every 3-5 years as necessary, as part of the mitigation monitoring requirement. For true functional replacement and determination of "no net loss", "High" functional ratings should result for all three parameters (hydrology, water quality and habitat).

Final Word:

Mitigation sites are dynamic living, growing and evolving ecosystems that are constantly subject to change. If left in a state of preservation protected from human interference, these sites will be subject only to nature's influence, whether good or bad. It's understood that this hands-off process, although it may take decades, will eventually correct itself into a balanced and stable wetland community, whatever type it may be. Regardless, it is still important, and highly recommended, to continue evaluating these sites for research purposes to document and record their natural progress.

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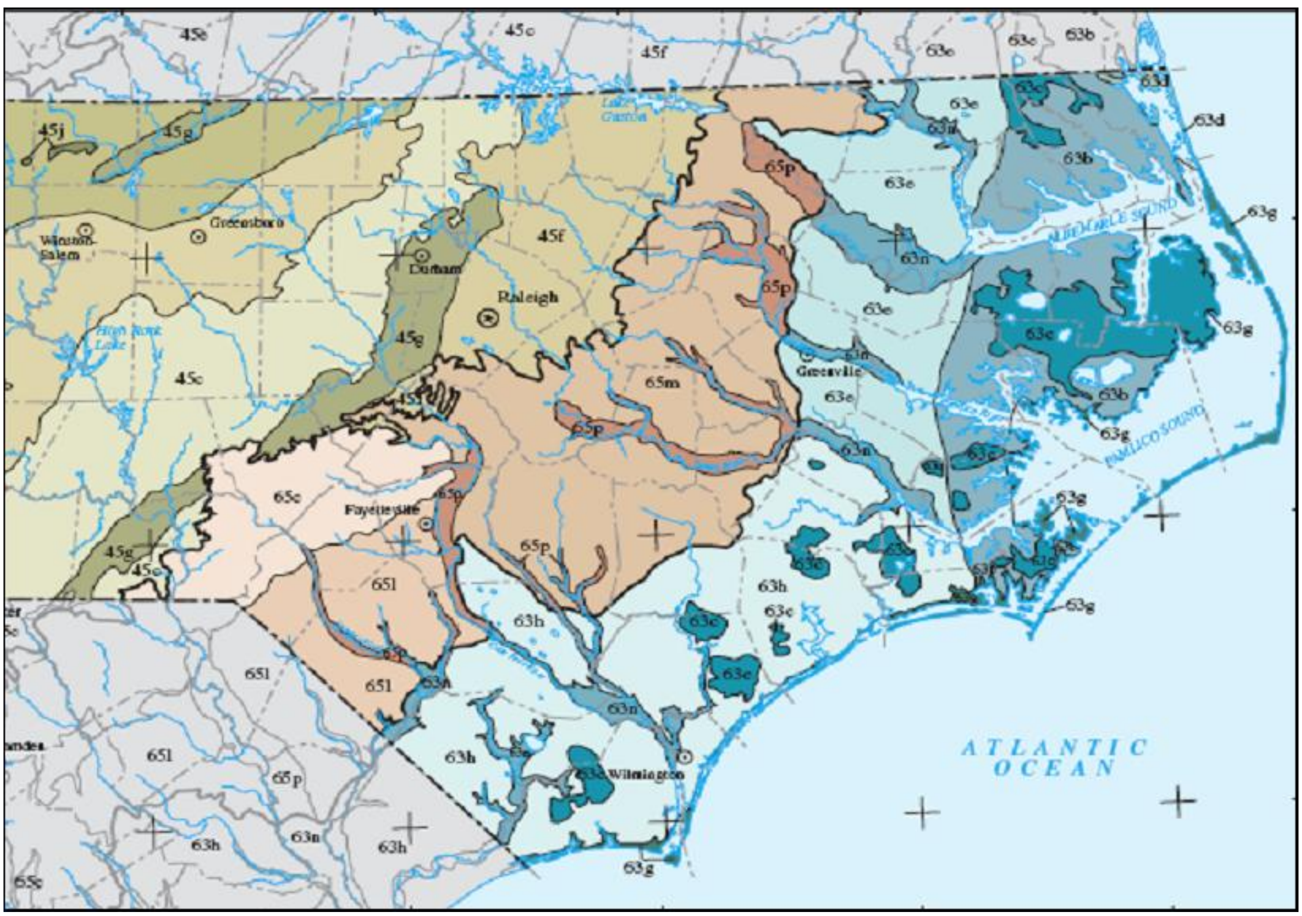
Figure 1. North Carolina Inner and Outer Coastal Plain Areas



Appendix A

Abbreviations:

AA – Assessment Area
BPJ – Best Professional Judgment
DBH – Diameter at Breast Height
EEP – Ecosystem Enhancement Program
GIS – Geographic Information Systems
GPS – Global Position System
GSA – Geographic Service Area
HUC – Hydrological Unit Code
IRT – Interagency Review Team
LIDAR – Light Detecting and Rating
MBI – Mitigation Banking Instrument

NCDENR – N.C. Department of Environment and Natural Resources
NCDOT – N.C. Department of Transportation
NCDWQ – N.C. Division of Water Quality
NC WAM – N.C. Wetland Assessment Method
NRCS – Natural Resources Conservation Service
PC – Prior Converted
USACE – U.S. Army Corps of Engineers (or Corps)
USEPA – U.S. Environmental Protection Agency
WRP – Wetland Restoration Program

Appendix B

Dichotomous Key to General North Carolina Wetland Types

Dichotomous Key to General North Carolina Wetland Types, v5.14, 3/16/07

Before using this key, the assessor should have read and become familiar with the descriptions of the general wetland types. The assessor should use best professional judgment to verify that the wetland type determined with the use of this key matches the written description.

The following rules should be used to assist the assessor in the selection of the most appropriate general wetland type. Narrative descriptions are also available to assist in this choice (see User Manual Section 3.1).

> Wetlands with modifications (man-made or natural) should generally be classified as the original, naturally occurring type if this determination can be made. However, if the full range of stable, existing wetland characteristics (vegetation, hydrology, and soils) better resemble another wetland type because of long-established, permanent alterations, the wetland should be classified as this current, more appropriate type.

If there is evidence suggesting the wetland is a type other than the keyed type, the wetland may be classified as the evidenced type. Also, if the wetland does not appear to conform to any of the following general types, the site should be evaluated based on what the assessor believes is the closest wetland type. If the wetland is "intensively managed" or "intensively disturbed," the assessor should note this fact on the field assessment form and then select the most appropriate general wetland type based on the guidance provided above.

- I. Wetland affected by lunar or wind tide, may include woody areas adjacent to tidal marsh
  - A. Wetland affected, at least occasionally, by brackish or salt water
    - i. Dominated by herbaceous vegetation – **Salt/Brackish Marsh**
    - ii. Dominated by woody vegetation – **Estuarine Woody Wetland**
  - B. Wetland primarily affected by freshwater
    - i. Dominated by herbaceous vegetation – **Tidal Freshwater Marsh**
    - ii. Dominated by woody vegetation – **Riverine Swamp Forest**
- II. Wetland not affected by tides
  - A. Not in a geomorphic floodplain <u>and</u> not associated with a natural linear conveyance (such as a topographic crenulation), <u>nor</u> associated with a natural lake greater than or equal to 20 acres in size
    - i. On a side slope – **Seep**
    - ii. On interstream divides <u>or</u> on a coastal island
      - 1. Flats or interstream divides in Coastal Plain ecoregions
        - a. Dominated by deciduous trees
          - i. Intermittently to seasonally inundated (typically dominated by sweetgum and oaks) – **Hardwood Flat**
          - ii. Seasonally to semi-permanently inundated (typically dominated by cypress and blackgum) – **Non-Riverine Swamp Forest**
        - b. Dominated by evergreens
          - i. Dominated by dense, waxy shrub species (typically include gallberries, fetterbushes, honeycup, greenbriar); canopy may include pond pine, Atlantic white cedar, and bays – **Pocosin**
          - ii. Not dominated by dense, waxy shrub species
            - 1. Dominated by long-leaf or pond pine and wire grass – **Pine Savanna**
            - 2. Dominated by loblolly or slash pines – **Pine Flat**
      - 2. In depressions surrounded by uplands anywhere in the state (mafic depressions, lime sinks, Carolina bays) or on shorelines of lakes/pond

DICHOTOMOUS KEY TO GENERAL NC WETLAND TYPES, CONTINUED

2. In depressions surrounded by uplands anywhere in the state (mafic depressions, lime sinks, Carolina bays) or on shorelines of lakes/ponds (repeated from the previous page)
    a. Dominated by dense, waxy shrub species (typically include gallberries, fetterbushes, honeycup, greenbriar; canopy may include pond pine, Atlantic white cedar, and bays) and not characterized by clay-based soils– **Pocosin**
    b. Not dominated by dense, waxy shrub species and not characterized by a peat-filled bay – **Small-Basin Wetland**

B. In a geomorphic floodplain or associated with a natural linear conveyance (such as a topographic crenulation) or along shorelines of natural water bodies greater than 20 acres or artificial impoundments
   i. Northern Inner Piedmont or Blue Ridge Mountains ecoregions and dense herbaceous or mixed shrub/herbaceous vegetation with characteristic bog species (see wetland type description), with or without tree canopy; typically long-duration saturation; sphagnum moss commonly present – **Mountain Bog**
   ii. Anywhere in the state and not Mountain Bog
      1. Dominated by herbaceous vegetation. At least semi-permanently inundated or saturated. Includes lacustrine and riverine fringe, and beaver ponds with dense herbaceous vegetation of large, grass-like plants and forbs, sphagnum moss scarce or absent – **Non-tidal Freshwater Marsh**
      2. Dominated by woody vegetation. Trees may be present on edges or hummocks.
         a. Localized depression; semi-permanently inundated – **Floodplain Pool**
         b. Not a localized depression
            i. Zero- to 1st-order stream[1]. May be 2nd- or 3rd-order stream in Sandhills level IV ecoregion. Diffuse surface flow and groundwater more important than overbank flooding.
               1. Intermittently inundated to seasonally saturated – **Headwater Wetland**
               2. Seasonally to semi-permanently inundated – **Riverine Swamp Forest**
            ii. Second-order or greater stream or associated with the shoreline of waterbodies 20 acres or greater
               1. Intermittently to seasonally inundated for long duration (may be dominated by sweetgum, ash, sycamore, and oaks) – **Bottomland Hardwood Forest**
               2. Seasonally to semi-permanently inundated for very long duration (may be dominated by cypress and blackgums in Coastal Plain and ash, overcup oak, and elms in Piedmont and Mountains) – **Riverine Swamp Forest**

[1]See stream order schematic diagram in User Manual Appendix C.

Appendix C

NCWAM Field Assessment Form

NC WAM FIELD ASSESSMENT FORM
VERSION 3.13 (January 12, 2007)

Wetland Site Name		**Date**	
Wetland Type		**Assessor Name/Organization**	
Level III Ecoregion		**Nearest Named Water Body**	
River Basin		**USGS 8-Digit Catalogue Unit**	
☐ **Yes** ☐ **No**	**Precipitation within 48 hrs?**	**Latitude/Longitude (deci-degrees)**	

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ☐ Yes ☐ No

Describe effects of stressors that are present.

Regulatory Considerations
Select all that apply to the assessment area.
☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Wetland adjacent to or associated stream drains to a Primary Nursery Area
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ N.C. Division of Water Quality best usage classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community

What type of natural stream is associated with the wetland, if any? (Check all that apply)
☐ Blackwater
☐ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

Is the assessment area on a coastal island? ☐ Yes ☐ No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ☐ Yes ☐ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual v1.0). If a reference is not applicable, then rate the assessment area based on evidence of alteration.

GS	VS	
☐A	☐A	Not severely altered
☐B	☐B	Severely altered over most of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the NRCS Scope and Effect Guide (see User Manual v1.0 Appendix G) for North Carolina hydric soils for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
☐A	☐A	Water storage capacity and duration are not altered.
☐B	☐B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
☐C	☐C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, stream incision, sewer lines, soil compaction).

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric**

Check a box in each column. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
☐A	☐A	> 50% of the wetland type with depressions able to pond water > 2 feet
☐B	☐B	> 50% of the wetland type with depressions able to pond water 1 to 2 feet
☐C	☐C	> 50% of wetland type with depressions able to pond water 6 inches to 1 foot
☐D	☐D	> 50% of wetland type with depressions able to pond water 3- to 6-inches deep
☐E	☐E	Depressions able to pond water < 3-inches deep

4. **Soil Texture/Structure – assessment area condition metric**

Select all that apply. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top foot. National Technical Committee for Hydric Soils regional indicators are noted (use most recent guidance).

☐A Sandy soil
☐B Predominantly characterized by mottled (redoxymorphic features), mineral soil (F6, F8, F12, TF10, S5, S6)
☐C Predominantly characterized by other, mineral soil (no mottling)
☐D Gleyed mineral soil (F2, S4)
☐E Soil ribbon < 1 inch
☐F Soil ribbon ≥ 1 inch
☐G No peat or muck presence
☐H A peat or muck presence (A6, A7, A8, A9, A10, F1, S1)
☐I Peat or muck soil (histosol or histic epipedon) (A1, A2, A3)

5. **Discharge into Wetland – opportunity metric**

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☐A	☐A	Little or no evidence of pollutants or discharges entering the assessment area
☐B	☐B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐C	☐C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation)

6. **Land Use – opportunity metric**

Check all that apply. Evaluation of this metric involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont and 30 feet wide in the Mountains.

WS	5M	2M	
☐A	☐A	☐A	> 30% impervious surfaces with stormwater Best Management Practices (BMPs) (land use examples: industrial, commercial, and high-density residential)
☐B	☐B	☐B	> 30% impervious surfaces without stormwater BMPs
☐C	☐C	☐C	10 to 30% impervious surfaces
☐D	☐D	☐D	< 10% impervious surfaces
☐E	☐E	☐E	Old urban development (pink areas on USGS 7.5-minute quadrangles)
☐F	☐F	☐F	New adjacent development
☐G	☐G	☐G	Confined animal operations (or other local, concentrated source of pollutants)
☐H	☐H	☐H	≥ 20% coverage of pasture without riparian buffer
☐I	☐I	☐I	≥ 20% coverage of pasture with effective riparian buffer
☐J	☐J	☐J	≥ 20% coverage of agricultural land (regularly plowed land) without riparian buffer
☐K	☐K	☐K	≥ 20% coverage of agricultural land (regularly plowed land) with effective riparian buffer
☐L	☐L	☐L	≥ 20% coverage of maintained grass/herb
☐M	☐M	☐M	Silvicultural land with disturbance < 5 years old
☐N	☐N	☐N	Little or no opportunity. Lack of opportunity may result from hydrologic modifications that prevent drainage or overbank flow from affecting the assessment area.

7. **Wetland Acting as Vegetated Buffer – assessment area condition metric**

Is the assessment area within 50 feet of a stream or other open water? ("open water" does not include man-made ditches or canals)

☐Yes ☐No If No, skip to next metric.

Stream width (Stream width is normal flow width [ordinary high water to ordinary high water]). If the stream is anastomosed, combine widths of channels/braids for a total stream width.

☐≤ 15-feet wide ☐> 15-feet wide ☐Not Applicable

Do roots of assessment area vegetation extend into the bank of the adjacent stream/open water?

☐Yes ☐No

Is stream or other open water sheltered or exposed?

☐Sheltered – adjacent open water with width < 2500 feet <u>and</u> no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet <u>or</u> regular boat traffic.

8. **Wetland/Riparian Buffer Width – assessment area/wetland type/wetland complex metric**

Check a box in each column. Select the appropriate width for the wetland type at the assessment area (WT), the wetland complex (WC), and the riparian buffer at the assessment area (RB) (if applicable). Riparian buffer width is measured from top of bank and need only be present on one side of the water body. The riparian buffer is measured from the outside banks of the outer channels of an anastomosed system. Make buffer judgment based on dominant landscape feature. Record a note if a portion of the buffer has been removed or disturbed.

WT	WC	RB (if applicable)	
☐A	☐A	☐A	≥ 100 feet
☐B	☐B	☐B	From 80 to < 100 feet
☐C	☐C	☐C	From 50 to < 80 feet
☐D	☐D	☐D	From 40 to < 50 feet
☐E	☐E	☐E	From 30 to < 40 feet
☐F	☐F	☐F	From 15 to < 30 feet
☐G	☐G	☐G	From 5 to < 15 feet
☐H	☐H	☐H	< 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

☐A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

☐A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the contiguous wetland complex (WC), and the size of the contiguous, forested wetland (FW) (if applicable, see User Manual). Boundaries are formed by uplands, four-lane roads, or urban landscapes. An observed beaver pond forms a boundary if it extends across the entire width of the floodplain. Additionally, other wetland types are considered boundaries for column WT. If assessment area is clear-cut, select "K" for FW column.

WT	WC	FW (if applicable)	
☐A	☐A	☐A	≥ 500 acres
☐B	☐B	☐B	From 100 to < 500 acres
☐C	☐C	☐C	From 50 to < 100 acres
☐D	☐D	☐D	From 25 to < 50 acres
☐E	☐E	☐E	From 10 to < 25 acres
☐F	☐F	☐F	From 5 to < 10 acres
☐G	☐G	☐G	From 1 to < 5 acres
☐H	☐H	☐H	From 0.5 to < 1 acre
☐I	☐I	☐I	From 0.1 to < 0.5 acre
☐J	☐J	☐J	From 0.01 to < 0.1 acre
☐K	☐K	☐K	< 0.01 acre

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

☐A Wetland type is the full extent (≥ 90%) of its natural landscape size.
☐B Wetland type is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

Check appropriate box(es). This metric refers to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate) that includes the wetland type. Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide. Consider if the wetland type is well-connected (WC) or loosely-connected (LC) to the landscape patch.

WC	LC	
☐A	☐A	≥ 500 acres
☐B	☐B	From 100 to < 500 acres
☐C	☐C	From 50 to < 100 acres
☐D	☐D	From 10 to < 50 acres
☐E	☐E	< 10 acres
☐F	☐F	Wetland type has a poor or no connection to other natural habitats

Check Yes or No.

☐Yes ☐No Does wetland type have a surface hydrology connection to open waters or tidal wetlands? (evaluate for marshes only)
☐Yes ☐No Is the assessment area subject to overbank flooding during normal conditions?

14. Edge Effect – wetland type condition metric

Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

☐A No artificial edge within 150 feet in all directions
☐B No artificial edge within 150 feet in four to seven directions
☐C An artificial edge occurs within 150 feet in more than four directions <u>or</u> assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for marshes and Pine Flat)

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☐B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

☐A Vegetation diversity is high and is composed primarily of native species.
☐B Vegetation diversity is low or has > 10% cover of exotics.
☐C Vegetation is dominated by exotic species.

17. Vegetative Structure – assessment area/wetland type condition metric

☐ **Vegetation present**

Evaluate percent coverage of vegetation for marshes only

☐A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

Check a box in each column for each stratum. Evaluate this portion of the metric for non-marsh wetlands. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
☐A	☐A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
☐B	☐B	Canopy present, but opened more than natural gaps
☐C	☐C	Canopy sparse or absent
☐A	☐A	Dense mid-story/sapling layer
☐B	☐B	Moderate density mid-story/sapling layer
☐C	☐C	Mid-story/sapling layer sparse or absent
☐A	☐A	Dense shrub layer
☐B	☐B	Moderate density shrub layer
☐C	☐C	Shrub layer sparse or absent
☐A	☐A	Dense herb layer
☐B	☐B	Moderate density herb layer
☐C	☐C	Herb layer sparse or absent

☐ **Vegetation absent**

18. Snags – wetland type condition metric

☐A Large snags (more than one) are present (> 12-inches DBH, or large relative to species present and landscape stability).
☐B Not A

19. Diameter Class Distribution – wetland type condition metric

☐A Most canopy trees have stems > 6-inches in diameter at breast height (DBH); many large trees (> 12-inches DBH) are present.
☐B Most canopy trees have stems between 6- and 12-inches DBH, few are > 12-inch DBH.
☐C Most canopy trees are < 6-inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

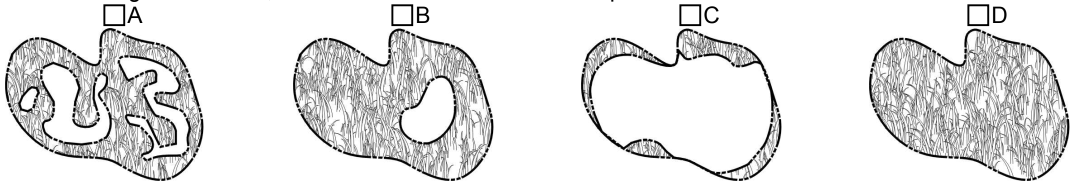
Include both man-made and natural debris piles.

☐A Large logs (more than one) are present (> 12-inches in diameter, or large relative to species present and landscape stability).
☐B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐A ☐B ☐C ☐D



22. Habitat Uniqueness – wetland type condition metric

☐Yes ☐No Has the N.C. Environmental Management Commission classified the assessment area as "Unique Wetlands" (UWL)?

Notes

Appendix D

NC WAM Wetland Rating Sheet

NC WAM Wetland Rating Sheet

Wetland Site Name ______________________ Date of Assessment ______________________

Wetland Type ______________________ Assessor Name/Organization ______________________

Presence of stressor affecting assessment area (Y/N) __________

Notes on Field Assessment Form (Y/N) __________

Presence of regulatory considerations (Y/N) __________

Wetland is intensively managed (Y/N) __________

Wetland may be a high-quality riverine wetland (Y/N) __________

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	
	Sub-surface Storage and Retention	Condition	
Water Quality	Pathogen Change	Condition	
		Condition/Opportunity	
		Opportunity Presence (Y/N)	
	Particulate Change	Condition	
		Condition/Opportunity	
		Opportunity Presence (Y/N)	
	Soluble Change	Condition	
		Condition/Opportunity	
		Opportunity Presence (Y/N)	
	Physical Change	Condition	
		Condition/Opportunity	
		Opportunity Presence (Y/N)	
	Pollution Change	Condition	
		Condition/Opportunity	
		Opportunity Presence (Y/N)	
Habitat	Physical Structure	Condition	
	Landscape Patch Structure	Condition	
	Vegetation Composition	Condition	
	Uniqueness	Condition	

Function Rating Summary

Function	Metrics	Rating
Hydrology	Condition	
Water Quality	Condition	
	Condition/Opportunity	
	Opportunity Presence (Y/N)	
Habitat	Condition	

Overall Wetland Rating __________

Appendix E

Mitigation Site Descriptions and Photos

1. Scuppernong River Corridor Mitigation Site

(Photo of Scuupernong River Mitigation Site, taken 3/26/08.)

The Scuppernong River Corridor tract is a private mitigation bank located in Tyrrell County consisting of a 19 acre prior-converted cropfield that lies within the Scuppernong River drainage system. It borders Hwy 94 on the west and is adjacent to the 26 acre Kitty Hawk Woods Wetland Mitigation Project to the north. Tomotley and Augusta Series comprise the soils on this tract: Tomotley being a poorly drained fine sandy loam soil subject to frequent flooding and persistent wetness much of the year, and Augusta being somewhat poorly drained soil subject to moderate to severe wetness much of the year.

The PC field had been restored to wet hardwood flats and swamp hardwoods (as defined by the 1999 Final Monitoring Report). In January 1993 three ground-monitoring wells were installed. In March it was planted with a total of 12,450 tree and shrub species and then planted again the following year with an additional 6,500 species (totaling approximately 1,000 per acre). These included hard mast oaks, green ash, river birch, black gums, cypress and Atlantic white cedar. After 2-3 years of established tree growth, ditch plugs were installed in all lateral field ditches in April of 1996.

Annual survival, natural regeneration recruitment, and height growth were measured in December 1998 at six locations. Tree and shrub density averaged 845 stems per acre. Natural regeneration of loblolly pine, sweetgum, red maple, Baccharis, buttonbush, red bay and wax myrtle ranged from 210 to 2,650 stems per acre. Removal of competing sweetgum and loblolly pine was necessary for the ultimate success of the planted hardwoods and Atlantic white cedar. Mechanical removal of these species at least once or twice during the first five years was recommended to assure survival and growth of planted species.

All three monitoring wells showed attainment of wetland hydrology as specified by the 1987 Corps Manual. NCDOT contracted to purchase all of the 22.8 credits available for use, and in 1999 the property was donated to the U.S. Fish and Wildlife Service for inclusion into the Pocosin Lakes National Wildlife Refuge.

NC WAM Results:

Scuppernong River	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Non-Riverine SF	High	High	High	Med	**High**
AA 2	Hardwood Flat	Med	High	High	High	**High**

2. Bull Farms Wetland Mitigation Site

(Photo of Bull Farms Mitigation Site, taken 3/5/08.)

The Bull Farms Wetland Mitigation Site is a NCDOT mitigation site located in Sampson County, adjacent to the South River, a tributary to the Cape Fear River. The site encompasses 425.5 acres, 72 acres of which were prior converted farmfields, and the sandy alluvial soils consist of those in the Leon, Woodington, Lumber, Paxville, Cape Fear, Torhunta and Johnston Series.

The mitigation site was first constructed in the summer 1995 with the plugging of all drainage ditches onsite. The following fall the site was KG sheared, ripped, disced, piled and bedded in preparation for planting. In January 1996 the site was planted with bald cypress, tupelo gum, black gum, overcup oak, swamp chestnut oak, willow oak, laurel oak, water oak, and Atlantic white cedar. In the same year groundwater gauges and rain gauges were installed to monitor hydrology.

The 2000 closing monitoring report revealed that planted trees were 3-4 meters tall, however it did not indicate where plots had been placed or which seedling mixture had been planted in which planting zone. Only one plot (#18) appeared to have not met the 320 stems per acre success criteria. Standing water was observed over portions of the site, assuming that saturation was within 12 inches of the surface for more than 12.5% of the growing season. Well data showed that fifteen of the eighteen wells met hydrological success criteria. One area that was excavated for the creation of anadromous fish habitat failed hydrology.

NC WAM Results:

Bull Farms	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Floodplain Pool	High	High	High	High	**High**
AA 2	Bottomland Hardwood	High	Low	High	Low	**Low**
AA 3	Riverine Swamp Forest	Med	Low	Med	Low	**Low**
AA 4	Bottomland Hardwood	High	Med	High	Low	**Med**
AA 5	Riverine Swamp Forest	High	High	High	Low	**High**

3. Dowd Dairy Farm Wetland Mitigation Site

(Photo of Dowd Dairy Mitigation Site taken 2/20/08)

The Dowd Dairy Farm Wetland Mitigation Site is a NCDOT-owned site located 7 miles north of Elizabethtown Off of Dowd Dairy Farm Road in Bladen County. The site represents a 658 acre interstream divide converted for dairy agricultural use (pasture, hay fields, and cropland). It receives drainage from elevated sandy terraces and discharges into Ellis Creek and Panther Branch, tributaries to the Cape Fear River. Torhunta and Johnston sandy soils exist on most of the site.

Construction of the site began in the summer of 1998, which consisted of ripping the compacted pastures and plugging lateral ditches (all except the largest one along Dowd Dairy Road), infilling of select ditch segments, and creating ephemeral pools and stormwater catchments. Vegetation was planted within 38 planting plots the following spring to restore headwater swampforest and non-riverine wet hardwood forest (according to the 2000 CTE/NCDOT Report). 31 monitoring gauges were installed February – April of 1999 of which 25 reached hydrological success criteria.

According to the CTE/NCDOT 2000 Report, survival of planted species appeared patchy across the site. It was determined that the headwater systems were not wet enough for hydric hardwoods such as bald cypress and water tupelo to withstand competition from less flood-tolerant species. It was estimated that a wet pine savanna community type likely covered the site originally.

NC WAM Results:

Dowd Dairy	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Non-Riverine Swamp Forest	High	Med	Med	Low	**Med**
AA 2	Non-Riverine Swamp Forest	High	High	High	Low	**High**
AA 3	Hardwood Flat	High	High	High	Low	**High**

4. ABC Wetland Mitigation Site

(Photo of the ABC Mitigation Site, taken 3/25/08.)

The ABC Wetland Mitigation Site is an NCDOT mitigation site located northeast of Washington in Beaufort County. The 184 acre site drains into Acre Swamp located along the southeastern border in the Tar-Pamlico River Basin, and consists of mostly loamy Leaf Series soils with a dense clay subsurface. This soil type is found on nearly level interstream divides, and is poorly to somewhat poorly drained. Frequently flooded Muchalee loam soils were identified along the floodplain area of Acre Swamp. The site has been historically cleared, ditched, and drained with wetlands effectively removed to facilitate agricultural production.

Site construction was completed in November of 2001 and included depression construction (B horizon contouring), impervious ditch plugging, ditch backfilling, field crown removal, and ripping and scarification of wetland soil surfaces. Following construction, the site was planted with vegetation characteristic of riverine and non-riverine forested wetlands (including riparian forest buffer restoration) based on soil types and landscape positioning.

Based on the 2004 Monitoring Report, 25 of the 29 ground water gauges showed saturation in excess of the 12.5% hydrological success criterion. Approximately 140.7 acres were planted with wetland vegetation species. 13 planting plots showed a success criteria of at least 320 stems per acre after three years, and at least 260/acre surviving at the end of year five.

As of 2004, the EEP became responsible for fulfilling the remaining monitoring requirements and future remediation for this site.

NC WAM Results:

ABC	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Bottomland Hardwood Forest	Low	Low	Low	Low	**Low**
AA 2	Hardwood Flat	Low	Low	Low	Low	**Low**

5. <u>Bear Creek-Mill Branch Mitigation Bank</u>

(Photo of the Bear Creek-Mill Branch Mitigation Site, taken 3/25/08.)

The Bear Creek-Mill Branch Mitigation Bank is a privately owned site located off of Promiseland Road (SR 1323) approximately 5 miles from confluence with the Neuse River in LaGrange, Lenoir County. The site is composed of approximately 145 acres within the floodplain of Bear Creek, and supports stream flows from Mill Branch. Frequently flooded Pamlico and Johnston Series hydric soils make up the majority of the site.

The site has been ditched, leveled, and drained to support agriculture and silviculture activities. Both the stream and river had been dredged, straightened, and levees constructed to further impede surface water impacts.

Site construction was performed in the fall of 2001. Restoration efforts included (1) restoration of overbank flooding from Bear Creek by means of levee removal and channel repair, (2) maximizing groundwater recharge by ditch plugging and back filling, (3) establishment of backwater sloughs, cypress-tupelo swamps, and bottomland hardwood forests, and (4) diversion of treated stream flows back into historic channels by means of embankment construction. Vegetation planting occurred the following winter, with a total of 66,850 seedlings planted within the restored wetland systems, including black willow, river birch, green ash, willow oak and tulip poplar.

Monitoring reports for this site were not available.

NC WAM Results:

Bear Crk Mill Brch	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Riverine Swamp Forest	Low	Low	Low	Low	**Low**
AA 2	Non-Tidal Fresh Water Marsh	High	High	High	High	**High**

6. Barra Farms Mitigation Bank (Phase I)

(Photo of Barra Farms Mitigation Site taken 2/20/08)

The Barra Farms Mitigation Bank (Phase I) is a privately owned site located along the upper reaches of Harrison Creek in Cumberland County. The site is approximately 623 acres and comprised of mineral and organic soil flats within an interstream divide. Approximately 362 acres was PC cropfields, ditched and drained for agricultural use.

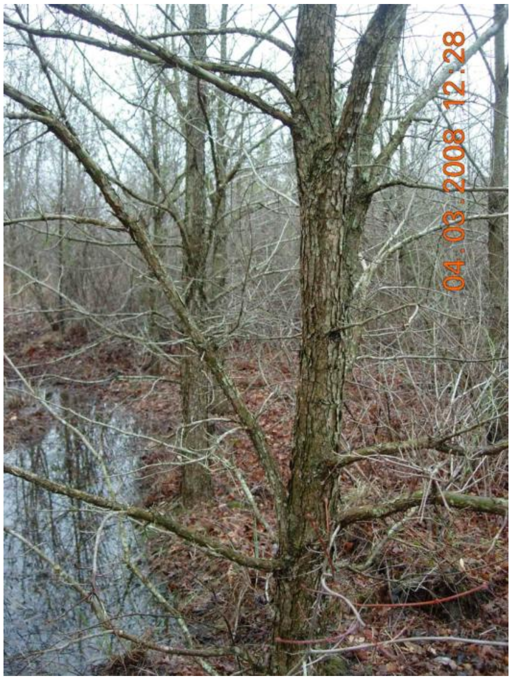
Site construction began in spring of 1997 backfilling ditches, and heavy rainfall in the winter/spring of 1998 and the fall of 1999 created ponding over much of the site which contributed to seedling mortality. Six drainage pipes were installed to alleviate the excess water and over 40,000 seedlings were planted in the winter of 2000.

Twenty-three ground water monitoring gauges were installed across the site. Data from the 2002 revealed that the restoration area had required wetland hydrology during an average of 14.3% of the growing season. Vegetation monitoring identified woody and herbaceous species within 34 planting plots were growing successfully at an abundance of 425 stems per acre.

NC WAM Results:

Barra Farms	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Hardwood Flat	High	Med	Med	Med	**Med**
AA 2	Non-Riverine Swamp Forest	High	High	High	Medium	**High**
AA 3	Pine Flat	Med	Med	Med	Med	**Med**
AA 4	Hardwood Flat	High	High	High	Low	**High**

7. Long Swamp Wetland Mitigation Site



(Photo of the Long Swamp Mitigation Site, taken 4/03/08.)

The Long Swamp Wetland Mitigation Site is NCDOT-owned property located approximately 8.7 miles southwest of Raeford in Hoke County at the head of the Long Swamp stream. The site is 242 acres and is characterized as nearly level, encompassing approximately 100 acres of headwater wetlands, minimal slopes associated with floodplain boundaries of low-energy streams, and rims of Carolina bays.

Approximately 191 acres of the site contain loamy to loamy-sand hydric soils. Those identified include Johnston, Pantego, and Rains series. Approximately 115 acres of the site was converted for agricultural and sivilculture (pine plantation) use by means of ditching, draining and leveling to successfully remove hydrology.

Site construction to restore riverine and non-riverine wetlands began in the summer of 1998, which consisted of plugging and backfilling lateral ditches except for the one large ditch located along Old Wire Road (SR 1105) to the northwest. A large swale (12-15 feet wide) was constructed from Old Wire Road running southeast towards the power utility easement to draw water towards the head of Long Swamp Creek. In March of 1999, monitoring wells were installed and in April the site was planted

Thirteen acres of prior converted cropland were successfully restored according to the 2002 final Monitoring Report, however the remaining 40 acres of agricultural land in the northeast corner did not meet hydrological requirements. It is believed that this area was not ripped deep enough, for a hard pan layer was discovered just 4-6" below the saturated surface. In total, approximately 24 acres of wetlands on site were restored and 112 acres were enhanced or preserved.

NC WAM Results:

Long Swamp	Wetland Community Type	Hydro-logy	Water Qual (C)	Water Qual (O)	Habitat	Overall Rating
AA 1	Hardwood Flat	High	High	High	Med	**High**
AA 2	Non-Riverine Swamp Forest	High	Med	Med	Low	**Med**

8. Gurley Tract Mitigation Site


(Photo of Gurley Mitigation Site taken 3/27/08)

The Gurley Tract Mitigation Site is a NCDOT-owned site located on SR 1058, 8 miles northwest of Snow Hill in Greene County. The site is approximately 179 acres, 27 of which was prior-converted agricultural land. Loamy hydric soils of the Lumbee and Paxville Series comprise most of this area. The majority of the site drains into Beaver Branch which flows south through the center of the property (except that it has been impounded by beaver), and is bordered by Nahunta Swamp to the south.

Nahunta Swamp was historically straightened and channelized, with a large levee on the north bank created from the spoil material. Drainage ditches were installed to covert the area for agriculture and timber harvesting.

The site was constructed in December of 1997. Twenty-five-foot breaks were created every 250 feet along Nahunta Swamp to increase overbank flooding on the site, and the spoil was used to plug ditch outlets. Scarification of top 12-18 inches of the PC fields to increase permeability rates and surface storage capacity was also conducted.

In the winter of 1998, non-riverine wet hardwood forest species (swamp chestnut oak, laurel oak, water oak, willow oak tulip tree, American sycamore, and American beech) were planted on the PC section of the site. Vegetation monitoring in 2003 yielded an average tree density of 486 trees per acre, well above the minimum success criterion of 320 trees per acre.

Sixteen groundwater, three surface water, and one rain gauge were installed on the Gurley Tract to monitor site hydrology. The 2003 monitoring report concluded that hydrology was successful within the PC areas.

NC WAM Results:

Gurley Tract	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Hardwood Flat	High	High	High	Med	**High**
AA 2	Bottomland hardwood Forest	High	High	High	Med	**High**

9. Mildred Woods Mitigation Site

(Photo of Mildred Woods Mitigation Site taken 3/27/08)

The Mildred Woods Mitigation Site was created to compensate for unavoidable wetland losses incurred during roadway construction of US 64. Located in Edgecombe County, the site is approximately three miles east of Tarboro. It encompasses approximately 593 acres and is situated near the Tar River, immediately adjacent to the newly constructed US 64.

The site was constructed in 1995 by means of plugging and filling ditches, as well as shearing of existing loblolly pines and sweet gums to prevent competition with saplings. In 1996, wetland plant communities were reestablished on approximately 372 of the 593 acres. Plant communities include swamp forest (37 acres), Atlantic white cedar (2 acres), wet hardwood forest (214 acres), oak-hickory forest (108 acres), and long leaf pine-oak/hickory forest (11 acres).

The site was first monitored for both hydrology and vegetation in 1996. Monitoring studies in 1998 found that many of the 43 gauges that were installed were missing or mislabeled, so hydrologic success could not be determined. In February of 1999 more gauges were installed, and monitoring continued until the end of 2001.

NC WAM Results:

Mildred Woods	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Pine Flat	High	High	High	Med	**High**
AA 2	Hardwood Flat	Med	High	High	Low	**Med**
AA3	Non-Riverine Swamp Forest	High	High	High	Low	**High**
AA4	Non-Riverine Swamp Forest	High	High	High	Low	**High**
AA5	Pine Flat	Med	Med	Med	High	**Med**
AA6	Pine Flat	High	High	High	Med	**High**

10. Dismal Swamp Mitigation Site

(Photo of Dismal Swamp Mitigation Site taken 3/27/08)

The Dismal Swamp Mitigation Site is located along the Gates and Perquimans County lines. It is 1.2 miles east of Sandy Cross on SR 1002 (Folly Road). The site encompasses approximately 612 acres of farm and forest communities.

Site hydrology was monitored using twenty-eight groundwater gauges, one surface gauge, five Infinity gauges and two rain gauges. Subsequently, five surface water gauges were installed in Spring 2002 to illustrate surface water levels in the riverine area. Two groundwater gauges (DS-28 and DS-29) were also installed adjacent to the surface gauges to show groundwater in the absence of surface water. Surface gauge (SG-1) was installed to record water levels from the ground up to the gauge's calibration line. Surface gauge (SG-2) was installed in the stream and records the water level fluctuations. Surface gauges (SG-3, SG-4, SG-5, and SG-6) were installed to record groundwater saturation and/or surface inundation.

Hydrologic monitoring indicated that the majority of the site has met the success criteria during the 2003-monitoring year. Eighteen of the twenty-three groundwater gauges met or exceeded the expected 12.5% jurisdictional wetland criteria. All four gauges in the upper landscape position met the success criteria of 5% - 12.5% hydrology.

Forty-eight plots were established to monitor vegetation. Vegetation monitoring yielded a successful total average density of 463 trees per acre across the four-planted zones. 2003 represented the fifth consecutive year that the site had been monitored for hydrology and vegetation.

NC WAM Results:

Dismal Swamp	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Riverine Swamp Forest	High	High	High	High	**High**
AA 2	Non-Riverine Swamp Forest	High	High	High	Med	**High**
AA3	Non-Riverine Swamp Forest	High	High	High	Med	**High**

11. Hidden Lake Mitigation Site

(Photo of Hidden Lake Mitigation Banking Sites taken on 3/26/08)

The Hidden Lake private mitigation banking site consists of two prior-converted agricultural tracts: the 34 acre Woodward Tract and the 12 acre Morris Tract. These properties are located north of SR 1209 (Soundside Road) approximately 5 miles east of Columbia in Tyrrell County.

Ground water levels were measured via the installment of monitoring wells at 15 locations (11 on Woodward and 4 on Morris). 2002 represented the seventh and final year of monitoring for hydrology and wetland vegetation. Data showed that all the wells exhibited saturation within 12 inches of the surface for the majority of the growing season. The average number of planted wetland tree and shrub species 610 and 390 plants per acre respectively, and planted tree survival rate was well above the minimum 320 trees per acre.

In April 2003 the majority of loblolly pine and sweetgum competition were removed from the areas of restoration planting. This assured the growth and survival of the planted hardwoods, cypress, and Atlantic white cedar.

In September of 2003, Hurricane Isabelle passes very closed to the Hidden Lake mitigation site. Due to its proximity to Albemarle Sound, the effects of the storm caused considerable saltwater intrusion, resulting in vegetation mortality. However, observations from the March 26, 2008 site visit showed that the storm did not have long-term effects.

NC WAM Results:

Hidden Lake	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1 (Woodward Tract)	Hardwood Flat	High	High	High	Low	**High**
AA 2 (Morris Tract)	Hardwood Flat	High	High	High	Low	**High**

12. Haws Run Mitigation Site

(Photo of Haws Run Mitigation Site taken 2/27/08)

Haws Run Mitigation Site was purchased by the NC Department of Transportation in 1995 to provide compensatory mitigation for impacts to wetlands resulting from the construction of the Jacksonville Bypass (U-2107). The site is located approximately 28 miles northeast of Wilmington, straddling the Pender-Onslow County line. The 595 acre site consists of riverine swampforests on the northern and southern ends (the north boundary being Sandy Run Swamp, and the south being Shelter Swamp), and an interior of former wet pine flats and savannas containing poorly-drained clay-rich Torhunta and Grifton soils.

Records show that the Haws Run site remained largely unaltered until 1972. In the mid 70s bald cypress were harvested from the site and the flat area was converted for bison pasture. Conversion was done through clear-cutting, stumping, chisel-plowing, and extensive ditching. Approximately 900 tons of lime (2 tons/acre) was applied to the acidic soil to increase the pH. The bison operation lasted about ten years.

The central canal and lateral ditches north of the power line easement were plugged to restore hydrology in December 1997, and full site construction began in the summer of 1998. Fill was removed from the roadcrossings and causeways to restore 8 acres of swamp forest. This material was used to fill the central canal and lateral field ditches to the north of the powerline easement. The south end ditch could not be filled due to the presence of critical rare species habitat and four listed federal species of concern. The perimeter ditch also could not be filled as it would flood the adjacent property.

Additional site construction included the excavation of 33 acres of topsoil (0.5 – 2.0m) to create supplementary floodplain along Sandy Creek to the north. This area was planted with Bottomland Hardwood tree species (*Taxodium distichum, Nyssa biflora, Quercus lyrata, and Quercus michauxii*) in the early spring of 1999.

A 2000 monitoring report determined the riverine swamp forest created at the north end of the site to be unsuccessful. Removing the O and A horizons left sandy clay soils exposed at the surface, and the trees planted were not surviving very well. At the edge of the excavated area, banks were sloughing off and eroding into the floodplain. In a 2002 monitoring report, it was identified that "another unintended consequence is that the excavation now functions as a 2m-deep ditch and so is likely draining the are upgradient from the excavation."

Ditch filling had appeared to restore hydrology to approximately 81 acres of wet pine savanna at the central portion of the site, and planted species were doing well.

NC WAM Results:

Haws Run	**Wetland Community Type**	**Hydro-logy**	**Water Qual (C)**	**Water Qual (O)**	**Habitat**	**Overall Rating**
AA 1	Riverine Swamp Forest (created)	Low	Med	Med	Low	**Low**
AA 2	Riverine Swamp Forest	High	High	High	Low	**High**
AA 3	Hardwood Flat	High	High	High	Low	**High**
AA 4	Pine Savanna	High	High	High	Low	**High**