

MITIGATION PLAN
GATLIN SWAMP WETLAND RESTORATION SITE
MARTIN COUNTY, NORTH CAROLINA

(CONTRACT #16-D05024)
FULL DELIVERY PROJECT
ROANOKE RIVER BASIN
CATALOGING UNIT 03010107

Prepared for:

**NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL
RESOURCES
RALEIGH, NORTH CAROLINA**

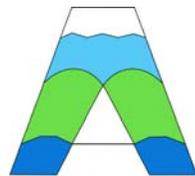
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January 2006

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Gatlin Swamp – Preconstruction Conditions



Photo 1

Gatlin Swamp – Post Construction Conditions



Photo 2

**GATLIN SWAMP WETLAND RESTORATION SITE
AS-BUILT MITIGATION REPORT
MARTIN COUNTY**

1.0 INTRODUCTION

Restoration Systems, L.L.C. (Restoration Systems) has completed the restoration of nonriverine wetlands at the Gatlin Swamp Wetland Restoration Site (hereafter referred to as the "Site") to assist the North Carolina Ecosystem Enhancement Program (EEP) in fulfilling wetland mitigation goals in the region. The Site is located approximately 1.5 miles southwest of Oak City, in Martin County (Figures 1 and 2). The Site encompasses 150.2 acres of land situated in an expansive interstream flat characterized primarily by timber production and agriculture. The project consists of 138.7 acres of nonriverine wetland restoration and 11.5 acres of reforested uplands, with benefits to water quality and wildlife in a watershed that is highly dissected for agriculture and timber production.

The Site is located within subbasin 03-02-09 of the Roanoke River Basin. This area is part of United States Geological Service (USGS) Cataloging Unit 03010107 of the South Atlantic/Gulf Region (14-digit hydrologic unit 03010107120020). The Site drains into Etheridge Swamp and Conoho Creek, a major tributary to the Roanoke River.

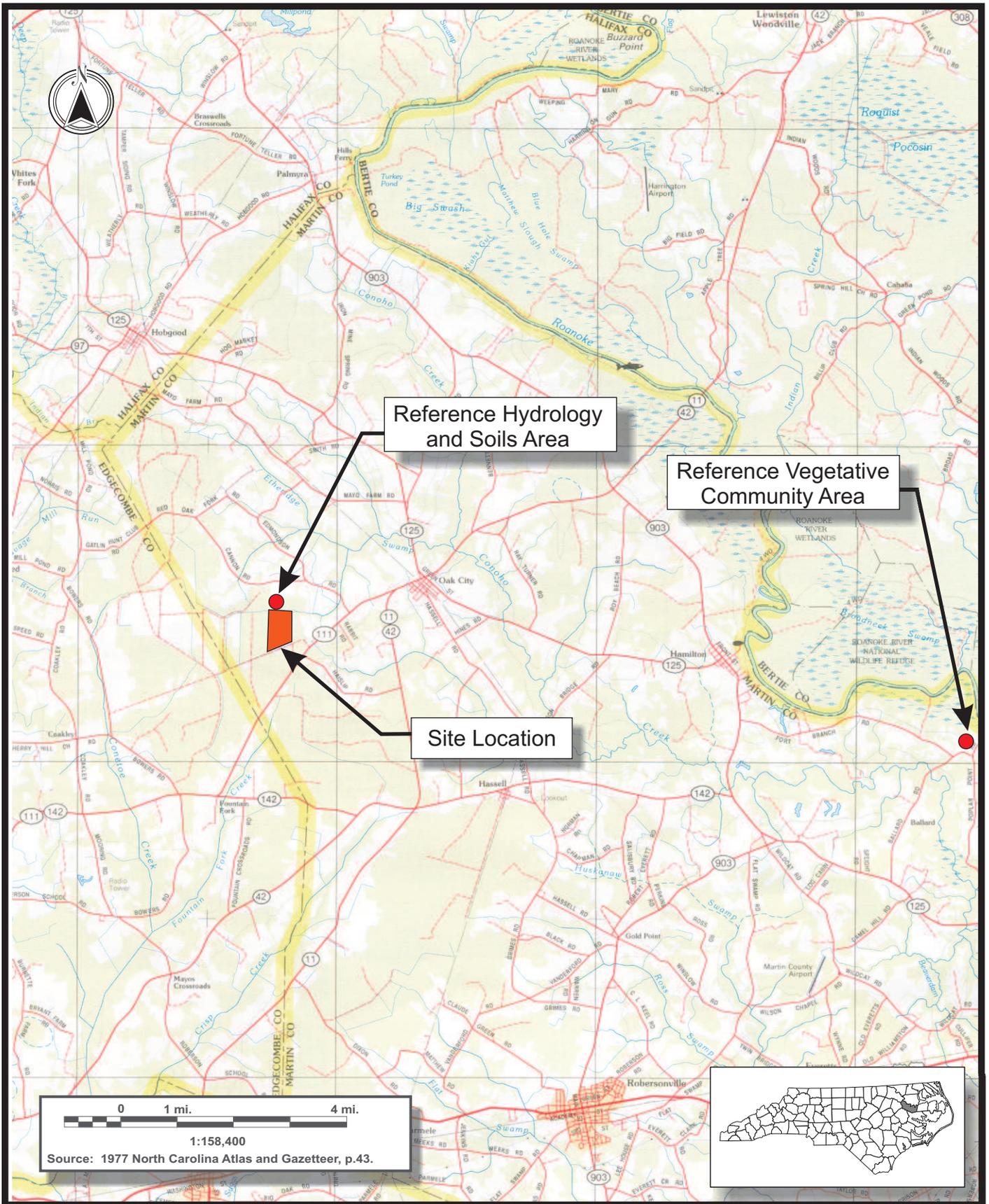
A Detailed Wetland Restoration Plan was completed for the Site in September 2005. The plan outlined methods designed to restore agricultural fields that had been ditched, drained, and cleared for row crop production. Prior to implementation, the entire 150.2 acre Site was underlain by 138.7 acres of hydric soil that had been effectively drained and contained no jurisdictional wetlands. The Detailed Wetland Restoration Plan outlined restoration procedures including 1) ditch cleaning prior to backfill, 2) depression construction, 3) impervious ditch plug construction, 4) ditch backfilling, 5) floodplain soil scarification, and 6) plant community restoration.

The following objectives were proposed to provide mitigation credit requested under the EEP Request For Proposal (RFP) #16-D05024 dated October 22, 2004.

- Provide 125 acres of nonriverine Wetland Mitigation Units, as calculated in accordance with the requirements stipulated in RFP #16-D05024.
- Restore approximately 125 acres of wetland through filling agricultural ditches, removal of spoil castings, eliminating row crop production activities, and/or planting with native forest vegetation.
- Protect the Site in perpetuity with a conservation easement held by the State of North Carolina.

The primary goals of the nonriverine wetland restoration project focused on improving water quality, enhancing flood attenuation, and restoring wildlife habitat and were accomplished by the following.

1. Removing non-point sources of pollution associated with agricultural row crop production including a) cessation of broadcasting fertilizers, pesticides, and agricultural materials into and adjacent to Site drainage ditches and b) providing a vegetative buffer adjacent to headwater streams and wetlands to treat agricultural runoff which may be laden with sediment and/or agricultural pollutants.

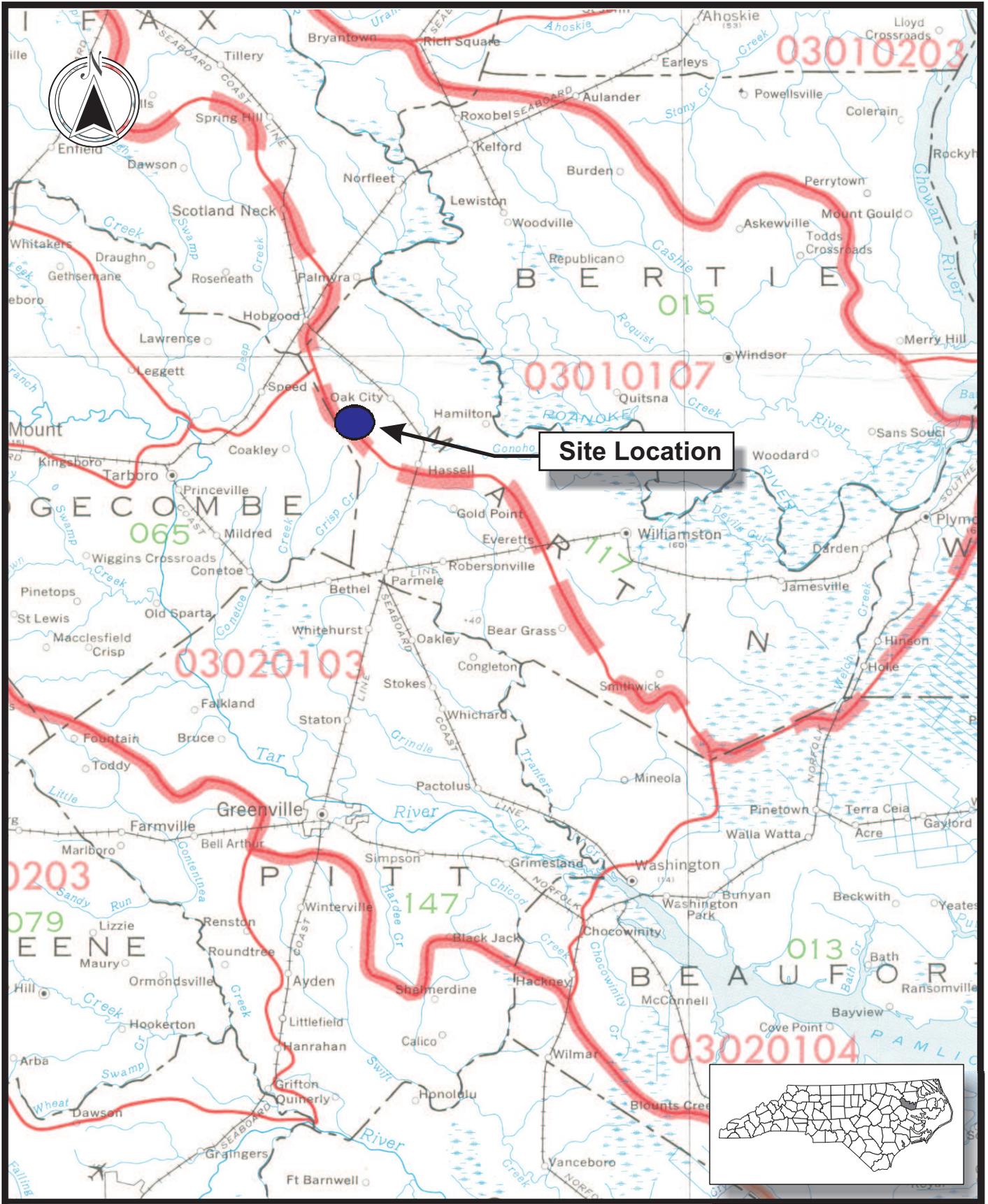


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SITE LOCATION
GATLIN SWAMP WETLAND RESTORATION SITE
 Martin County, North Carolina

Dwn. by:	WGL
Ckd by:	WGL
Date:	Jan 2006
Project:	05-009

FIGURE
1




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**USGS HYDROLOGIC UNIT MAP
GATLIN SWAMP WETLAND RESTORATION SITE
Martin County, North Carolina**

Dwn. by:	WGL	FIGURE 2
Ckd by:	WGL	
Date:	Jan 2006	
Project:	05-009	

2. Restoring wetland hydroperiods that satisfy wetland jurisdictional requirements and approximate the Site's historic natural range of variation.
3. Promoting floodwater attenuation through removal of inter-field ditches and enhancing groundwater storage capacity.
4. Restoring and re-establishing natural community structure, habitat diversity, and functional continuity.
5. Protecting the Site's full potential of wetland functions and values in perpetuity.

As constructed, the Site provides 138.7 acres of nonriverine wetland restoration and 11.5 acres of forested upland buffer.

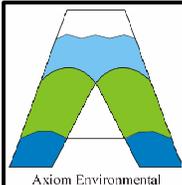
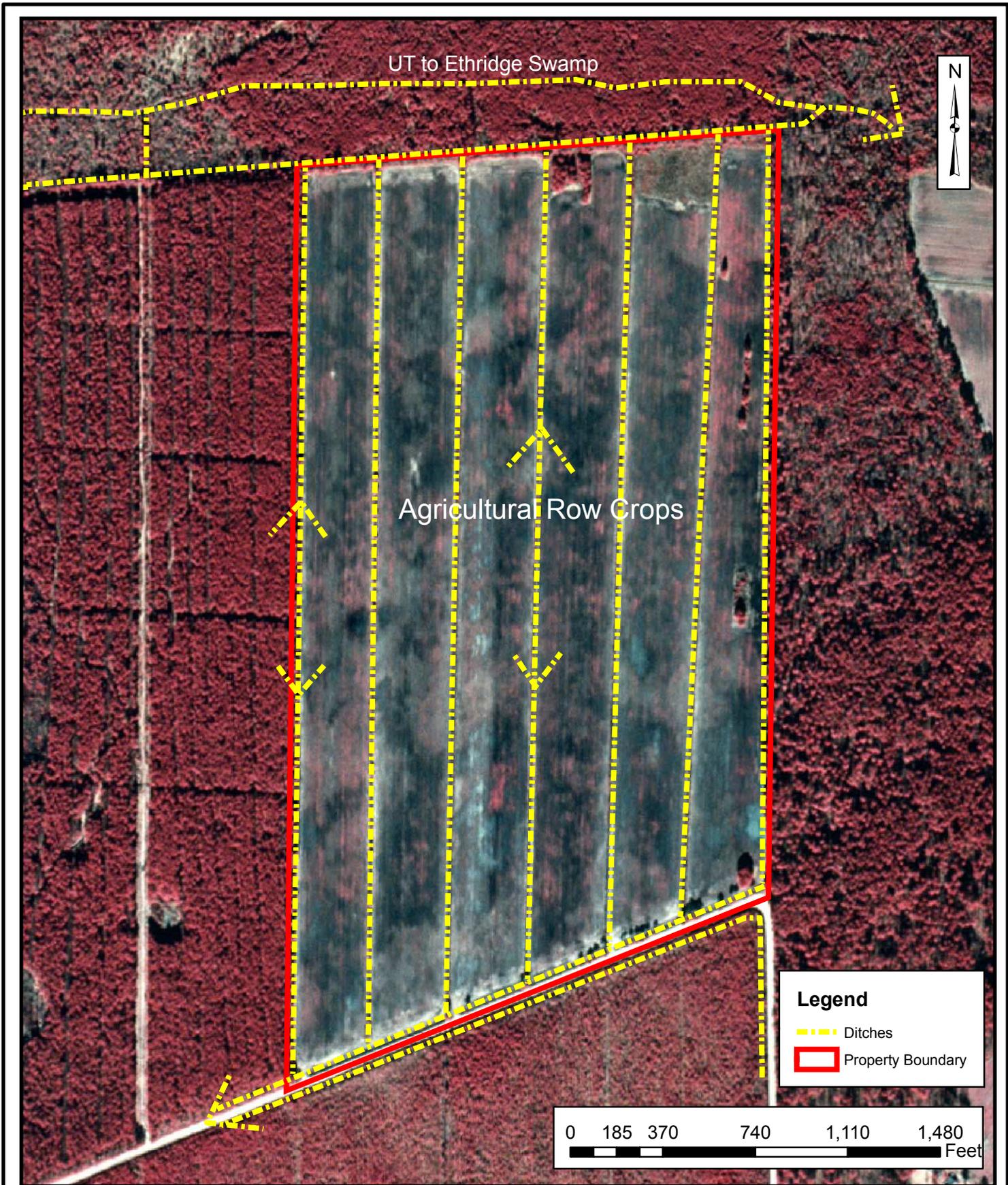
2.0 SUMMARY

2.1 Preconstruction Condition

The Site includes 150.2 acres of land located in an expansive, nonriverine interstream flat. Prior to construction, the entire 150-acre tract was utilized for agricultural row crop production including corn, soybeans, and peanuts (Figure 3). The Site is surrounded by timber tracts approximately 20 years in age. An extensive ditch system had been excavated to drain the Site for agricultural land uses. These ditches were excavated to a depth of approximately 2 to 4 feet, oriented primarily in a north to south direction, and drained towards perimeter ditches which removed hydrology from the Site.

The Site drains into an unnamed tributary to Etheridge Swamp via the perimeter ditches along the northern edge of the Site and a complex network of roadside and timber stand ditches. Site drainage flows for approximately 2 miles prior to converging with Etheridge Swamp, a third-order stream that drains to the larger Conoho Creek.





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PRE CONSTRUCTION CONDITIONS
GATLIN SWAMP WETLAND RESTORATION SITE
Martin County, North Carolina

Dwn. by: WGL

Date: Jan 2006

Project: 05-009

FIGURE

3

The Site is located in a hydrophysiographic region that consists of relatively flat, Coastal Plain environments characterized by moderate rainfall, averaging approximately 48 inches of precipitation per year (USDA 1977). The Site is situated along the apex of a Coastal Plain interstream divide and includes groundwater slopes at the upper headwaters of an unnamed tributary to Etheridge Swamp. Therefore, historic wetlands were most likely influenced primarily by precipitation and lateral migration of groundwater flows toward the upper reaches of the tributary to Etheridge Swamp.

Prior to Site implementation, soil surfaces had been leveled, graded, and compacted as a result of agricultural practices. Typical of crop land with clayey subsurface horizons (ex: Rains series), approximately 9 inches of the Site soil surface (A horizon or plow layer) was characterized by loamy soils with relatively high permeability that were plowed annually. Immediately below this plow layer, a compacted clay layer or "pan" (upper portion of the B horizon) exhibited low permeability. Precipitation that infiltrated to the clay pan migrated laterally through the permeable plow layer into Site and perimeter ditches.

2.2 Project History

In June 2005, the EEP entered into a contract with Restoration Systems to restore the Site. A combined Detailed Wetland Restoration Plan was completed for the project in September 2005. Upon completion of the detailed plan, construction schematics were developed and construction was initiated in October 2005. Anderson Farms completed earthwork and grading at the Site in December 2005. Carolina Silvics completed planting of the Site in January 2006.

Information on project managers, owners, and contractors follows:

Owner Information

Restoration Systems, L.L.C.
George Howard and John Preyer
1101 Haynes Street, Suite 107
Raleigh, North Carolina 27604
(919) 755-9490

Planting Contractor Information

Carolina Silvics
Dwight McKinney
908 Indian Trail Road
Edenton, North Carolina 27932
(919) 523-4375

Designer Information

Axiom Environmental, Inc.
W. Grant Lewis
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Earthwork Contractor Information

Anderson Farms
Gary Wilkerson and Richard Anderson
179 NC 97 East
Tarboro, North Carolina 27886
(252) 823-4730

3.0 RESTORATION ACTIVITIES

Site alterations designed to restore characteristic wetland soil features and groundwater wetland hydrology included 1) ditch cleaning prior to backfill, 2) depression construction, 3) impervious ditch plug construction, 4) ditch backfilling, 5) floodplain soil scarification, and 6) plant community restoration (Figure 4). Restoration plans depicted in Figure 4 restored 138.7 acres of nonriverine, interstream flat wetland and 11.5 acres of adjacent upland buffer.

3.1 Ditch Cleaning Prior to Backfill

Ditches identified for backfilling (Figure 4) were cleaned, as needed, to remove unconsolidated sediments within the lower portion of the cross-section. Accumulated sediments within the ditches consisted of relatively high permeability material that could have acted as a conduit for continued drainage after restoration. The unconsolidated sediments were removed from the ditches to expose the underlying, relatively impermeable clay substrate along the ditch bottoms. The sediment material was placed on adjacent surfaces and later incorporated into top soils during soil preparation for planting.

3.2 Depression Construction

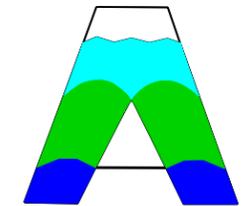
Based on volume calculations for ditch-backfill material, approximately 24,375 cubic yards of material were borrowed from the Site. Borrow material was generated through excavation of groundwater storage depressions throughout the Site landscape. The primary purpose of these depressions was to provide suitable, low permeability material for ditch plugs and backfilling, to increase water storage potential within the wetland restoration area, and to increase potential for biological diversity within the complex.

The depressions were constructed by excavating and stockpiling top soils overlying the B horizon (clay layer). Subsequently, clay from the B horizon was excavated as individual pockets approximately 2 to 4 feet in width and 2 to 4 feet in depth, such that the landscape was “pockmarked” with small, groundwater storage depressions (Figure 5). Clays excavated from the depressions were utilized as backfill material on adjacent ditch sections. Top soils and sediment removed from ditch cleaning efforts were utilized to backfill the depression to within 0.3 foot of the surface.

3.3 Ditch Plugs

Ditch plugs were installed along on-Site ditches at locations depicted in Figure 4. In addition, all Site outfall locations were effectively plugged to prevent migration of surface water to and from the Site. The plugs were constructed of low density material designed to withstand erosive forces associated with concentrated surface water or groundwater flows. Each plug consisted of earthen material backfilled in 2-foot lifts of vegetation free material and compacted into the bottom of the ditch.





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NOTES/REVISIONS

Project:

Gatlin Swamp
Wetland Restoration
Site

Martin County
North Carolina

Title:

DITCH PLUGGING
&
DITCH BACKFILL

Scale:

1" = 400'

Date:

JAN 2006

Project No.:

05-009

FIGURE NO.

4

LEGEND	
DESCRIPTION	SYMBOL
SITE BOUNDARY	
DITCH BACKFILL	
DITCH PLUGS	

CONSTRUCTION NOTES

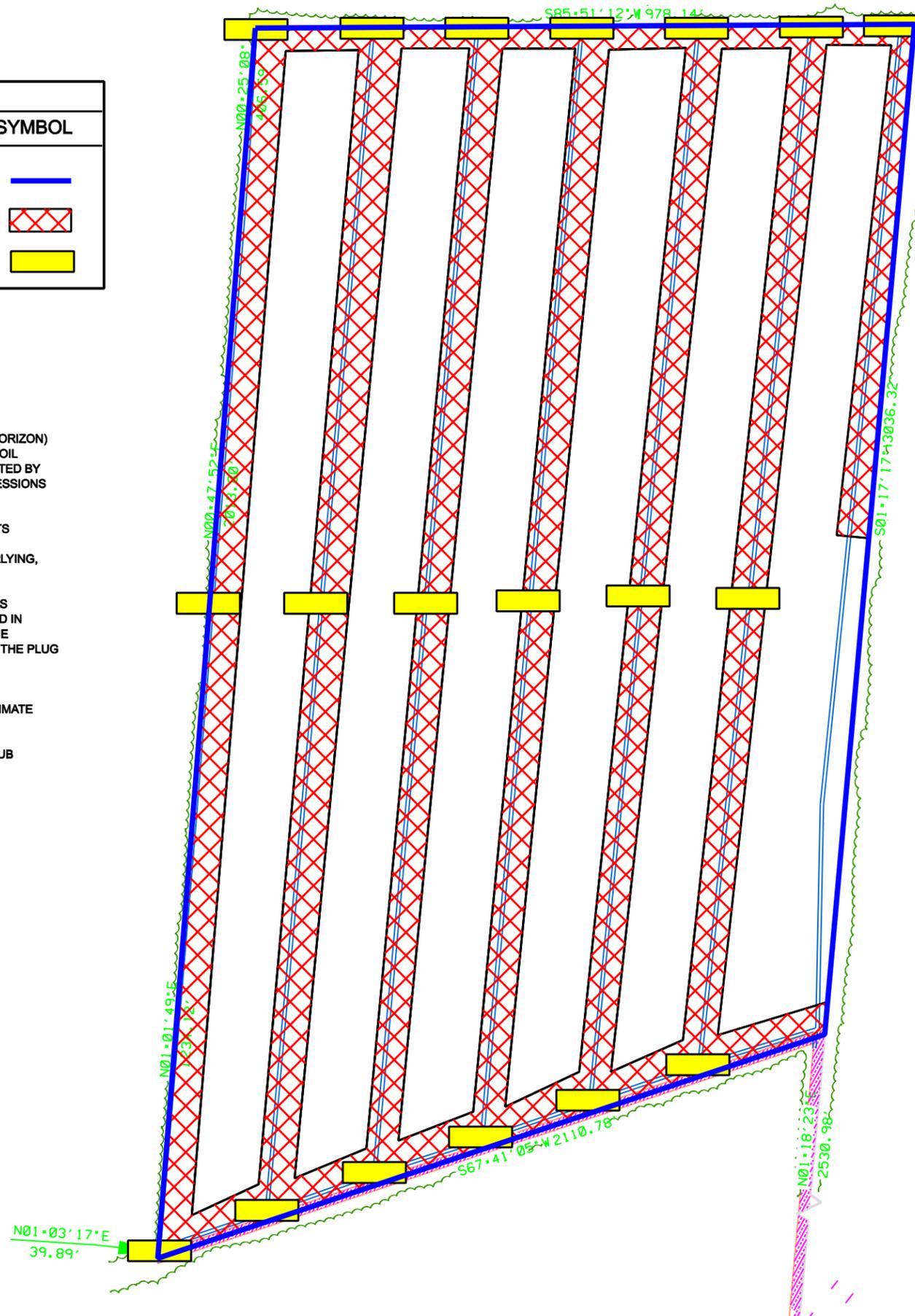
THE CONTRACTOR EXCAVATED MATERIALS FROM THE SITE BY REMOVING TOP SOILS (A-HORIZON) AND EXCAVATING SMALL (3'X3'X3') DEPRESSIONS WITHIN THE UNDERLYING (B-HORIZON) SOIL LAYERS. B-HORIZON MATERIALS WERE STOCKPILED IN DESIGNATED AREAS AND PROTECTED BY EROSION CONTROL MEASURES. ONCE THE DEPRESSIONS WERE EXCAVATED, THE DEPRESSIONS WERE COVERED WITH STOCKPILED TOP SOILS (A-HORIZON).

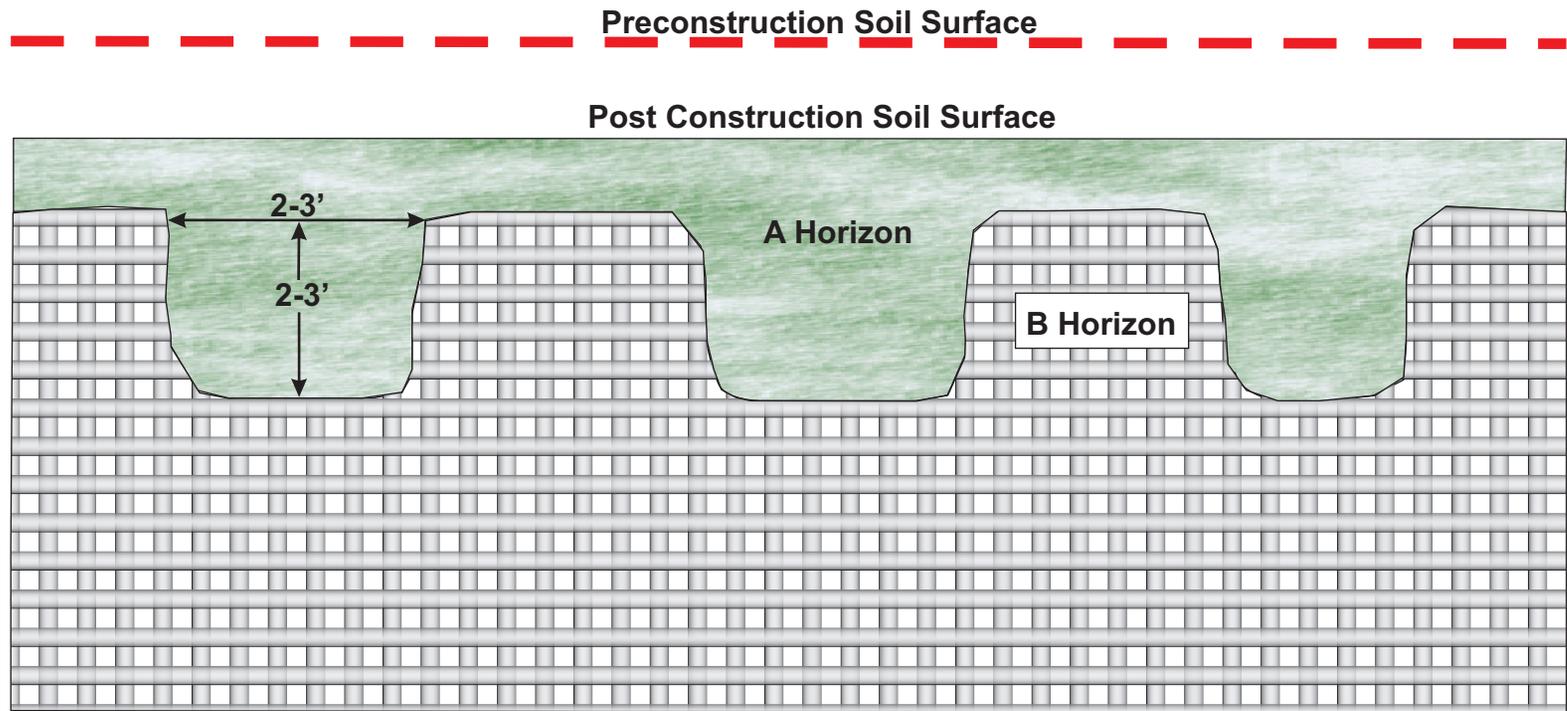
ON-SITE DITCHES WERE CLEANED, AS NEEDED, TO REMOVE UNCONSOLIDATED SEDIMENTS WITHIN THE LOWER PORTION OF THE CROSS SECTION PRIOR TO BACKFILLING. THE UNCONSOLIDATED SEDIMENTS WERE LIFTED FROM THE DITCHES TO EXPOSE THE UNDERLYING, RELATIVELY IMPERMEABLE CLAY SUBSTRATE ALONG THE DITCH INVERT.

DITCH PLUGS WERE INSTALLED ALONG ON-SITE DITCHES AT CRITICAL LOCATIONS SUCH AS SITE INFALLS AND OUTFALLS. EACH PLUG CONSISTED OF EARTHEN MATERIAL BACKFILLED IN 2-FOOT LIFTS OF VEGETATION FREE MATERIAL AND COMPACTED INTO THE BOTTOM OF THE DITCH. EARTHEN PLUGS WERE REINFORCED BY INCORPORATION OF FILTER CLOTH INTO THE PLUG TO MINIMIZE PREFERENTIAL FLOW OF GROUNDWATER THROUGH FILL MATERIAL.

DITCHES WERE BACKFILLED USING ON-SITE MATERIAL EXCAVATED FROM SMALL (3'X3'X3') DEPRESSIONS. DITCHES WERE BACKFILLED, COMPACTED, AND GRADED TO THE APPROXIMATE ELEVATION OF THE ADJACENT WETLAND SURFACE.

ON-SITE SOILS WERE RIPPED TO 21 INCHES IN DEPTH TO PROMOTE SOIL SURFACE AND SUB SURFACE MICROTOPOGRAPHIC VARIATIONS ACROSS THE SITE.





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DEPRESSION CONSTRUCTION
 GATLIN SWAMP WETLAND RESTORATION SITE
 Martin County, North Carolina

Dwn. by:	WGL
Ckd by:	WGL
Date:	Jan 2006
Project:	05-009

FIGURE
5

Earthen plugs were reinforced by incorporation of filter cloth into the plug to minimize preferential flow of groundwater through fill material. Earthen material was obtained from excavation of groundwater storage depressions within the Site.

3.4 Ditch Backfilling

Ditches were backfilled using on-Site, earthen material from excavated depressions. Based on cut-fill estimates for this project, approximately 24,375 cubic yards of ditch backfill material was required to effectively fill all on-Site ditches. Material excavated from the groundwater storage depressions was stockpiled adjacent to the ditches to be backfilled. Ditch backfill locations were filled, compacted, and graded to the approximate elevation of the adjacent wetland surface.



4.0 WETLAND COMMUNITY RESTORATION

In January 2006, the Site was planted with native, wetland-adapted tree species. On-Site observations and pertinent community descriptions from *Classification of the Natural Communities of North Carolina* (Schafale and Weakley 1990) were used to develop the primary plant community association promoted during restoration efforts. The entire 150.2-acre Site was planted with species characteristic of a Pine Flatwoods community (Figure 6).

Before wetland plant community restoration was implemented, the entire Site was scarified. Scarification was performed as linear bands directed perpendicular to the land slope. Subsequently, community restoration was initiated on scarified wetland surfaces.

Nine tree species were planted at the Site; they are as follows (with planted quantity).

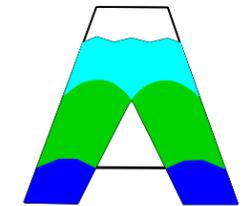
Vegetation Association (Planting Area)	Pine Flatwoods	
Area (acres)	150	
SPECIES	Total Number Planted	Percentage of Total
Loblolly Pine (<i>Pinus taeda</i>)	16,675	11.7
Pond Pine (<i>Pinus serotina</i>)	12,500	8.8
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	16,700	11.7
Cherrybark Oak (<i>Quercus pagodaefolia</i>)	16,700	11.7
Southern Red Oak (<i>Quercus falcata</i>)	16,700	11.7
Water Oak (<i>Quercus nigra</i>)	16,700	11.7
Willow Oak (<i>Quercus phellos</i>)	16,700	11.7
Sweetbay (<i>Magnolia virginiana</i>)	13,400	9.4
River Birch (<i>Betula nigra</i>)	16,700	11.7
TOTAL	142,775	100.0

Bare-root seedlings of canopy and understory tree species were planted within the Site at a density of 950 stems per acre (6.8-foot centers). Planting was performed during January 2006 to allow plants to stabilize during the dormant period and set root during the spring season. Bare-root seedlings were hand planted to minimize wetland soil disturbance. A total of 142,775 diagnostic tree and shrub seedlings were planted in support of Site wetland restoration. The entire 150-acre restoration area was re-vegetated during implementation of this plan.



LEGEND	
DESCRIPTION	SYMBOL
SITE BOUNDARY	
PINE FLATWOODS	

VEGETATIVE ASSOCIATION (Planting Area)	PINE FLATWOODS	
Area (acres)	150	
SPECIES	Total Number Planted	Percentage of Total
Loblolly Pine (<i>Pinus taeda</i>)	16,667	11.1
Pond Pine (<i>Pinus serotina</i>)	16,667	11.1
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	16,667	11.1
Cherrybark Oak (<i>Quercus pagodaefolia</i>)	16,667	11.1
Southern Red Oak (<i>Quercus falcata</i>)	16,667	11.1
Water Oak (<i>Quercus nigra</i>)	16,667	11.1
Willow Oak (<i>Quercus phellos</i>)	16,667	11.1
Sweetbay (<i>Magnolia virginiana</i>)	16,667	11.1
River Birch (<i>Betula nigra</i>)	16,667	11.1
TOTAL	150,003	100



Axiom Environmental, Inc.

RESTORATION SYSTEMS
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RALEIGH, NC 27604

NOTES/REVISIONS

Project:

**Gatlin Swamp
Wetland Restoration
Site**

**Martin County
North Carolina**

Title:

**PLANTING
PLAN**

Scale:

1" = 400'

Date:

JAN 2006

Project No.:

05-009

FIGURE NO.

6

5.0 MONITORING PLAN

The Gatlin Swamp Restoration Site monitoring plan consists of a comparison between reference and restoration areas along with evaluation of jurisdictional wetland criteria (Environmental Laboratory 1987). Monitoring will entail analysis of two primary parameters: hydrology and vegetation. Monitoring of restoration efforts will be performed for a minimum of 5 years or until success criteria are fulfilled. The detailed monitoring plan is depicted in Figure 7.

5.1 Hydrology

After hydrological modifications were completed at the Site, continuously recording, surficial monitoring gauges were installed in accordance with specifications in *Installing Monitoring Wells/Piezometers in Wetlands* (NCWRP 1993). Monitoring gauges were set to a depth of approximately 18 inches below the soil surface. Screened portions of each gauge were surrounded by filter fabric, buried in screened well sand, and sealed with a bentonite cap to prevent siltation and surface flow infiltration during floods.

Five monitoring gauges were installed in wetland restoration areas to provide representative coverage of the Site (Figure 7). Two gauges were also placed in a reference wetland area in similar landscape positions for comparison with on-site conditions (Figure 1). Hydrological sampling will be performed in restoration and reference areas during the growing season (March 16 through November 14) at daily intervals necessary to satisfy the hydrology success criteria within each physiographic landscape area.

5.2 Vegetation

Restoration monitoring procedures for vegetation are designed in accordance with guidelines presented in *Mitigation Site Classification* (MiST) (EPA 1990) and *Compensatory Hardwood Mitigation Guidelines* (DOA 1993). The following presents a general discussion of the monitoring program.

During the first year, vegetation will receive visual evaluation on a periodic basis to ascertain the degree of overtopping of planted elements by nuisance species. Subsequently, quantitative sampling of vegetation will be performed between September 1 and October 30, late in the growing season, until the vegetation success criteria are achieved.

Quantitative vegetation sampling will be conducted in early fall of the first year. Five sample transects were installed within planted areas of the Site to equally represent the various hydrologic regimes (Figure 7). Each transect is 600 feet in length, 7.25 feet in width (0.1 acre), and consists of two 300-foot long segments. The two segments are anchored to a groundwater monitoring gauge and are defined identified by the corresponding gauge number. Each segment extends from the gauge on a randomly selected compass bearing. In each sample, vegetation parameters to be monitored include species composition and species density. Visual observations of the percent cover of shrub and herbaceous species will also be recorded.

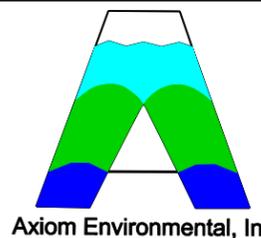
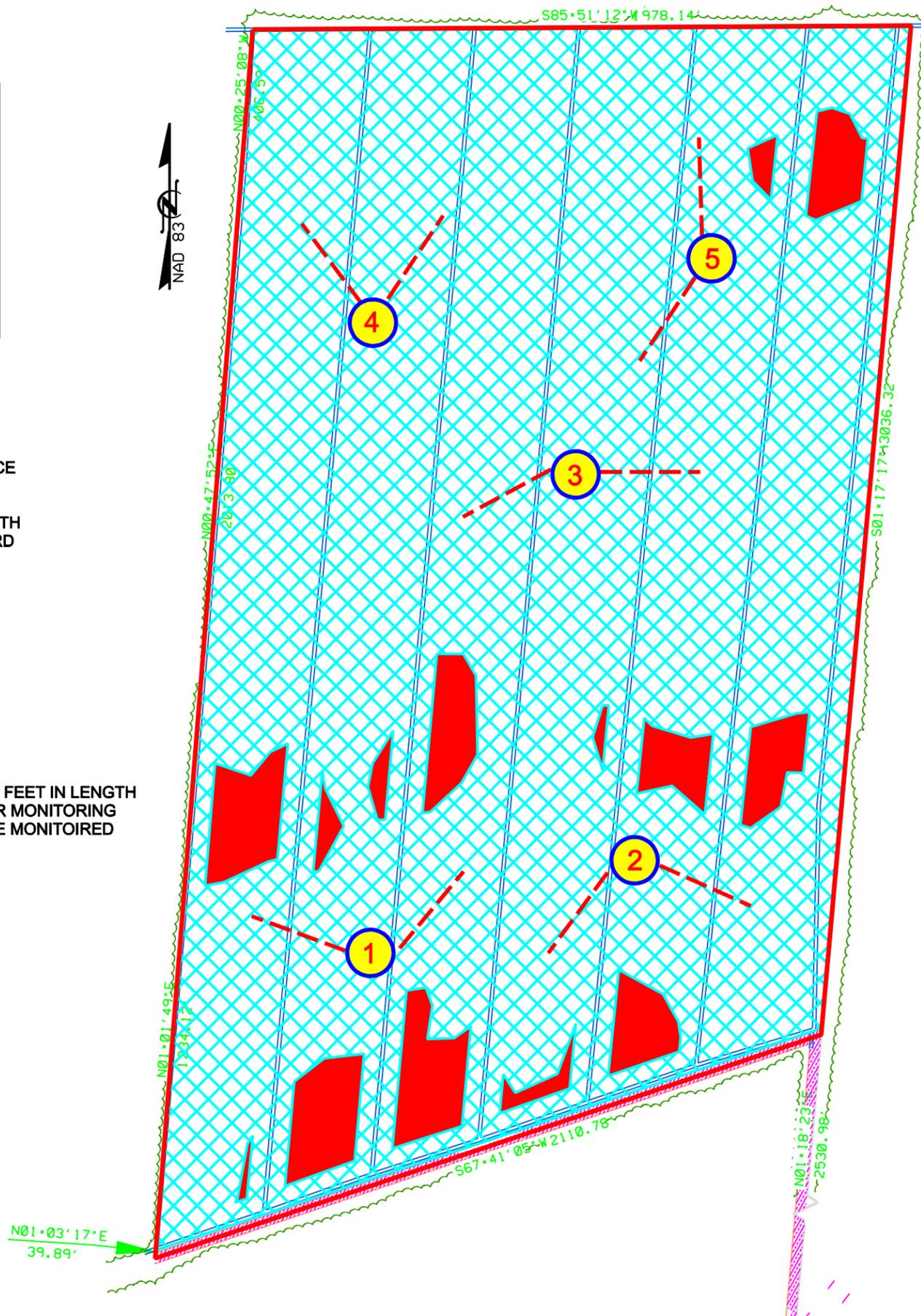
LEGEND		
DESCRIPTION	SYMBOL	AREA
SITE BOUNDARY		150.2 AC
WETLAND RESTORATION		138.7 AC
UPLAND		
GROUNDWATER GAUGE		
VEGETATION PLOTS		

GROUNDWATER GAUGES

INFINITY CONTINUOUS MONITORING GAUGES INSTALLED IN ACCORDANCE WITH SPECIFICATIONS OUTLINED IN U.S. ARMY CORPS OF ENGINEERS, INSTALLING MONITORING WELLS/PIEZOMETERS IN WETLANDS (WRP TECHNICAL NOTE HY-IA-3.1, AUGUST 1993). SCREENS ARE SET TO A DEPTH OF APPROXIMATELY 18 INCHES. GAUGES ARE PROGRAMMED TO RECORD AT 24-HOUR INTERVALS. DAILY RAINFALL IS CORRELATED FROM DATA OBTAINED AT A NATIONAL WEATHER SERVICE STATION LOCATED IN TARBORO (STATION 318500 - COOP).

VEGETATION MONITORING PLOT

VEGETATION MONITORING PLOTS ARE COMPRISED OF TRANSECTS, 600 FEET IN LENGTH AND 8 FEET IN WIDTH CENTERED ON EACH OF THE FIVE GROUNDWATER MONITORING GAUGES. IN EACH MONITORING PLOT, VEGETATION PARAMETERS TO BE MONITORED INCLUDE SPECIES COMPOSITION AND DENSITY.



RESTORATION SYSTEMS
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NOTES/REVISIONS

Project:

**Gatlin Swamp
Wetland Restoration
Site**

**Martin County
North Carolina**

Title:

**MONITORING
PLAN**

Scale:
1" = 400'
Date:
JAN 2006
Project No.:
05-009

FIGURE NO.

7

6.0 SUCCESS CRITERIA

6.1 Hydrologic Success Criteria

Target hydrological characteristics have been determined through a combination of regulatory wetland hydrology criteria and reference groundwater modeling. Evaluation of success criteria may also be supplemented by sampling and data comparison between restoration areas and the reference wetland site.

Regulatory Wetland Hydrology Criteria

The regulatory wetland hydrology criterion requires saturation (free water) within 1 foot of the soil surface for 5 percent of the growing season under normal climatic conditions. In some instances, the regulatory wetland hydroperiod may extend between 5 and 12.5 percent of the growing season.

Reference Groundwater Modeling

The reference groundwater model forecasted that the wetland hydroperiod in the restoration area will range between approximately 2 and 26 percent of the growing season in early successional phases. Because wetland hydroperiods during old field stages of wetland development are projected to extend for less than 12.5 percent of the growing season, wetland monitoring plans that extend for a five year period after restoration should utilize a minimum 5 percent wetland hydrology criterion to substantiate restoration success.

Reference Wetland Sites

Two monitoring gauges have been placed in reference wetlands located in the northern periphery of the Site. Wetland hydroperiods measured by groundwater gauges located within the reference areas will be compared to hydroperiods exhibited by groundwater gauges in the restoration area to further evaluate restoration success. Success criteria outlined by the groundwater model indicates that the wetland restoration area should maintain saturation within one foot of the soil surface for at least 74 percent of the hydroperiod exhibited by the reference wetland in any given year.

Under normal climatic conditions, the hydrologic success criterion requires saturation (free water) within one foot of the soil surface for a minimum of 5 percent of the growing season. This hydroperiod translates to saturation for a minimum, 12-day (5 percent) consecutive period during the growing season, which extends from March 16 to November 14 (USDA 1977).

In atypical dry years, the hydroperiod must exceed 75 percent of the hydroperiod exhibited by the reference gauges. Reference gauge data will be used to compare wetland hydroperiods between the restoration areas and relatively undisturbed reference wetlands. This data will supplement regulatory evaluation of success criteria and also provide information that shall allow interpretation of mitigation success in years not supporting "normal" rainfall conditions.

6.2 Vegetation Success Criteria

Success criteria have been established to verify that the vegetation component supports community elements necessary for floodplain forest development. Success criteria are dependent upon the density and growth of characteristic forest species. Additional success

criteria are dependent upon density and growth of "Characteristic Tree Species." Characteristic Tree Species include planted species and species identified through inventory of a reference (relatively undisturbed) forest community used to orient the planting plan. All canopy tree species planted and identified in the reference forest will be utilized to define "Characteristic Tree Species" as termed in the success criteria.

PLANTED SPECIES	REFERENCE SPECIES
Loblolly Pine (<i>Pinus taeda</i>)	Northern Red Oak (<i>Quercus rubra</i>)
Pond Pine (<i>Pinus serotina</i>)	Red Maple (<i>Acer rubrum</i>)
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	White Oak (<i>Quercus alba</i>)
Cherrybark Oak (<i>Quercus pagodaefolia</i>)	Swamp Chestnut Oak (<i>Quercus michauxii</i>)
Southern Red Oak (<i>Quercus falcata</i>)	Hop Hornbean (<i>Ostrya virginiana</i>)
Water Oak (<i>Quercus nigra</i>)	Tulip Tree (<i>Liriodendron tulipifera</i>)
Willow Oak (<i>Quercus phellos</i>)	Sweetgum (<i>Liquidambar styraciflua</i>)
Sweetbay (<i>Magnolia virginiana</i>)	American Beech (<i>Fagus grandiflora</i>)
River Birch (<i>Betula nigra</i>)	Mockernut Hickory (<i>Carya tomentosa</i>)
	American Sycamore (<i>Platanus occidentalis</i>)
	Ironwood (<i>Carpinus carolinia</i>)
	Black Walnut (<i>Juglans nigra</i>)
	Hackberry (<i>Celtis laevigata</i>)
	Bitternut Hickory (<i>Carya cordiformis</i>)
	Green Ash (<i>Fraxinus pennsylvanica</i>)

An average density of 320 stems per acre of Characteristic Tree Species must be surviving at the end of the third monitor year. Subsequently, 290 Characteristic Tree Species per acre must be surviving at the end of year 4 and 260 Characteristic Tree Species per acre at the end of year 5. Planted species must represent a minimum of 30 percent of the required stems per acre total (96 stems/acre). Planted Characteristic Tree Species may serve as a seed source for species maintenance during mid-successional phases of forest development. Each naturally recruited Characteristic Tree Species may represent up to 10 percent of the required stems per acre total. In essence, seven naturally recruited Characteristic Tree Species may represent a maximum of 70 percent of the required stems per acre total. Additional stems of naturally recruited species above the 10 percent and 70 percent thresholds are discarded from the statistical analysis.

If vegetation success criteria are not achieved, based on average density calculations from combined plots over the entire restoration area, supplemental planting may be performed with tree species approved by regulatory agencies. Supplemental planting will be performed as needed until achievement of vegetation success criteria.

No quantitative sampling requirements are proposed for herb assemblages as part of the vegetation success criteria. Development of floodplain forests over several decades will dictate the success in migration and establishment of desired understory and groundcover populations.

Visual estimates of the percent cover of herbaceous species and photographic evidence will be reported for information purposes.

7.0 MONITORING REPORT SUBMITTAL

An Annual Wetland Monitoring Report will be prepared at the end of each monitoring year (growing season). The monitoring report will depict the sample plot and quadrant locations and include photographs which illustrate Site conditions. Data compilation and analyses will be presented including graphic and tabular format, where practicable. Raw data in paper or computer (EXCEL) file format will be prepared and submitted as an appendix or attachment to the monitoring report.

8.0 CONTINGENCY

In the event that vegetation or hydrology success criteria are not fulfilled, a mechanism for contingency will be implemented. For vegetation contingency, replanting and extended monitoring periods will be implemented if community restoration does not fulfill minimum species density and distribution requirements.

Hydrological contingency will require consultation with hydrologists and regulatory agencies if wetland hydrology restoration is not achieved during the monitoring period. Recommendations for contingency to establish wetland hydrology will be implemented and monitored until the hydrology success criteria are achieved.

9.0 REFERENCES

- Environmental Laboratory. 1987. Corps of Engineers Wetland Delineation Manual. Technical Report Y-87-1. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
- North Carolina Wetlands Restoration Program (NCWRP). 1993. Installing Monitoring Wells/Piezometers in Wetlands (WRP Technical Note HY-IA-3.1). North Carolina Department of Environment, Health, and Natural Resources, Raleigh, North Carolina
- Schafale, M. P., A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation, NC Natural Heritage Program, Division of Parks and Recreation, NC DEM, Raleigh NC.
- United States Department of Agriculture (USDA). 1977. Soil Survey of Martin County, North Carolina. United States Department of Agriculture.
- United States Department of the Army (DOA). 1993 (unpublished). Compensatory Hardwood Mitigation Guidelines. United States Corps of Engineers Wilmington District.
- United States Environmental Protection Agency (EPA). 1990. Mitigation Site Classification (MiST). A Methodology to Classify Pre-Project Mitigation Sites and Develop Performance Standards for Construction and Restoration of Forested Wetlands. USEPA Workshop, August 13-15, 1989. USEPA Region IV and Hardwood Research Cooperative, North Carolina State University, Raleigh, NC.