DETAILED MITIGATION PLAN

WETLANDS, NEUSE RIVER RIPARIAN BUFFERS, AND NEUSE RIVER NITROGEN REDUCTION

BEAR CREEK - MILL BRANCH MITIGATION SITE
LENOIR COUNTY, NORTH CAROLINA

Prepared for:

Restoration Systems
114 White Lake Court
Morrisville, NC 27560
(919) 319-7521

Prepared by:

EcoScience

EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605

September 1999

EXECUTIVE SUMMARY

Restoration Systems, a private sector mitigation company, has established the Bear Creek-Mill Branch mitigation site (Site) approximately 5 miles from confluence with the Neuse River, in western Lenoir County. The Site is composed of approximately 145 acres within the floodplain of Bear Creek, and supports stream flows from Mill Branch and two unnamed tributaries at confluence with the river. This Site offers opportunities for riverine (stream-side) wetland restoration, Neuse River basin riparian buffer establishment, and Neuse River nitrogen reduction.

This mitigation plan details restoration and enhancement procedures for riverine wetland restoration. The Site historically serviced a watershed of approximately 54 square miles. The objective of this plan is to restore watershed functions associated with water quality and to restore a regional wildlife corridor extending from the Neuse River. The Site will be coupled with approximately 300 acres of riverine wetland preservation within the watershed to ensure that a viable wetland refuge is established in the region.

Under existing conditions, the river floodplain has been ditched, leveled, and drained to support agricultural and silvicultural activities. Streams and the river have been dredged, straightened, and levees constructed to further impede surface water impacts to alternative land uses. Based on surface water models, river flooding onto the former floodplain has been effectively reduced to a 100-year return interval due to constructed levees. This plan includes removal of a section of the river levee; consequently, flooding from the river may be restored to a 5-year return interval, a 95-year increase in return interval relative to existing conditions.

Under existing conditions, nitrogen loading into the Neuse River from the Bear Creek and Mill Branch watersheds is projected to total 2,575,000 pounds per year, representing a seven-fold increase in nutrient loads discharged into the River due to land uses in the watershed. River dredging and levee construction throughout the Bear Creek watershed has most likely exacerbated the water quality problems. Nutrient recycling functions associated with riverine wetlands and floodplains is expected to be diminished or negated throughout the region. Therefore, wetland restoration plans have been designed specifically to maximize nutrient cycling functions at this Site. The effort includes: 1) restoration of overbank flooding from the river as described above; 2) maximizing the amount of groundwater recharge across the floodplain from auxiliary watersheds; 3) establishment of backwater sloughs, cypress-tupelo swamps, and bottomland hardwood forests in flow pathways; and 4) diversion of treated stream flows back into historic channels, located approximately 3000 feet down-valley from the existing ditch outlets. Based on preliminary studies, this wetland restoration project exhibits potential to provide up to a 5 percent reduction in nitrogen loads for the 54-square mile Bear Creek region, or an 80 percent reduction in nitrogen loads for the 3-square mile, Mill Branch watershed.

Site alterations to restore groundwater, surface flow dynamics, and wetland function include: 1) ditch backfilling; 2) ditch outlet plugs; 3) river levee removal; 4) embankment construction; 5) Mill Branch channel repair; 6) wetland surface scarification; 7) seasonal pool construction; 8) woody debris deposition; and 9) tree planting. The alterations will serve to: 1) establish a backwater cypress-tupelo swamp; 2) provide a perennial source for groundwater recharge

through restored bottomland hardwood forest; 3) allow diversion of Mill Branch back into the historic stream channel; and 4) facilitate nutrient reduction goals in the Neuse River basin. The wetland design has been prepared to mimic riverine wetland attributes measured in regional reference wetlands (carbon copy method for wetland restoration). A total of 34,750 characteristic trees will be planted within the restored wetland systems.

Mill Branch will be diverted from inter-field ditches into exiting forested areas. In the forested area, the stream will be allowed to re-develop primarily through passive processes. Braiding, ponding, and anastomosed conditions will occur, mimicking reference streams in the region. Reference streams often exhibit braided (alluvial fan), backwater, or anastomosed features at the confluence with large river floodplains. The outlet for Mill Branch will be established approximately 3000 feet down-valley from the existing outfall, providing approximately 1710 feet in additional valley length relative to existing, straightened conditions (restored sinuosity not included). The increased length of stream corridor will allow for the restoration and maintenance of in-stream aquatic habitat relative to existing conditions. In addition, nutrient reduction in surface water flows will be maximized.

A Monitoring Plan has been prepared that consists of a comparison between regional reference wetlands along with evaluation of jurisdictional wetland criteria. Monitoring will entail analysis of wetland hydrology, soil, and vegetation for 5 years or until success criteria are fulfilled.

Restoration Systems intends to immediately transfer the land deed and conservation easements for the Site and regional wetland preservation areas to the North Carolina Wildlife Habitat Foundation (Eddie C. Bridges, Executive Director). Immediate transfer to the conservation organization will ensure that the 445-acre land area remains protected and managed as a regional wetland refuge in perpetuity.

Restoration plans will re-introduce surface water flood hydrodynamics from a 54 square mile watershed. The plan includes establishment of an array of riverine communities, including levee forest, bottomland hardwood forests, riverine swamp forests, and backwater cypress-gum swamps. Therefore, riverine hydrodynamic and biogeochemical functions will be restored, including pollutant removal, organic carbon export, sediment retention, nutrient cycling, flood storage, and energy dissipation. Physical wetland functions typically associated with water quality will be replaced within the Neuse River basin.

Biological functions associated with the riverine system will also be restored including in-stream aquatic habitat, structural floodplain habitat, and interspersion and connectivity between the restored stream, floodplain, and adjacent uplands.

Based on restoration plans, the area includes approximately 88 acres of riverine wetland restoration, 34 acres of wetland enhancement, 300 acres of wetland preservation, and 23 acres of upland buffer restoration. Based on Environmental Protection Agency guidelines, the plan provides 88 wetland mitigation credits for bottomland hardwood and swamp forest wetlands on riverine floodplains (5th order streams or less). In addition, the Site provides for 3390 linear feet of riparian buffer credit and a conservative estimate of 100,000 pounds per year of nitrogen removal in the Neuse River Basin. The project is scheduled for completion in December, 2000.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

DETAILED MITIGATION PLAN

WETLANDS, NEUSE RIVER RIPARIAN BUFFERS, AND NEUSE RIVER NITROGEN REDUCTION

BEAR CREEK - MILL BRANCH MITIGATION SITE LENOIR COUNTY, NORTH CAROLINA

1.0 INTRODUCTION

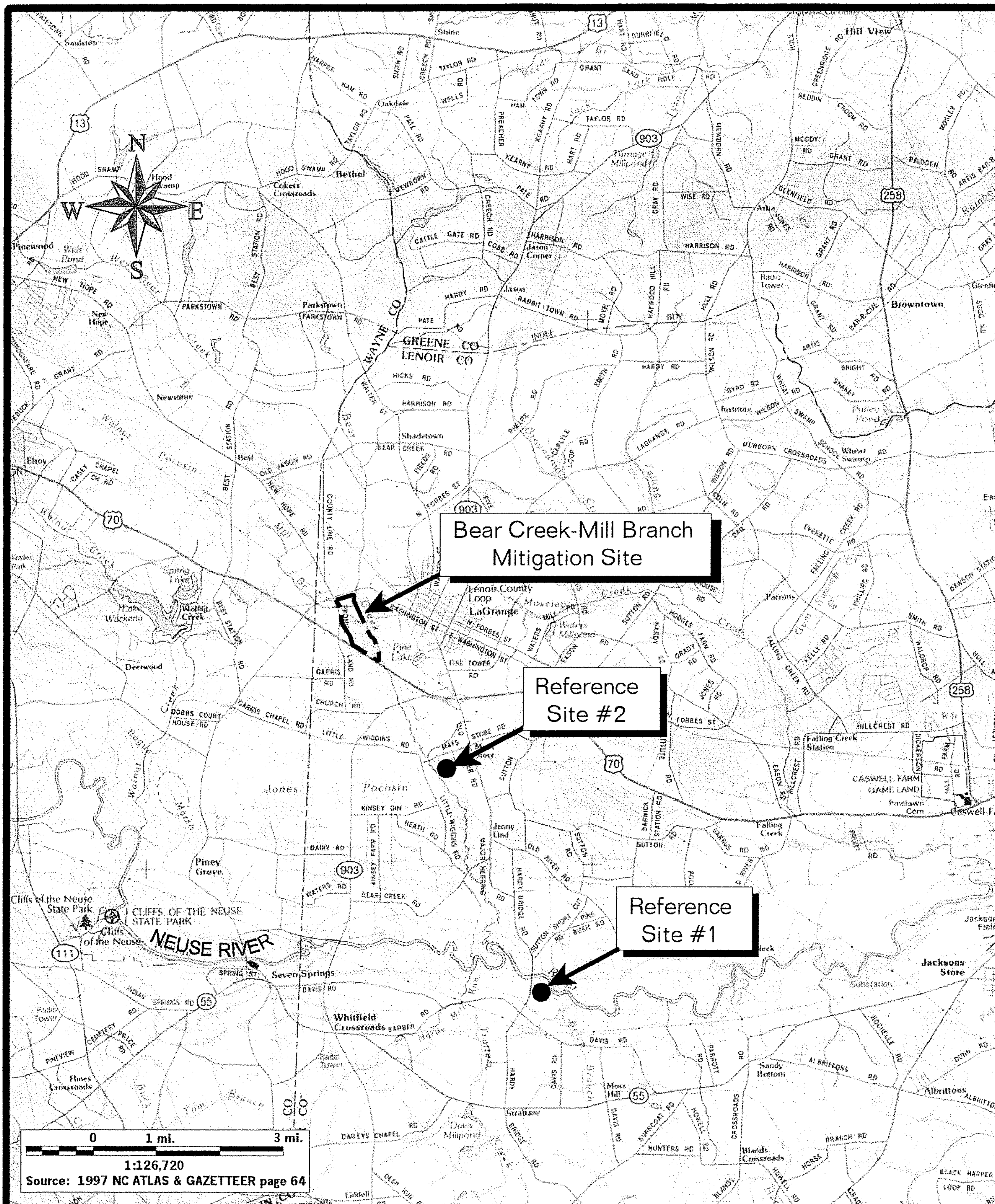
Restoration Systems, a private sector mitigation company, has established a regional mitigation site (Site) within the Coastal Plain region of the Neuse River Basin. This region is expected to sustain unavoidable wetland and stream (riparian) buffer impacts associated with projected population growth, infrastructural development, and highway construction planned in the river basin. The Site is designed to provide up-front, compensatory mitigation for in-kind, unavoidable wetland and riparian buffer impacts associated with development.

The Site is composed of approximately 145 acres located immediately north of US Highway 70 and east of Promise Land Road (SR1323) in western Lenoir County (Figure 1). Additional wetland tracts will be incorporated into the Site as detailed wetland studies are completed within the watershed. The Site is positioned within the floodplains of Bear Creek and Mill Branch at the Confluence between these two systems. The tributaries flow into the Neuse River approximately 5 miles downstream. The floodplains have been ditched, leveled, and drained to support agricultural and silvicultural activities. Streams have been dredged, straightened, and levees constructed to further impede surface water impacts to alternative land uses. This Site offers opportunities for riverine (stream-side) wetland restoration and enhancement with benefits to water quality and wildlife realized in proximity to the Neuse River corridor.

The benefits of up-front mitigation are numerous. Mitigation will be performed prior to permit submittal and construction of a specific development project. This mitigation will allow resource and regulatory agencies the opportunity to evaluate the success of proposed mitigation efforts early in the Section 404 process. Mitigation will be in-kind and within the same basin, thereby replacing lost wetland functions and acreage before impacts occur.

This mitigation plan details restoration and enhancement procedures for riverine wetland restoration. This document also outlines measures designed to facilitate wetland restoration success and evaluates wetland functional replacement benefits potentially realized from up-front mitigation activities.

A mitigation banking instrument (MBI) has been developed for this Site and represents a supplemental document to this mitigation plan. This plan is designed to promote consensus from various resource and regulatory agencies regarding potential for wetland restoration success and to facilitate confirmation of the MBI.



EcoScience Corporation

Site and Reference Wetland Locations
Bear Creek - Mill Branch Mitigation Site
Lenoir County, North Carolina

Figure: 1

Project: 99-016

Date: July 1999

2.0 METHODS

Natural resource information for the Site was obtained from available source, including: U. S. Geological Survey (USGS) topographic mapping (USGS 1983, LaGrange 7.5 minute quadrangle), U. S. Fish and wildlife service (USFWS) National Wetlands Inventory (NWI) mapping, and Natural Resource Conservation Service (NRCS) soil survey (USDA 1977). These resources were utilized for base mapping and evaluation of existing landscape and soil information prior to on-site inspection. Current (1999) aerial photography was obtained and utilized to map relevant environmental features (Figure 2).

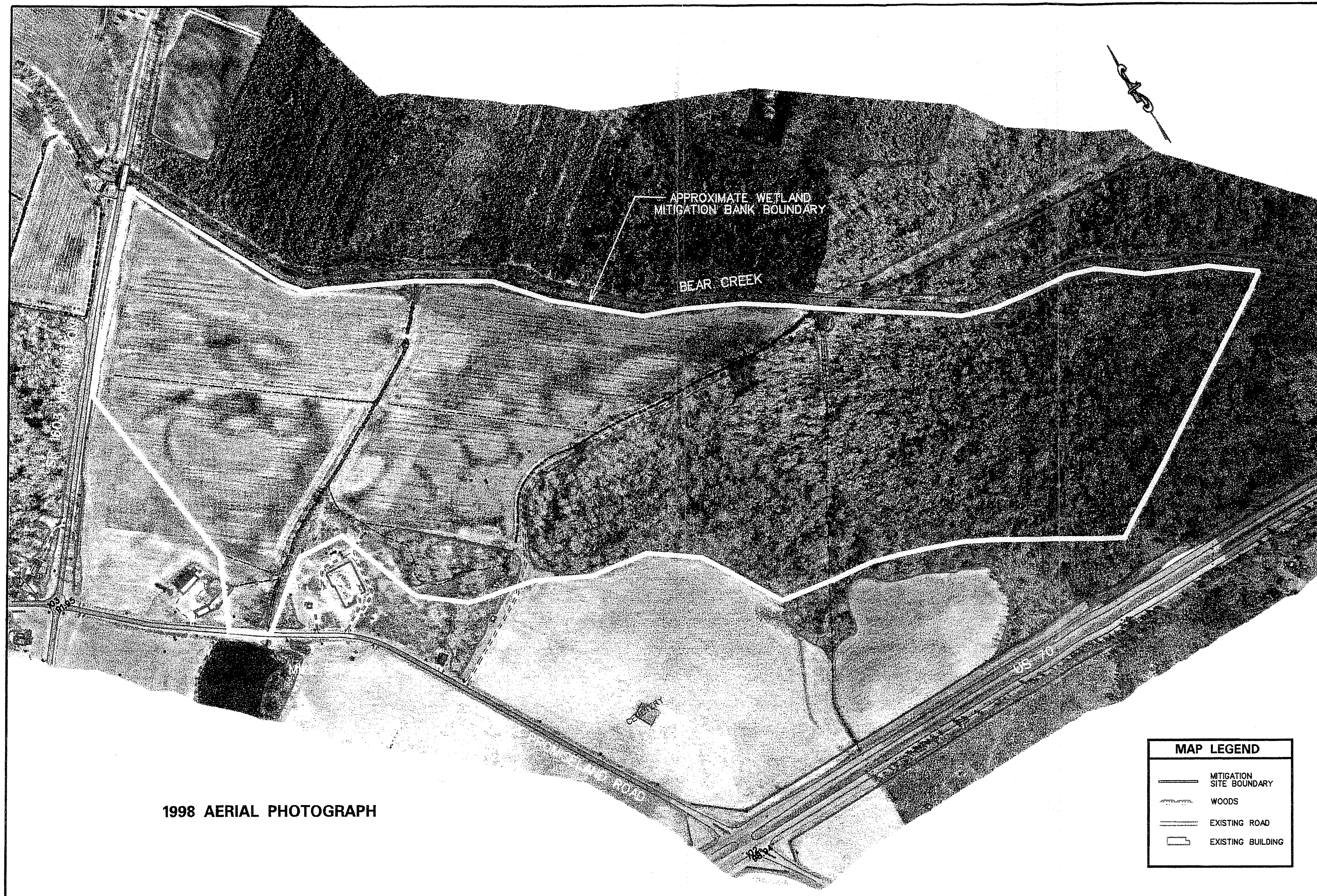
Characteristic and target natural community patterns were classified according to constructs outlined in Schafale and Weakley's, Classification of the Natural Communities of North Carolina (1990). North Carolina Natural Heritage Program (NCNHP) data bases were evaluated for the presence of protected species and designated natural areas which may serve as reference (relatively undisturbed) wetlands for restoration design.

Two primary reference sites were selected to orient restoration design and to provide baseline information on target (post-restoration) wetland condition (Figure 1). In reference areas, 10 vegetation plots (0.1 acre) were sampled to characterize species composition. Topographic maps of the basin floor and embankments were also prepared for semi-permanently inundated, backwater swamp areas. The topographic data was overlayed on wetland restoration areas to establish methods for construction and restoration of backwater, cypress-tupelo swamp forests.

Detailed topographic mapping to 1 foot (ft) contour intervals was developed through corrected aerial photography and land elevation surveys. Additional land surveys were performed to establish channel and ditch cross-sections, measure reference wetland surface topography, and to determine accurate water table elevations at groundwater piezometers and stream gauges.

Field investigations were performed in the Spring and Summer of 1999, including soil surveys, on-site resource mapping, land surveys, hydrological measurements, and landscape ecosystem classifications. Existing plant communities and jurisdictional wetlands were described and mapped according to landscape position, structure, composition, and groundwater analyses.

NRCS soil mapping was refined to accurately delimit hydric soil boundaries. NRCS soil map units were ground truthed by licenced soil scientists to verify units and to map (using GPS) inclusions and taxadjunct areas. The revised soils maps were used as additional evidence for predicting natural community patterns and wetland limits prior to human disturbances.



EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
919 828-3433 Fax: 919 828-3518

Client:

Project: **BEAR CREEK–MILL BRANCH WETLAND RESTORATION SITE LENOIR COUNTY, NORTH CAROLINA**

Dwn By: MAF	Date: JUNE 1999	Figure
Ckd By: JWN	Scale: 1"= 400'	2
ESC Project No.: 99-016		

Hydrologic conditions were characterized from the following activities: 1) soil and geologic profile descriptions; 2) installation of groundwater piezometers; 3) installation of a continuous monitored stream flow gauge in Mill Branch; 4) placement of a stream staff gauge in Bear Creek; 5) hydraulic conductivity tests; 6) development of groundwater contour maps; 7) groundwater models (DRAINMOD); and 8) surface water models (HEC and WSPRO).

A series of 15 piezometers were installed in March and April, 1999 and sampled at weekly intervals through the early growing season. Three continuous monitoring wells were also installed to allow interpolation of weekly data in response to episodic rain events and groundwater recharge rates.

Groundwater contour maps were generated at periodic intervals to establish primary wetland physiographic areas and to assess drainage impacts from dredged streams and ditches. Groundwater conditions were modeled using DRAINMOD, a computer model for simulating withdrawal rates for shallow soils with high water tables. The model was utilized to predict historic hydroperiods, the extent of wetland degradation due to ditching, and the potential for wetland restoration through the effective removal of the drainage network.

Surface water drainage and stream flows were modeled by interpreting USGS stream gauge data in the region, modifying Flood Emergency Management Agency (FEMA) HEC-2 models for Bear Creek, and by using WSPRO on Mill Branch, a program for establishing water surface profiles for various peak flow return intervals (1-year, 2-year, 5-year, 10-year, etc.). The extent of flooding was used to determine potential for riverine wetland restoration in floodplain portions of the Site.

The Neuse River Nutrient Sensitive Waters Management Strategy and associated regulations are designed to achieve a 30 percent reduction in nitrogen flowing into the Neuse River. This Site has been selected, in part, to assist in achieving this nutrient reduction goal. Therefore, nutrient analyses were performed to predict the amount of nitrogen being discharged into the Neuse River by the watershed under existing conditions. The analyses utilized land use mapping within the Mill Branch watershed along with the Total Nitrogen and Phosphorous Load Estimation Worksheet provided by the N.C. Division of Water Quality (Appendix A). The objective of mitigation at this strategically located Site is to provide nutrient recycling from surface waters within restored forested wetlands. Recycling functions are designed to reduce elevated nitrogen loads from the watershed to near-background (forest) levels, prior to discharge into Bear Creek and the Neuse River.

3.0 EXISTING CONDITIONS

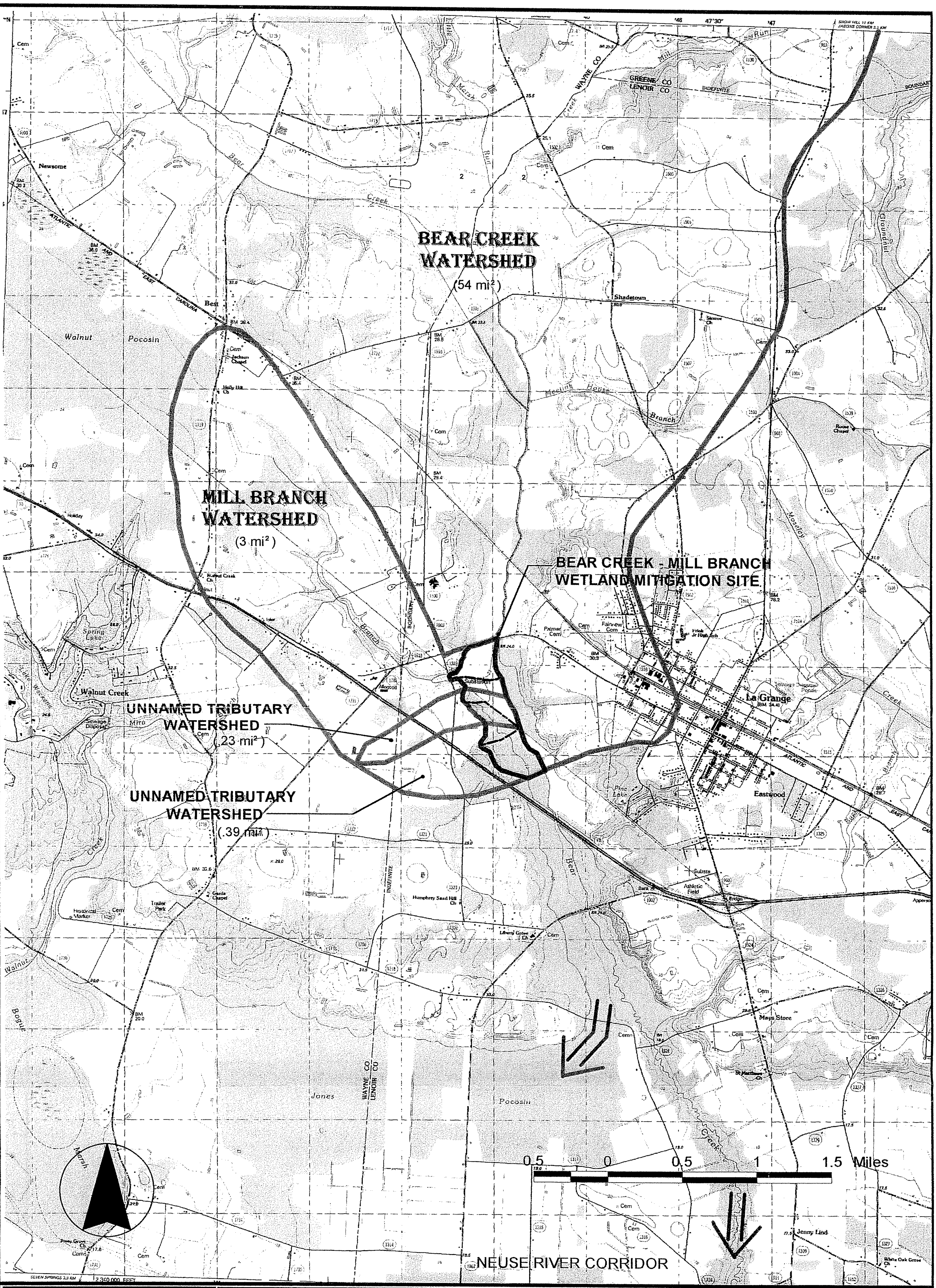
3.1 PHYSIOGRAPHY, TOPOGRAPHY, AND LAND USE

The Site is located in the Atlantic Coastal Plain Physiographic Province of North Carolina within the Inner Coastal Plain region of the Neuse River Basin. The Coastal Plain portion of the Neuse River Basin extends from the Piedmont/Coastal Plain boundary (Fall Line) near Smithfield, in Johnston County, east to the Pamlico Sound and Atlantic Ocean (Hydrologic Unit #03020201[portion], #03020202, #03020203, and #03020204 [USGS 1974]). The Site is located approximately 33 miles (mi) southeast of Smithfield and approximately 80 miles northwest of Pamlico sound. Annual precipitation in the region averages 48 inches per year with July and August representing the months that support the highest average rainfall (7.1 inches and 5.8 inches respectively, USDA 1977).

The Site is situated within the floodplains of Bear Creek, abutting a 5600-ft reach of Coastal Plain, fifth-order blackwater river (Strahler 1964) (Figure 3). Bear Creek supports a primary watershed of approximately 54 mi^2 and flows into the Neuse River approximately 5 miles downstream. The Site is also dissected by three tributaries flowing into Bear Creek: Mill Branch (1770 linear feet) and two unnamed tributaries (1900 linear feet and 1200 linear feet). These secondary watersheds support drainage areas of 3 mi^2, 0.23 mi^2, and 0.39 mi^2 respectively.

Land uses in the primary and secondary watersheds are dominated by rural uses, including large scale agriculture, hog farms, residential homes, and state roads with limited commercial development occurring in the vicinity of towns in the area. Based on USGS mapping (Figure 3), agriculture and hog farms occupy 85% of the land area while small commercial and residential development occurs within 7% of the watershed. Under existing conditions, forest cover occurs as isolated fragments in the region, occupying approximately 8% of the land area in watersheds associated with this project. Based on limited field reconnaissance, less than 30 % of these successional and forested areas support functioning wetlands (less than 3% of the project watershed). Therefore, wetlands may have been effectively eliminated as a land use feature associated with habitat and water quality functions in the Bear Creek and Mill Branch watersheds.

Increased industrial and commercial development along with population expansion are anticipated in the next several decades. Development pressures include highway construction projects such as the Kinston Bypass approximately 10 miles to the east, the Goldsboro Bypass immediately west and abutting the Site, Crescent Road 4 miles east, and improvements to existing US 70 in the vicinity of the project. Accelerated development is also anticipated within the municipalities of Goldsboro 7 miles to the west, the Seymour Johnson Air Force Base, and Kinston, 10 miles to the east. Expansion of population, industrial, and commercial development may also be induced by establishment of the N.C. Global TransPark, 9 miles to the east. Therefore, the area surrounding the Site, including associated watersheds, are expected to undergo land use changes in the next several decades to more urban, residential, infrastructural, and commercial conditions.



EcoScience Corporation
612 Wade Ave., Suite 200
Raleigh, North Carolina 27605
Ph: 919 828-3433 Fax: 919 828-3518

Project:

WATERSHEDS AND REGIONAL CORRIDORS
BEAR CREEK-MILL BRANCH MITIGATION SITE
LENOIR COUNTY, NORTH CAROLINA

dwn by:	MAF
ckd by:	JWN
scale:	AS SHOWN
date:	AUG 1999
ESC job #:	99-016

FIGURE 3

The Site encompasses approximately 145 acres, including 70 acres of active crop land and 75 acres of remnant forest. A Carolina Power & Light (CP&L) utility easement extends through central reaches, along the edge of the forest-crop land boundary. Farm storage buildings and a CP&L transformer station also occur along the western property boundary (Figure 4).

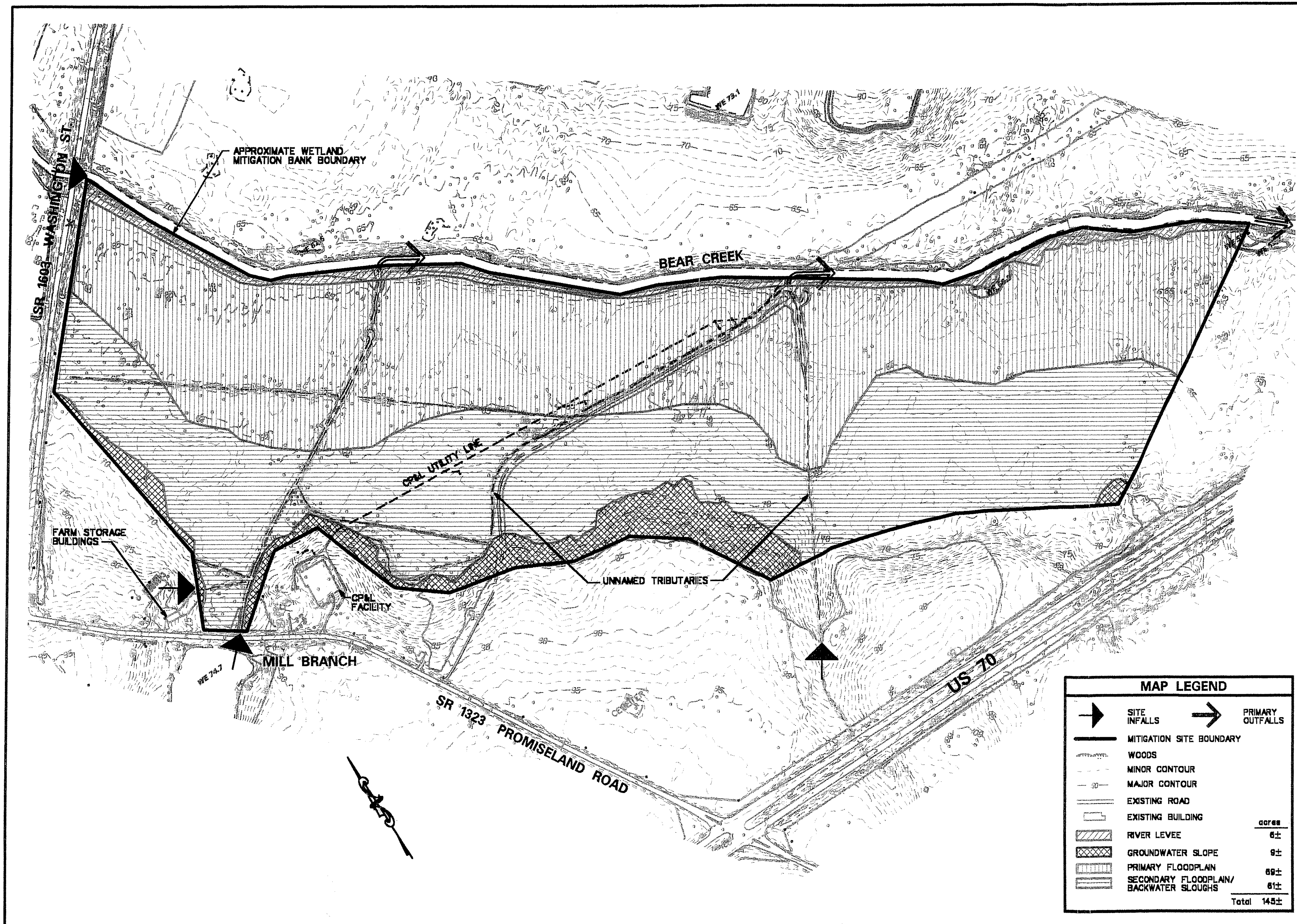
The acreage has been subdivided into four primary physiographic units for restoration planning purposes. 1) river levee; 2) primary floodplain; 3) secondary floodplain (backwater slough), and 4) groundwater (upland) slopes (Figure 4). The primary variables utilized to segregate wetland landscape units include land slope, river flood elevations from Bear Creek (Section 4.1), and the rate and direction of groundwater flow.

River Levee

River levees are represented by an approximately 6-acre, linear band along the banks of Bear Creek. The physiographic area extends along the entire 5600-foot section of Bear Creek, averaging approximately 50 feet in width. Under historic conditions, the river levee represented slightly elevated, upland habitat influenced by the frequent deposition of coarse, sandy alluvium during river floods. Groundwater flow in the area is characterized by relatively rapid, lateral to radial interflow towards the river channel, inducing well drained conditions throughout a large majority of the year. Based on reference stream reaches, natural river levees are elevated approximately 1 to 3 feet above the adjacent floodplain, with intermittent openings residing at lower elevations. In the early 1950s, Bear Creek was dredged, straightened, and the low-lying levees buried under spoil material. The elevated levees constructed along the banks of the river typically range from 4 to 6 feet above the floodplain, providing additional confinement of river flows in agricultural areas. River dredging and levee construction lowered the channel bottom up to 13 feet below the top of the constructed levee (Figure 4). Under historic conditions, the river levee is expected to have supported Coastal Plain levee forest communities (Schafale and Weakley 1990).

Primary Floodplain

The primary river floodplain encompasses approximately 69 acres located in central and northeastern portions of the Site (Figure 4). The floodplain historically supported frequent overbank flooding (estimated at an approximate, 1-year return interval) and was periodically re-worked by alluvial processes and periodic, long term inundation/saturation. The physiographic area continues to support undecomposed organic matter within the soil surface (range 5 to 40%), suggesting that long term water storage functions were historically provided by the system. Groundwater flow is dominated by vertical to semi-radial recharge with episodic lateral discharge and surficial expression of groundwater occurring within seepage areas. Intermittent stream flows in the vicinity of seeps have been observed disappearing and reappearing in localized portions of the forested landscape area. Under historic conditions, natural communities are expected to include Coastal Plain bottomland hardwood forest (blackwater subtype) and oval to linear pockets of riverine swamp forest in the vicinity of seepage areas (Schafale and Weakley 1990).



Project: PHYSIOGRAPHY, TOPOGRAPHY AND LAND USE
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919 828 3433
Fax: 919 828 3518

Dwn By	MAF	Date	AUG 1999	Figure
Ckd By	JWN	Scale	1"= 400'	4
ESC Project No.:	99-016			

Dredging along the river reduced the frequency of overbank flooding within the primary floodplain from an estimated 1-year return interval to a 100-year return interval that overtops the constructed levee. (Section 4.1). Therefore, the primary floodplain and associated riverine wetland functions (energy dissipation, flood storage, etc.) have been effectively eliminated from the physiographic area by river alterations. Northern portions of the abandoned floodplain were converted for agricultural use, while remaining forests were periodically logged after dredging activities. Organic matter subsidence and accelerated drainage is evident throughout the primary floodplain physiographic area due to dredging activities and auxiliary ditch construction.

Secondary Floodplain

The secondary floodplain (61 ac) represents relatively flat to gently sloping, organic soil areas situated along the toe of adjacent valley walls. Land slopes in this area vary significantly across localized portions of the landscape but typically remain less than .01 rise/run. The area includes numerous seeps, convex hummocks, and relatively long term ponding within depressional backwater sloughs. Groundwater flow is expected to range from vertical recharge in sloughs to lateral discharge along convex slopes adjacent to the primary floodplain. Discharge from adjacent groundwater slopes into the floodplain floor provides sustained surface water expression throughout the year, potentially supporting various intermittent and perennial channels and ponded areas. Under historic conditions, the area was likely dominated by riverine swamp forest and cypress-gum swamp communities.

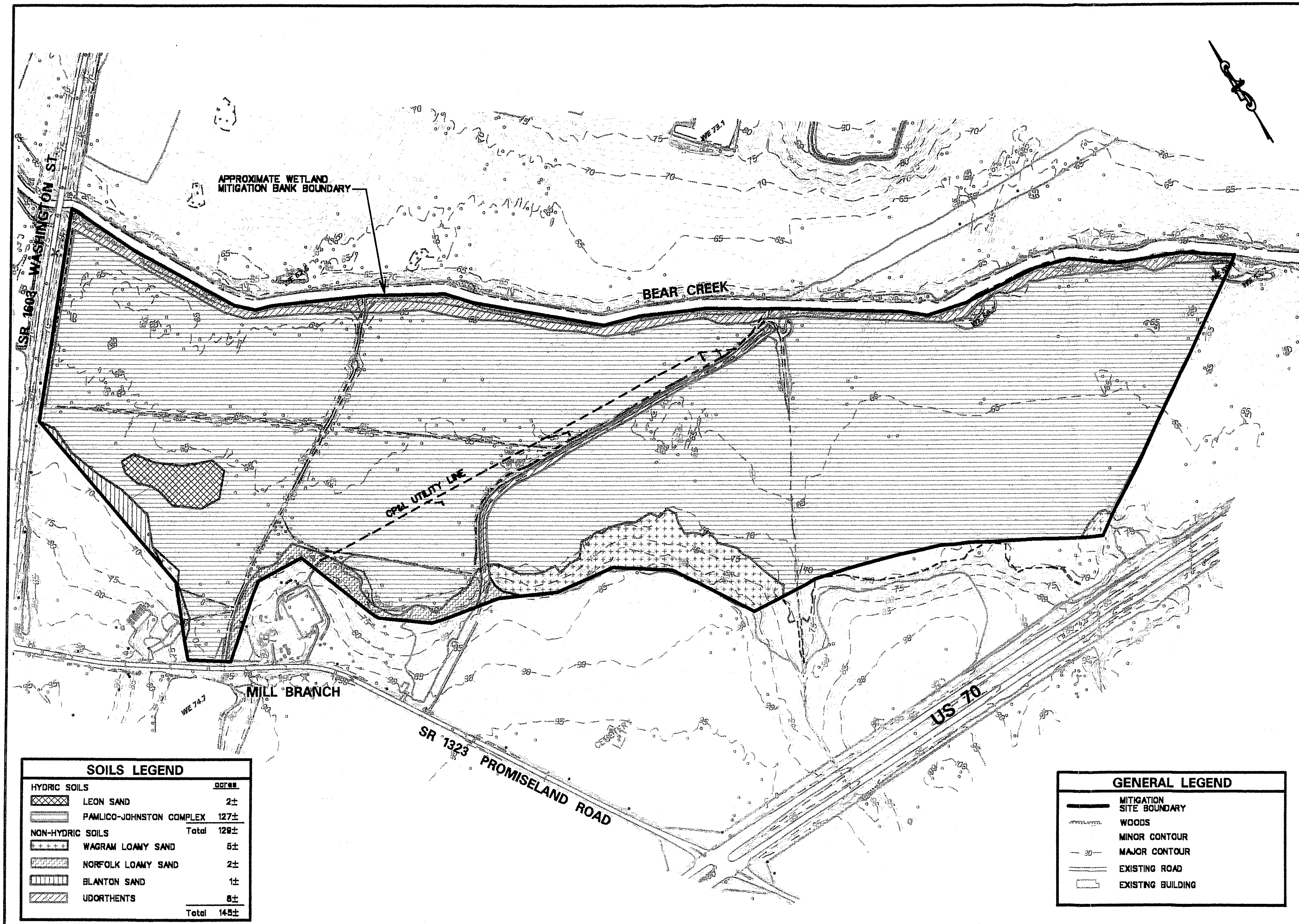
The secondary floodplain is dissected by Mill Branch, the two unnamed tributaries and historically supported auxiliary overbank flow from the 3.6 square mile, secondary watersheds. However, these tributaries have been diverted into approximately 7,200 linear feet of ditches and canals through the Site. The ditches were installed to facilitate agricultural production and to convey drainage from upslope areas through the Site. The constructed drainage network provides direct connectivity of surface waters to Bear Creek and the Neuse River, effectively bypassing land surfaces and potential floodplain functions on the Site.

Groundwater (Upland) Slopes

Upland slopes, occupying approximately 9 acres of the Site, are situated along the western valley wall and include the base of moderately sloped escarpments that rise above the floodplain floor. Under historic conditions these slopes are expected to exhibit unidirectional overland flow and accelerated radial to lateral groundwater flow towards the floodplain. Mesic hardwood forests persist within the physiographic area in areas not converted to crop land.

3.2 SOILS

Surficial soils have been mapped by NRCS (USDA 1990). Soils were verified in the summer of 1999 by licenced soil scientists to refine soil map units and locate inclusions and taxadjunct areas. Systematic transects were established and sampled to ensure proper coverage. Refined soil mapping is depicted in Figure 5.



EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919. 828 3433
Fax: 919 828-3518

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

Project:
SOIL MAP UNITS
HYDRIC /NON-HYDRIC SOIL BOUNDARIES
BEAR CREEK – MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Dwn By: MAF	Date: AUG 1999	Figure	
Ckd By: JWN	Scale: 1"= 400'		5
ESC Project No.: 99-016			

The Site occurs along a landscape-soil gradient characterized as the Wagram-Johnston-Pamlico catena. Valley escarpments (groundwater slopes) consist of well drained, sandy to loamy marine sediments (Wagram, Norfolk map units) while interior portions of the site are dominated by very poorly drained, mineral to organic soils associated with the Johnston and Pamlico series. These areas comprise a complex of organic material, coarse marine deposits, and fine alluvial sediments that were historically mixed and reworked by fluvial actions from overbank floods.

These series maintain upper horizon soil textures ranging from sand to organic muck with drainage classes ranging from very poorly drained to well drained. Actual surface horizon textures varied, with specific sites being affected by fluvial activity, agricultural practices, and organic matter subsidence. Modified surface textures were utilized to refine drainage models implemented for wetland (groundwater) restoration planning (Section 4.1).

3.2.1 Hydric Soils

Hydric soils are defined as "soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper soil layer" (USDA 1987). Hydric soils comprise 89 percent (approximately 129 ac) of the 145-ac mitigation area. Hydric soils identified include the Leon (*Aeric Haplaquods*), Johnston (*Cumulic Humaquepts*), and Pamlico (*Terric Medisaprists*) series.

Construction of large canals and feeder ditches has drained most of the hydric soil units to the extent that hydric conditions in the upper soil horizons are currently limited. In addition, soil surfaces have been cleared, leveled, and graded to facilitate agricultural production in northern portions of the tract. Groundwater models (Section 4.1) suggest that, in undisturbed (historic) conditions, the predominant hydric soil (Pamlico series) supported saturation/inundation for an average 32% (89 consecutive days) during the growing season. In 1999, these hydric soil areas supported, on average, saturation for less than 5% (15 days) during the early growing season.

Spoil ridges and piles occur systematically throughout the hydric soil area. Much of the excavated spoil material was used to construct river levees and to build roads adjacent to canals. However, substantial spoil ridges persist along isolated ditch segments and range from 1 feet to 6 feet in height above the adjacent soil surface.

Hydraulic Conductivity

Hydraulic conductivity for upper soil horizons (top 24 inches) within the Pamlico-Johnston complex was estimated within two physiographic areas. Hydraulic conductivity represents an indication of how readily water will pass through a soil in response to a given gradient. Soil conductivity estimates provides information concerning the potential for restoring wetland hydroperiods based on the hydrologic inputs and drainage rates applied to the system.

Hydraulic conductivity tests (slug tests) were conducted by removing a volume of water from screened groundwater wells and recording the depth to water at selected intervals as the water returned to equilibrium. Data was processed using the "Auger Hole Method", as outlined by the USDA (SCS 1986).

Slug tests were conducted within interior (relatively flat) areas of the primary and secondary floodplain and in the vicinity of groundwater seepage (slightly sloping) areas. The interior floodplain samples were conducted within areas supporting relatively high organic matter content while groundwater seepage slopes were dominated by fine sand and moderate organic matter.

Slug test results indicate that hydraulic conductivities are within the published range for the Pamlico and Johnston Series (USDA 1977 and Figure 6). In the interior floodplain (Pamlico series), conductivities ranged from 0.6 to 1.0 inches/hour and generally increased with depth. The groundwater seepage areas (Johnston Series) exhibited much higher permeabilities, ranging to 19 inches/hour within sand layers approximately 10 inches below the soil surface. These conductivities translate to drainage, along an unconfined discharge gradient, at a rate ranging from 1.6 feet to 38 feet per day. Based on the permeability range, interception with the unconfined (not perched) groundwater table may represent the primary hydraulic input in support of wetland hydroperiods. Conversely, precipitation inputs are expected to represent a relatively minor factor in the development of wetlands on the Site.

Organic Matter Content

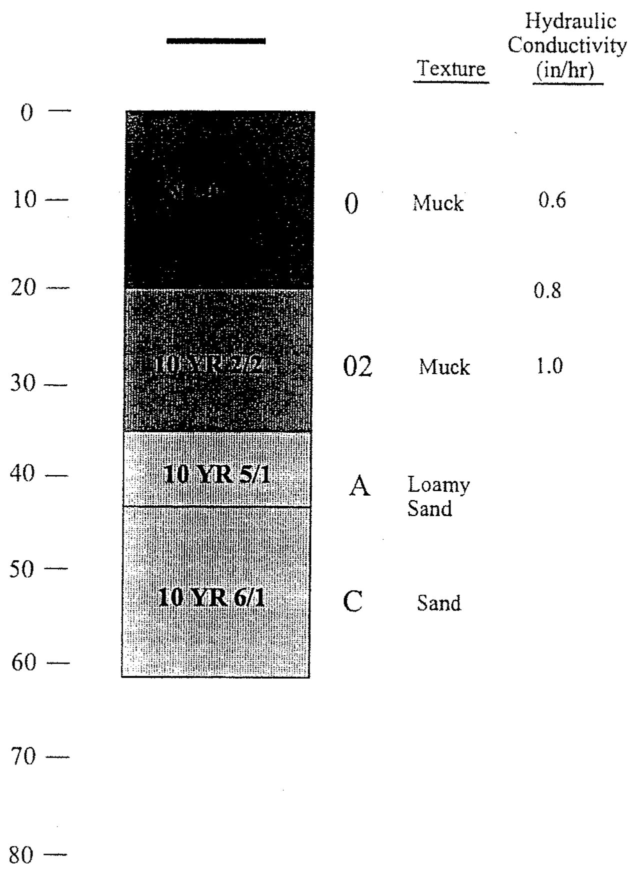
River dredging, ditch construction, leveling of soil surfaces, and crop production have assisted in inducing a decrease in organic matter content in the upper soil layer of the Pamlico-Johnston complex. Organic matter subsidence is evident within forested areas, including exposure of root collars, voids under root mats, and large-scale wind-throw of trees supporting exposed root systems. Laboratory analyses of soils on-site indicate that the plow layer in Pamlico soils supports less than 10% humic matter while reference wetland sites in the region typically support up to 40% humic matter. The elevated content of organic matter (peat) at the surface in undisturbed wetlands is expected to promote standing water during certain periods of the year. Beneath the surface layers, on-site soils and reference wetland soils appear to support similar organic matter content (20% to 60%; USDA 1977).

In farmed portions of the Site, the decrease in organic matter content and elimination of surface microtopography has increased soil hydraulic conductivity and drainage rates relative to reference wetlands. As a result, drainage has most likely been accelerated towards downslope areas, lateral ditches, and into the major canals. The decrease in surface water storage potential on crop land may provide as much encouragement to soil drainage as the construction of ditches in certain areas (Schouwenaars 1995). Preferential migration of perched water laterally through the permeable plow layer may assist in providing adequate drainage for farming shallow-rooted crops.

Soil Profiles

Pamlico Muck

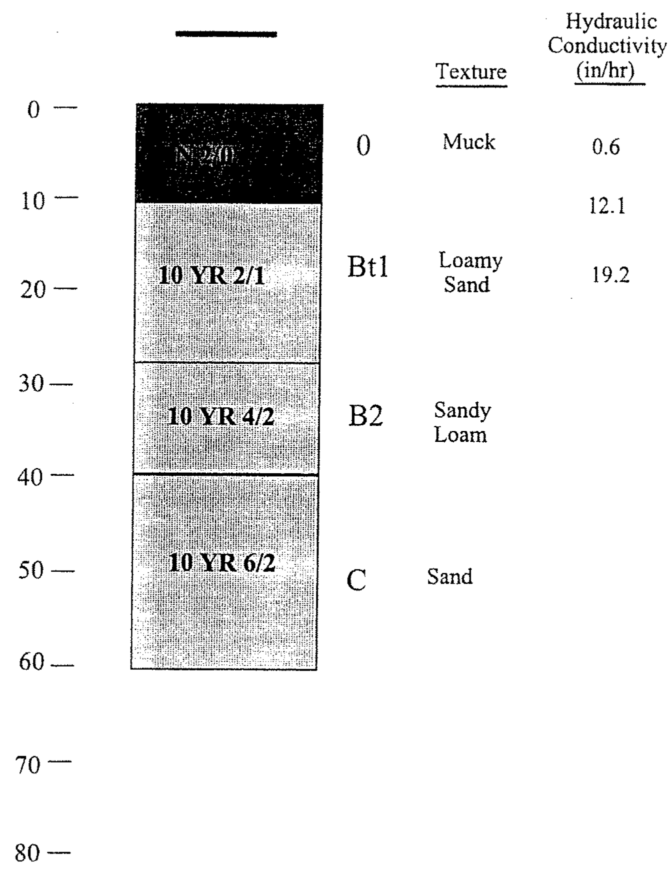
(Inner Floodplain)



Depth in inches

Pamlico/Johnston Complex

(Groundwater Seepage Areas)



Depth in inches

EcoScience Corporation	Soil Profiles Bear Creek Mitigation Site Lenoir County, North Carolina	Figure: 6 Project 99-016 Date: August 1999

Soil Surface Microtopography

Surface microtopography represents an important component of wetlands as water storage functions and micro-habitat complexity are provided by hummocks and swales across the wetland landscape. In reference wetlands, surface water expression is localized and influenced by local configurations of soils, vegetation, and drainage patterns. Reintroduction of microtopographic complexity across soil surfaces represents an important component of wetland restoration in converted crop land. If ditches are back-filled but the surface layer is not modified, water may continue preferential migration laterally through the surface soil layer, promoting flood conditions in downslope areas and dryer conditions in upper reaches of the wetland.

Deep soil scarification (i.e. below 10 inches) and introduction of woody debris will promote soil surface microtopography and surface water storage. In addition, deep scarification will assist in increasing organic matter content in the wetland surface by mixing low permeability organics present below the plow layer. Wetland restoration plans which require immediate success must address surface water storage (surface microtopography) and soil hydraulic conductivities (organic matter content) along with the influence of ditching.

3.2.2 Nonhydric Soils

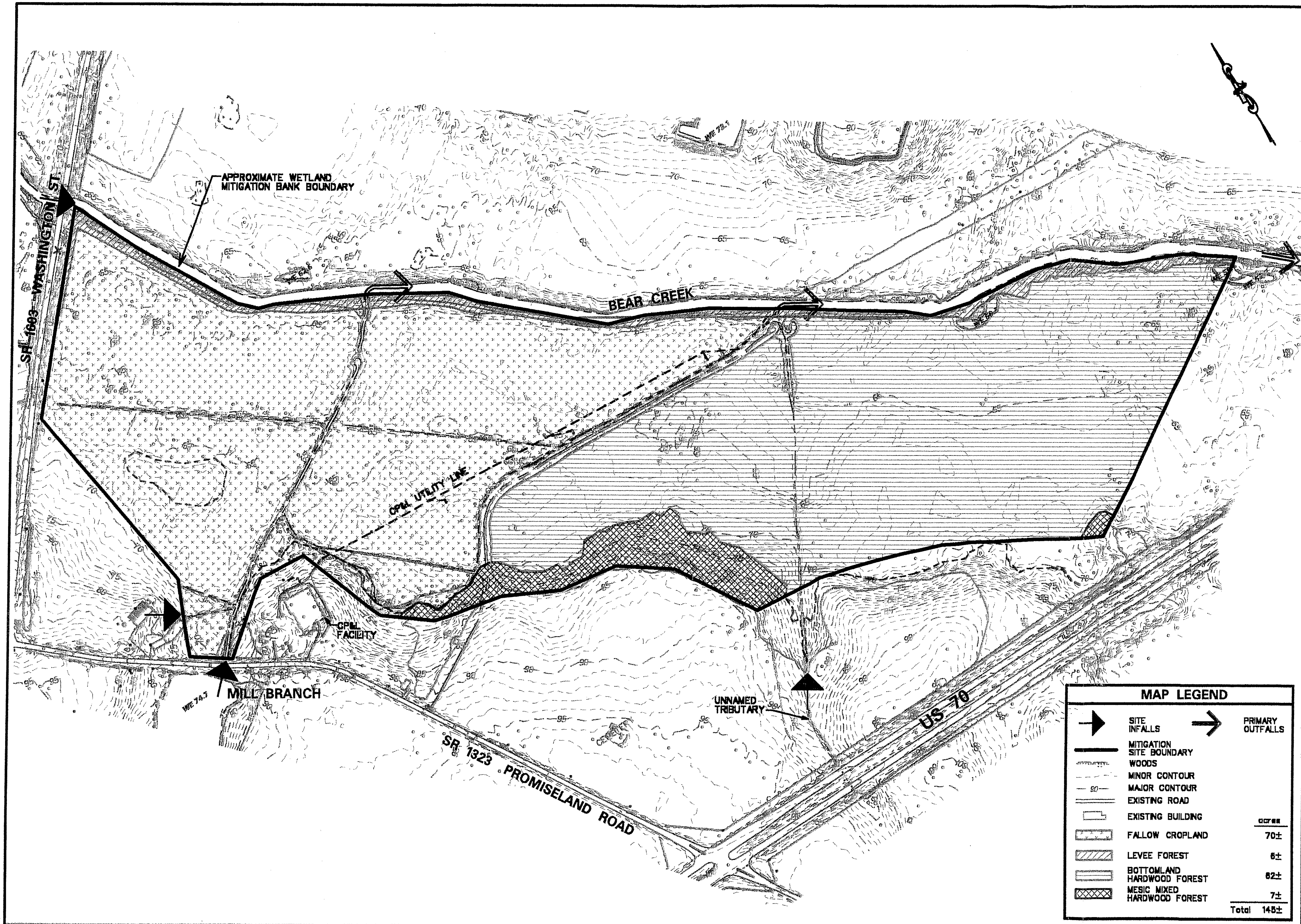
Non-hydric soils present include the Wagram (*Arenic Paleudults*), Norfolk , Blanton, and Udorthents series. These series comprise approximately 9 acres of the Site. The non-hydric series occupy the valley walls and groundwater discharge slopes, exhibiting well drained to excessively drained conditions. These soils lack wetland hydrology but are included in the mitigation landscape to provide a buffer from future development and to allow restoration of upland/wetland ecotones. These ecotones are among the most diverse and productive environments for wildlife (Brinson *et al.* 1981).

3.3 PLANT COMMUNITIES

Plant communities at Bear Creek are influenced, in large part, by past land use practices. Site preparation, drainage, and logging over the years have substantially altered the natural communities. Five communities have been identified for descriptive purposes, including: 1) crop land; 2) levee forest; 3) bottomland hardwood forest; and 5) mixed hardwood forest (Figure 7).

Crop Land

Approximately 48% (70 ac) of the 145-ac Site consists of crop land. The last crop grown in these areas was harvested in September of 1998. Disturbance-adapted species indicative of moderately well drained conditions are currently re-colonizing the area. Characteristic pioneer species include broom sedge (*Andropogon virginicus*), asters (*Aster* spp.), goldenrod (*Solidago* spp.), horseweed (*Erigeron canadensis*), pigweed (*Chenopodium album*), ragweed (*Ambrosia artemisiifolia*), common morning glory (*Ipomoea purpurea*), love grass (*Erogrostis* sp.), thistle (*Carduus* sp.), red maple seedlings (*Acer rubrum*), loblolly pine seedlings (*Pinus taeda*), winged sumac (*Rhus copallinum*), sicklepod (*Cassia obtusifolia*), and blackberry (*Rubus* spp.).



EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919 828 3433
Fax: 919 828 3518

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

Project: PLANT COMMUNITIES
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Dwn By: MAF	Date: AUG 1999	Figure	7
Ckd By: JWN	Scale: 1"= 400'		
ESC Project No.: 99-016			

Adjacent border and forest edge communities support young sweetgum (*Liquidambar styraciflua*), black cherry (*Prunus serotina*), and red maple (*Acer rubrum*). Thickets containing blackberry, winged sumac, Canada elder (Sambucus canadensis), switch cane (*Arundinaria gigantea*), muscadine grape (*Vitis rotundifolia*), and common greenbrier (*Smilax rotundifolia*) are also present.

Numerous inter-field ditches support hydrophytic plants such as soft rush (*Juncus effusus*), woolgrass (*Scirpus cyperinus*), numerous sedges (Carex spp.), cattail (*Typha latifolia*), seedbox (*Ludwigia alternifolia*), creeping seedbox (*Ludwigia repens*), false nettle (*Boehmeria cylindrica*), yellow-eyed grass (*Xyris* sp.), duckweed (*Lemna minor*), and beak rush (*Rhynchospora* sp.). Inter-field dirt road berms are invaded by various upland and invasive species including blackberry, broom sedge, asters, and numerous annual and perennial grasses and herbs. Characteristic wetland vegetation is generally absent from crop land portions of the Site.

<u>Levee Forest</u>
Approximately 6 acres of levee forest are found in a narrow band, on the elevated deposits (natural and man-made) along Bear Creek. These moderately well drained areas support plant species characteristic levee forest communities (Schafale and Weakley 1990). Canopy species include river birch (Betula nigra), water oak (*Quercus nigra*), green ash (*Fraxinus pennsylvanica*), pumpkin ash (*Fraxinus profunda*), Carolina ash (*Fraxinus caroliniana*), tag alder (*Alnus serrulata*), American elm (*Ulmus americana*), sweetgum (*Liquidambar styraciflua*), ironwood (*Carpinus caroliniana)*, and red maple. The mid-story is dominated by deciduous holly (*Ilex deciduous*), American holly (*Ilex opaca*), Elliott blueberry (*Vaccinium elliottii*), and Virginia willow (*Itea virginica*). Understory species include muscadine grape, pokeweed (*Phytolacca americana*), common greenbrier, switch cane, sedges, poison ivy (*Toxicodendron radicans*), and false nettle.

<u>Bottomland Hardwood Forest</u>
Southeastern portions of the site maintain bottomland forest assemblages (62 acres) which have experienced prolonged degradation from past logging, watershed diversion, and ditch networks. The forest canopy includes swamp tupelo (*Nyssa biflora*), sweetgum, red maple, river birch, loblolly pine, cherrybark oak (*Quercus pagoda*), and water oak. Mid-story species include sweetbay (*Magnolia virginiana*), American holly, and highbush blueberry (*Vaccinium corymbosum*). Under-story species distribution is variable along hydrologic gradients and includes muscadine grape, Japanese honeysuckle (*Lonicera japonica*), cinnamon fern (*Osmunda cinnamomea*), netted chain-fern (*Woodwardia areolata*), poison ivy, yellow jessamine (*Gelsemium sempervirens*), and several types of sedges.

Included within this bottomland community are relic backwater areas found in depressional sites. This remnant community, covering approximately 14-acres, appears to have been affected by reductions in drainage area, loss of surface hydrodynamics, reductions in hydroperiod, and periodic timber harvest. Like the surrounding forest, the canopy is dominated swamp tupelo, sweetgum, and red maple.

Mesic Mixed Hardwood Forest

Approximately 7ac of mesic mixed hardwood forest and oak-hickory forest are found on the valley wall along the western boundary of the site. These moderately well drained to well drained areas support plant species characteristic of low elevation and mid-slope sites (Schafale and Weakley 1990). Canopy species include water oak, pignut hickory (*Carya glabra*), mockernut hickory (*Carya alba*), white oak (*Quercus alba*), and southern red oak (*Quercus falcata*). The mid-story is dominated by beautyberry (*Callicarpa americana*), Chinese privet (*Ligustrum sinense*), American holly, flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), downy arrowwood (*Viburnum rafinesquinum*), and various blueberry species (*Vaccinium* spp.). Under-story species are dominated by vines that include common greenbrier, poison ivy, muscadine (*Vitis rotundifolia*), Carolina jessamine, and Japanese honeysuckle.

3.4 HYDROLOGY

The hydrophysiographic region consists of relatively flat, Inner Coastal Plain environments characterized by moderate rainfall (USDA 1990). In Lenoir County, precipitation averages 48 inches per year with peak annual precipitation events typically occurring in the summer months. Large floods (20-100 year return interval) typically correspond to hurricane events in the region.

Valley slopes[1] typically range from 0.001 to 0.005 rise/run with depositional material consisting of coastal sands and silts, inducing the formation of relatively slow flowing, high bed load streams and rivers. The relative lack of land slope discourages runoff, promoting elevated groundwater tables, predominantly vertical groundwater flow, extensive wetland presence along interstream divides, and broad, relatively shallow valleys and floodplains along streams.

3.4.1 Surface Water (Streams)

The Site sustains surface water hydrology from four primary sources: Bear Creek, Mill Branch, and two unnamed tributaries (Figure 3 and Figure 4).

Bear Creek

The Site abuts a 5600-ft reach of Bear Creek, a fifth-order river (Strahler 1964) (Figure 3). Bear Creek supports a primary watershed of approximately 54 mi^2 and flows into the Neuse River approximately 5 miles downstream. The watershed supports agricultural land and hog farms (85%), forested land (8%), and residential and small commercial development (7%)

[1] Valley slopes are a measurement of rise/run along the valley floor in the downstream direction.

(based on USGS mapping). However, commercial, industrial, and residential development is expected to expand in the watershed over the next several decades due to infrastructural projects in the region (Section 3.1).

Bear Creek was dredged, straightened, and river-side dikes constructed throughout the watershed in the early 1950s. Below SR 1603, the abandoned floodplain resides at approximately 65 feet above MSL while constructed dikes extend, on average, to 69 feet above MSL. Relative to the floodplain elevation, the dredged channel supports a bankfull width of 56 feet, and average depth of 6 feet, and cross-sectional area of approximately 320 ft^2 (max depth 8.3 feet). The channel cross-section is effectively enlarged to 550 ft^2 by the constructed dikes. Conversely, the historic channel is projected to support cross-sections of less than 200 ft^2.

Table 1 and Figure 8 provide model results that predict Bear Creek discharge and flood elevations for the 1, 2, 5, 10, 50, and 100 year storm (Section 4.2). The model indicates that dredging and dike construction have effectively eliminated the influence of overbank flooding. The dike is not overtopped until the 100-year storm. Limited flooding and backwater conditions at the confluence of Mill Branch with Bear Creek and the unnamed tributaries does not occur until the 10-year storm. If the dike were lowered to the elevation of the adjacent floodplain below SR 1603 (approximately 65 feet above MSL), flooding from the river would be restored to a 5-year return interval, a 95-year increase in return interval relative to existing conditions.

Mill Branch

Mill Branch represents a second order stream supporting a 3 mi^2 watershed. Land use is similar to conditions found in the Bear Creek watershed, including an approximately 87% conversion rate for agricultural use. In the upper watershed, a majority of tributaries and portions of the main-stem channel have been dredged through agricultural areas. The stream discharges into a constructed pond immediately above SR 1323 (Promise Land Road) (Figure 4). The pond supports a fixed weir immediately above SR 1323 and the Site. The top of the weir and pond water surface resides at approximately 74.5 feet above MSL. However, the weir was blown out during Hurricane Floyd in September 1999 with the sediment wedge above the weir rapidly descending to the road culvert elevation (68.3 feet above MSL). Sediment supply into the Site has increased dramatically since the weir and pond were breached. However, the landowner plans to rebuild the weir as the pond is utilized for irrigation purposes.

The on-site reach of Mill Branch includes approximately 1770 linear feet of channel, extending from the SR 1323 bridge and weir to the confluence with Bear Creek. The channel has been diverted into an inter-field ditch, ranging from 20 feet to 40 feet wide, 4 feet to 6 feet in maximum depth, averaging a cross-sectional area of approximately 80 ft^2. Based on limited gauge data (May-June 1999), the base flow channel supports an average discharge of 3 to 4 cubic feet per second (CFS) with the 1-year peak flow exceeding 70 CFS (Section 4.1). Under historic (potentially stable) conditions, the channel is projected to have supported a cross-sectional area of less than 15 ft^2.

TABLE 1

Surface Water Discharge and Flood Elevation Estimates
Bear Creek-Mill Branch Mitigation Site

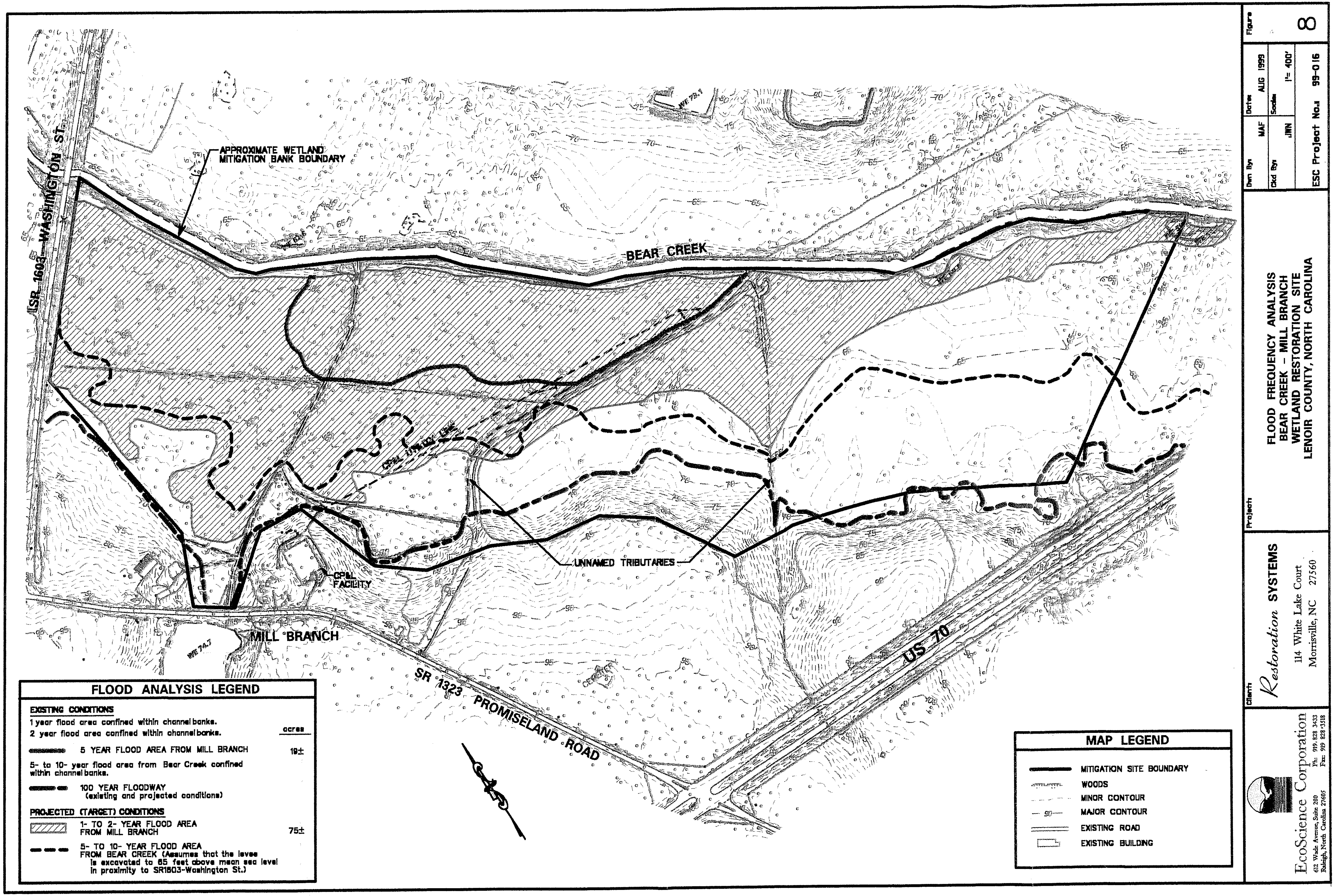
Bear Creek
(54 mi^2 Watershed)

Frequency years	**Discharge** cubic feet/ second (CFS)	**Flood Water Elevation** feet above mean sea level (MSL)	**Notes** (Immediately below SR 1603 Bridge)
1	550	62.8	App. floodplain elevation: 65 feet MSL
2	850	64.0	App. constructed dike elevation: 69 feet MSL
5	1500	65.5	Flood waters confined in Bear Creek channel behind dike; backwater conditions at the Mill Branch and Unnamed Tributary outlets (Figure 4)
10	1870	66.1	Flood waters begin to enter the site through dike openings at Mill Branch.
50	4150	68.3	
100	5200	69.1	over-tops constructed dike
500	8500	71.0	

Mill Branch
(3 mi^2 Watershed)

Frequency years	**Discharge** CFS	**Flood Water Elevation** feet above MSL			**Notes**
		Sect. 1[1]	Sect. 2[1]	Sect. 3[1]	
1	75	63.1	64.7	65.7	Flood water confined in channel banks
2	130	63.8	65.5	66.6	confined in channel banks
5	270	64.5	66.7	68.1	tops bank immediately prior to Bear Creek
10	400	64.8	67.1	69.0	Elevations mimic projected 1-year flood prior to canal construction
25	650	64.9	67.4	70.1	
50	850	65.0	69.0	70.4	
100	1100	65.1	69.3	70.7	

1: Sect. 1: Cross-Section 500 feet upstream from confluence with Bear Creek
Sect. 2: Cross-Section 1000 feet upstream from confluence with Bear Creek
Sect. 3: Cross-Section 1800 feet upstream from confluence with Bear Creek, immediately below SR 1323 (Promise Land Road).



APPROXIMATE WETLAND MITIGATION BANK BOUNDARY
SR 1603 WASHINGTON ST.
BEAR CREEK
UNNAMED TRIBUTARIES
CP&L FACILITY
MILL BRANCH
SR 1323 PROMISELAND ROAD
US 70
FLOOD ANALYSIS LEGEND
EXISTING CONDITIONS
1 year flood area confined within channel banks.
2 year flood area confined within channel banks.
acres
5 YEAR FLOOD AREA FROM MILL BRANCH 19±
5- to 10- year flood area from Bear Creek confined within channel banks.
100 YEAR FLOODWAY (existing and projected conditions)
PROJECTED (TARGET) CONDITIONS
1- TO 2- YEAR FLOOD AREA FROM MILL BRANCH 75±
5- TO 10- YEAR FLOOD AREA FROM BEAR CREEK (Assumes that the levee is excavated to 65 feet above mean sea level in proximity to SR1603-Washington St.)
MAP LEGEND
MITIGATION SITE BOUNDARY
WOODS
MINOR CONTOUR
MAJOR CONTOUR
EXISTING ROAD
EXISTING BUILDING
Figure 8
Dwn By: MAF
Date: AUG 1999
Ckd By: JWN
Scale: 1"= 400'
ESC Project No.: 99-016
Project: FLOOD FREQUENCY ANALYSIS
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA
Client: Restoration SYSTEMS
114 White Lake Court
Morrisville, NC 27560
EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919.828.3433
Fax: 919.828.3518

Surface water models predict that Mill Branch stream flows are confined within the ditch up to the 5-year flood event (Table 1 and Figure 8). During the 5-year event, limited flooding occurs immediately prior to the confluence of Mill Branch with Bear Creek, induced primarily by backwater conditions in the area. Based on the model, flood elevations associated with the 10-year return interval along Bear Creek results in wide-spread flooding which appears to mimic historic conditions during the 1- to 2-year flows. Restoration plans should be designed to restore this 1- to 2-year flood extent, while providing a perennial source for groundwater recharge in the primary floodplain areas associated with Bear Creek (Section 3.4.2).

Unnamed Tributaries

Two unnamed tributaries also dissect southern portions of the Site (Figure 8). These systems extend for approximately 1900 linear feet and 1200 linear feet and support watersheds of 0.23 square miles and 0.39 square miles respectively. These tributaries represent intermittent or marginally perennial streams that receive drainage from the US 70 highway corridor immediately south and west of the Site. Both systems have been diverted into canals that bypass the primary and secondary floodplains, providing direct connectivity to Bear Creek and the Neuse River. The northern tributary originates on-site and flows within a drainage canal that parallels the CP&L utility easement. The southern tributary is located within the forested portion of the tract, with dredging impacts becoming most pronounced in proximity to Bear Creek.

3.4.2 Groundwater

Periodic river and stream floods, fluvial sediment deposition, and hydraulic energy dissipation represent important attributes of floodplains and bottomland hardwood forest in the region. However, these channels represent base flow, groundwater withdrawal features throughout most of the year. Therefore, groundwater inputs represent the primary hydrologic factor in the development and maintenance of riverine wetlands at this Site. Wetland hydroperiods are greatest along the toe of the outer floodplain, immediately adjacent to upland buffers (groundwater discharge areas). Hydroperiods decrease across the floodplain as the groundwater table approaches stream channels (groundwater discharge features). Dredging of Bear Creek, Mill Branch, and the unnamed tributaries has significantly lowered the groundwater table and steepened the groundwater discharge gradient throughout agricultural and forested portions of the Site.

Groundwater migration has been further accelerated in crop lands by leveling of the soil surface and by reductions in soil organic matter content. The induced groundwater migration is intercepted by a network of interior canals and inter-field ditches which effectively drains the area (Figure 4). Approximately 7,200 linear feet of ditches and canals have been constructed and range from approximately 3 feet deep in inter-field ditches to 8 feet deep at the Site out-fall.

Groundwater flow diagrams were prepared weekly for late March, April, May, and early June 1999. Groundwater elevation data is presented in Table 2. A representative groundwater flow map for late March (shallow conditions) and June (deep conditions) is presented in Figures 9A and 9B.

Groundwater was encountered in the borings as part of a shallow, unconfined surficial aquifer within 0.6 feet to 4.5 feet of the ground surface. The highest groundwater elevations were observed in the southern reaches of the forested area (Well #W14, Figure 9A). The area is located, more than 600 feet from drainage structures, and may serve as a reference (relatively undisturbed) wetland for hydrology monitoring use. Portions of the tract surrounding Well #14 represents the only area supporting wetland hydroperiods during the early 1999 growing season.

Water table elevations decrease along drainage gradients extending from the secondary floodplain to, on average, 3.5 feet below ground surface immediately adjacent to Bear Creek (primary floodplain). This deep and relatively steep groundwater gradient is due primarily to dredging in the river. To restore wetlands, the groundwater drainage wedge induced by dredging must be filled with auxiliary sources of recharge in proximity to Bear Creek.

3.5 WATER QUALITY

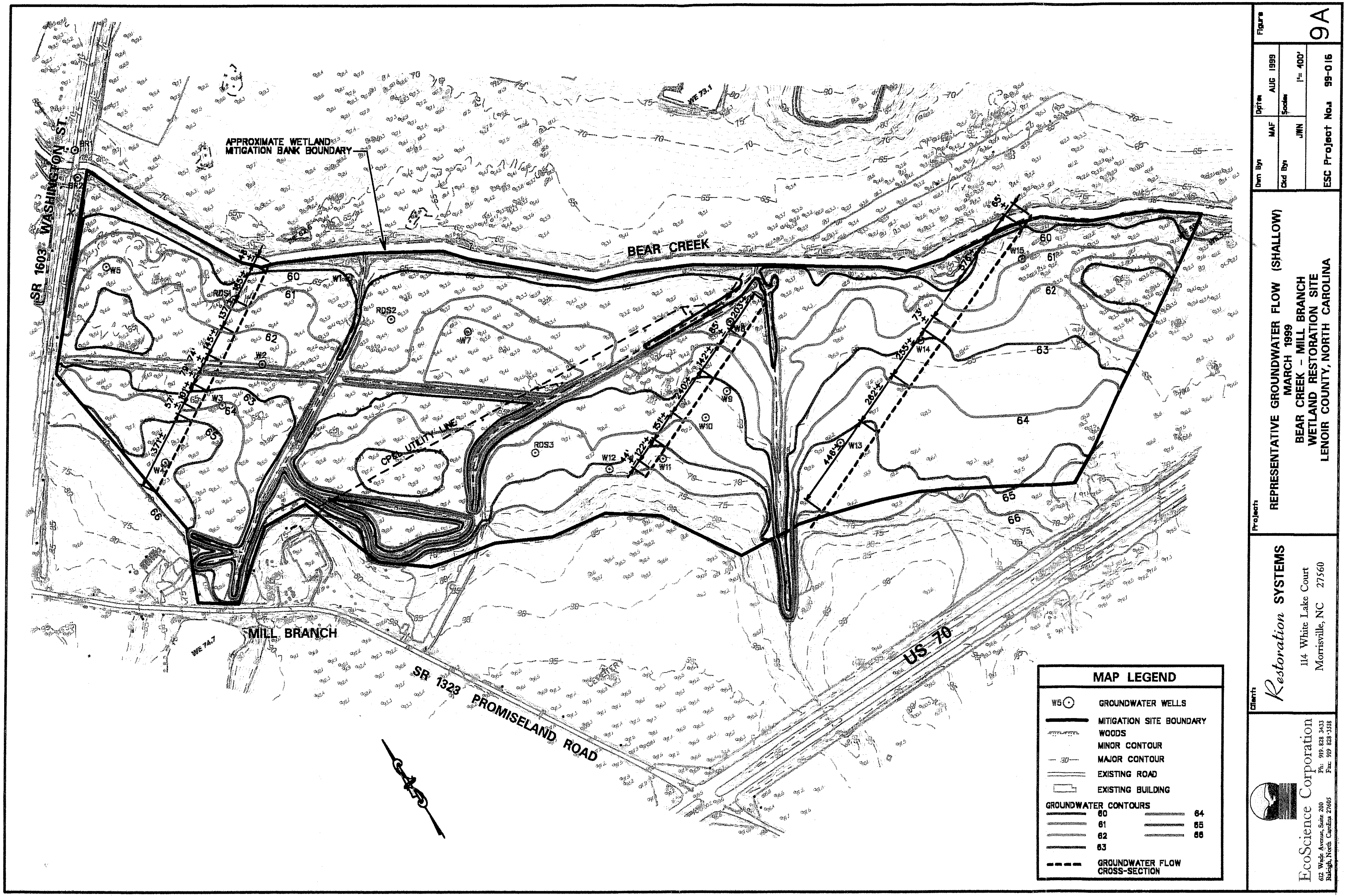
Bear Creek and Mill Branch maintain a State best usage classification of **C Sw NSW** (Stream Index No. 27-72 and 27-72-4) (DWQ 1998). Class **C** uses include aquatic life propagation and survival, fishing, wildlife, and secondary recreation. Secondary recreation refers to activities involving human body contact with water on an infrequent or incidental basis. These systems have also been assigned a "Nutrient Sensitive Waters" (NSW) supplemental classification, which requires limitations on future nutrient inputs that could be detrimental to water quality. In addition, the "Swamp Waters" (Sw) designation signifies systems which support low velocities and other natural characteristics, which are different from adjacent waters (DWQ 1998).

The Site consists of crop land located adjacent to a network of drainage ditches and canals, including direct connectivity with a major drainageway (Bear Creek and the Neuse River). Fertilizers, pesticides, and nutrients associated with farming practices are expected to have influenced water quality in flows leaving the Site. Turkey farms are located immediately adjacent to the Site, with turkey waste spread by truck on the agricultural areas (no lagoons). However, vegetated buffers adjacent to drainage ditches, which may serve as nutrient and chemical filtration strips, do not exist within the farm-fields. In addition, farm runoff enters the drainage network and transports off-site with associated deleterious effects on water quality. The unprotected drainage network extends into nutrient sensitive waters of the Neuse River approximately 5 miles downstream.

TABLE 2

Representative Groundwater Elevations
Bear Creek-Mill Branch Mitigation Site

Date		4/15/99		4/29/99		5/13/99		5/27/99	
Well Number	Well Elevation (feet above MSL)	Depth below ground surface (feet)	Ground-water Elevation (feet above MSL)	Depth below ground surface (feet)	Ground-water Elevation (feet above MSL)	Depth below ground surface (feet)	Ground-water Elevation (feet above MSL)	Depth below ground surface (feet)	Ground-water Elevation (feet above MSL)
W-1	64.4	4.5	59.9	4.4	60.0	4.2	60.2	3.8	60.6
W-2	64.4	2.4	62.0	2.0	62.4	2.4	62.0	2.3	62.1
W-3	65.3	1.5	63.8	1.0	64.3	1.5	63.8	1.2	64.1
W-4	67.5	2.3	65.2	1.8	65.7	2.3	65.2	1.8	65.7
W-5	65.2	2.7	62.5	2.4	62.8	2.8	62.4	2.5	62.7
W-6	65.6	2.1	63.5	1.4	64.2	2.0	63.6	1.8	63.8
W-7	63.6	1.7	61.9	0.9	62.7	1.7	61.9	1.3	62.3
W-8	62.6	2.2	60.4	1.7	60.9	2.1	60.5	1.9	60.7
W-9	67.0	4.1	62.9	3.8	63.2	4.2	62.8	3.9	63.1
W-10	66.0	3.3	62.7	2.0	64.0	2.7	63.3	2.3	63.7
W-11	68.0	3.0	65.0	2.6	65.4	3.3	64.7	2.9	65.1
W-12	68.2	2.0	66.2	1.7	66.5	2.1	66.1	2.2	66.0
W-13	67.8	1.6	66.2	0.9	66.9	1.6	66.2	1.4	66.4
W-14	**64.4**	**0.8**	**63.6**	**0.6**	**63.8**	**1.0**	**63.4**	**0.8**	**63.6**
W-15	62.6	1.6	61.0	1.3	61.3	2.3	60.3	1.3	61.3
RDS-1	64.9	4.5	60.4	4.3	60.6	4.5	60.4	4.0	60.9
RDS-2	64.1	6.6	57.5	3.5	60.6	3.8	60.3	3.6	60.5
RDS-3	65.9	2.1	63.8	1.5	64.4	-----	-----	1.8	64.1


APPROXIMATE WETLAND MITIGATION BANK BOUNDARY
BEAR CREEK
MILL BRANCH
SR 1603 WASHINGTON ST.
SR 1323 PROMISELAND ROAD
US 70
CP&L UTILITY LINE
MAP LEGEND
GROUNDWATER WELLS
MITIGATION SITE BOUNDARY
WOODS
MINOR CONTOUR
MAJOR CONTOUR
EXISTING ROAD
EXISTING BUILDING
GROUNDWATER CONTOURS
60
61
62
63
64
65
66
GROUNDWATER FLOW CROSS-SECTION
Client
Restoration SYSTEMS
114 White Lake Court
Morrisville, NC 27560
EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919 828 3433
Fax: 919 828 3518
Project
REPRESENTATIVE GROUNDWATER FLOW (SHALLOW)
MARCH 1999
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA
Dwn By MAF
Date AUG 1999
Ckd By JWN
Scale 1"= 400'
ESC Project No. 99-016
Figure 9A

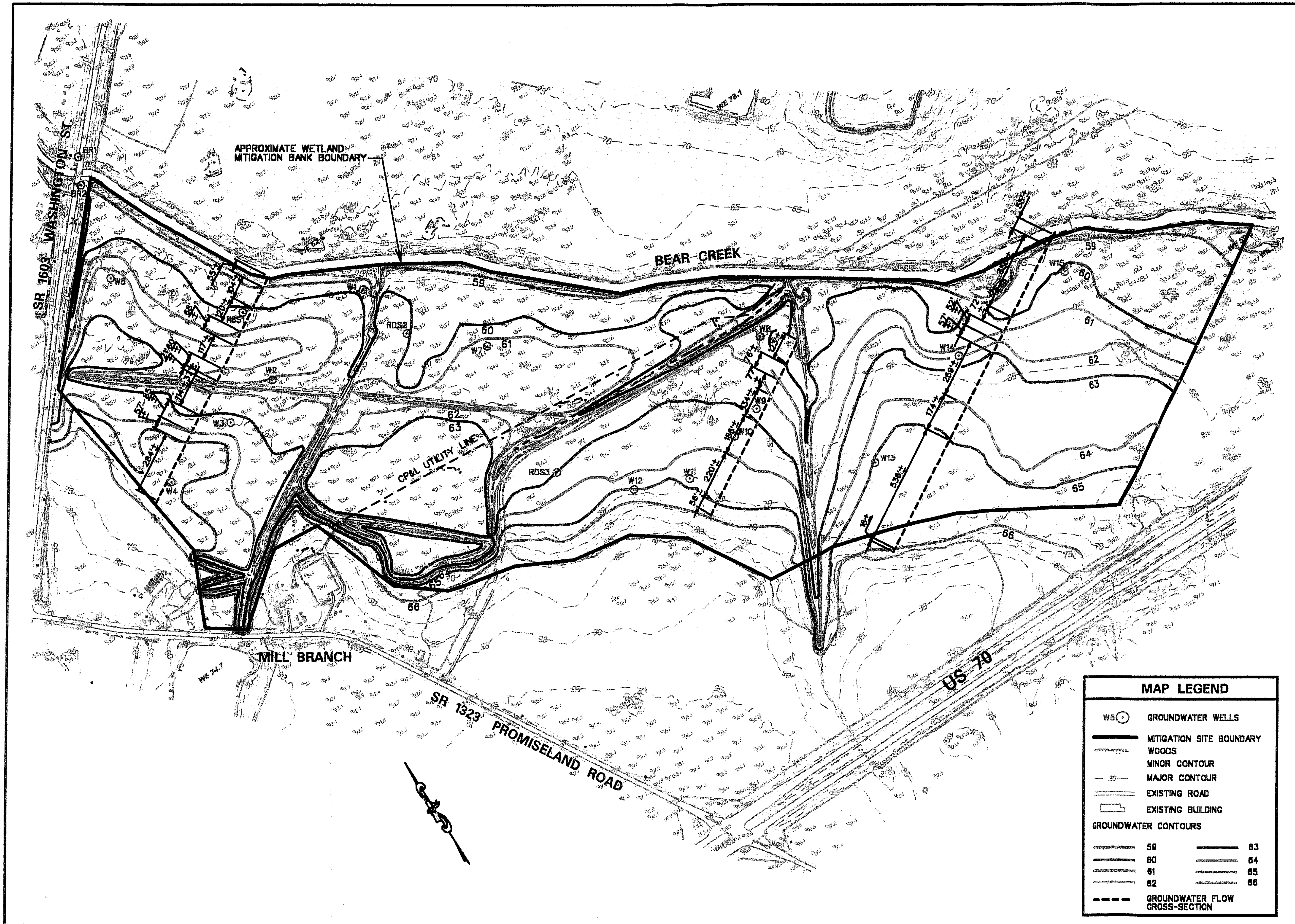


Figure 9B

Dwn By: MAF | Date: AUG 1999
Ckd By: JWN | Scale: 1"= 400'

ESC Project No.: 99-016

Project: REPRESENTATIVE GROUNDWATER FLOW (DEEP)
JUNE 1999
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919. 828 3433
Fax: 919 828-3518

Historically, the floodplain provided water quality benefits to watersheds associated with Bear Creek (54 square miles) and Mill Branch (3 square miles). However, runoff from this land area effectively bypasses wetland floodplains as drainage canals transport flow directly through the Site. Restoration of wetland hydrology and diversion of watersheds onto restored wetland surfaces will provide regional water quality benefits, including important functions such as particulate retention, removal of elements and compounds, and nutrient cycling.

The North Carolina Wetland Restoration Program (WRP) has developed a basinwide wetland and riparian restoration plan for the Neuse River Basin, including watersheds that encompass the Site (WRP 1998). The restoration plan identifies priority watersheds based on the need for restoration. Subsequently, sites within priority watersheds are evaluated to determine potential for restoration that contributes to goals established for the river basin. Primary restoration goals in the Neuse River Basin include: 1) improvement of water quality; 2) increase in flood retention capacity; 3) improvement in wildlife habitat; and 4) increase in recreational opportunities.

The Site resides within the State, 14 digit sub-basin 03020202030030, within Hydrologic Unit (HU) # 15. The watershed surrounding the Site is designated as priority sub-basin 05 for wetland and stream restoration use. Bear Creek is listed, based upon biological and chemical characteristics, as partially supporting for designated uses (WRP 1998).

3.5.1 Neuse River Nutrient Sensitive Waters Management Strategy

Perennial and intermittent streams in the Neuse River basin, including Bear Creek and Mill Branch, are regulated by DWQ under rules established by the Neuse River Nutrient Sensitive Waters Management Strategy (DWQ 1997). The strategy is designed, in part, to provide a 30% reduction in nitrogen loads flowing into the Neuse River.

The DWQ Neuse River rules apply regulations which prohibit, with certain exceptions, clearing of existing forest vegetation, filling, and development activities within 50 feet of perennial and intermittent tributaries of the Neuse River. This protected, 50-foot zone on either side of stream channels has been designated as the riparian buffer. Under existing conditions, the Site contains 1770 linear feet of Mill Branch that does not support riparian buffers; the buffer area has been converted for agricultural use. The area lacking stream buffers encompasses approximately 4 acres of land within 50-feet either side of the channel. The land area is situated within the primary and secondary floodplain physiographic units (Figure 4).

Under existing conditions, the Site abuts 3240 feet of Bear Creek that does not support a riparian buffer throughout a majority of the protected, 50-foot zone. The buffer area extends along the west side of Bear Creek, encompassing approximately 4 acres of land adjacent to the channel. The area is situated within the river levee physiographic unit (Figure 4).

3.5.2 Nutrient Loading

Nitrogen loads supplied to the Neuse River by the Bear Creek and Mill Branch watersheds have been estimated under existing, historic (background) and projected, post-restoration conditions. The nutrient export model was developed using coefficient values provided by the N.C. Division of Water Quality (Appendix A).

Under existing conditions, nitrogen loading into the Neuse River from the Bear Creek watershed is projected to total 2,575,100 pounds (lbs)/year (Table 3). Conversely, background (historic forest) levels are projected to total 345,600 lbs/year representing a seven-fold increase in nutrient loads discharged into the River due to changing land uses. River dredging and levee construction throughout the Bear Creek watershed has most likely exacerbated the water quality problems. Nutrient recycling functions associated with riverine wetlands and floodplains is expected to be diminished or negated throughout the region.

Nitrogen loading from the Mill Branch, secondary watershed is estimated to total 143,800 lbs/year, or 6 percent of the total nutrient load in the Bear Creek watershed (Table 3). The discharge bypasses the Site through constructed canals along the tributary. Historic land use coefficients predict that background nutrient loads in Mill Branch total 19,200 lbs/year. A primary objective of this mitigation plan entails the reduction of nitrogen loads from the Mill Branch watershed to levels approaching the historic (background) level, providing up to a 5 percent reduction in nitrogen loads for the 54-square mile region.

3.6 WILDLIFE

Although forested tracts in the region have been extensively removed for large-scale agricultural purposes, isolated natural areas provide food, water, and cover for various species of wetland dependent wildlife. Forested floodplains along lower reaches of the Site support wildlife species adapted to riparian forest habitat. In addition, ephemeral drainageways and ponding within isolated wetland areas provide interaction among riparian and non-riparian wildlife guilds in the region. Wetland/upland ecotones provide additional habitat diversity near the Site. These ecotones are among the most diverse and productive environments for wildlife (Brinson *et al.* 1981).

In spite of area-wide changes to forested habitat (agriculture, timber harvesting, etc), forested portions of the Site continue to support large mammals such as bobcat (*Felis rufus*), and white-tailed deer (*Odocoileus virginianus*). Surrounding lands support many smaller mammals, including character species such as gray squirrel (*Sciurus carolinensis*), Virginia opossum (*Didelphis virginiana*), gray fox (*Urocyon cinereoargenteus*), striped skunk (*Mephitis mephitis*), and eastern cottontail rabbit (*Sylvilagus floridanus*). Numerous small burrows were noted as indications of small rodent populations such as mole (*Scalopus aquaticus*), shrew (*Sorex longirostris*, *Blarina carolinensis*), and mice (primarily *Peromycus* spp.).

TABLE 3
Neuse River Nitrogen Export Estimates
Bear Creek-Mill Branch Mitigation Site

Land Use	Export Coefficient (pounds/acre/year)		Watershed (square miles)	Percent of Watershed (%)	Watershed (acres)	Export Totals (Pounds/year)
	Range	Median				
Bear Creek Existing Conditions						
Forest	4 - 14	10	4.3	8	2,770	27,700
Crops	53 - 116	83	45.9	85	29,380	2,438,540
Residential/Comm.	27 - 53	45	3.8	7	2,420	108,900
TOTAL	-----	75	54.0	100	34,560	**2,575,100**
Bear Creek Historic Conditions						
Background (Forest)	4-14	10	54	100	34,560	**345,600**
Mill Branch Existing Conditions						
Forest	4 - 14	10	0.3	9	173	1,730
Crops	53 - 116	83	2.6	87	1,670	138,610
Residential/Comm.	27 - 53	45	0.1	4	77	3,465
TOTAL	-----	75	3.0	100	1,920	**143,800**
Mill Branch Historic Conditions						
Background (Forest)	4-14	10	3.0	100	1920	**19,200**
Mill Branch Projected Post-Restoration Conditions[1]						
Groundwater (Background)	4-14	10	2.4	80	1,540	15,400
Surface Water (Watershed)	48-104	75	0.6	20	380	28,500
TOTAL	-----	23	3.0	100	1,920	**43,900**

1: Target Post-Restoration Conditions assume that 80% of surface water flows from Mill Branch will be diverted into groundwater flow pathways or will sustain relatively long term surface water storage within forested bottomlands on the Site. The remaining 20% of stream flows are projected to maintain relatively direct, in-channel conveyance to Bear Creek.

Characteristic bird species that can be expected to utilize wetlands in the region include great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), and barred owl (*Strix varia*). In addition, a high number of passerine birds, both permanent and summer resident species, nest in bottomland hardwood forest. Among these are several neotropical migrants such as Swainson's warbler (*Limnothlypis swainsonii*) and prothonotary warbler (*Protonotaria citrea*), and other forest interior species such as the wood thrush (*Hylocichla mustelina*) and Acadian flycatcher (*Empidonax virescens*), that require large tracts of contiguous forest for survival (Keller *et al.* 1993).

Isolated areas of standing water, ditches, and canals in the area provide marginal conditions for species of fish, reptiles, and amphibians. Characteristic species include red-bellied water snake (*Nerodia erythrogaster*), cottonmouth (*Agkistrodon piscivorus*), yellow-bellied turtle (*Trachemys scripta*), spotted turtle (*Clemmys guttata*), southern leopard frog (*Rana utricularia*) and marbled salamander (*Ambystoma opacum*). However, due to dredging, straightening, and diversion of streams into linear ditches that lack riparian cover, functional in-stream habitat is considered significantly reduced within Mill Branch and the unnamed tributaries (Figure 4). Riffles, pools, and diagnostic in-stream habitats including shade are lacking within the linear dredged channels on-site.

3.7 REGIONAL CORRIDORS, ADJACENT NATURAL AREAS, AND PROTECTED SPECIES

The Site is located within watersheds where over 80% of the land area has been converted for agricultural and residential use. As depicted in Figure 3, local forest corridors are primarily isolated along Bear Creek floodplains below the Site, within Walnut Pocosin to the northwest, and within Jones Pocosin to the southwest (Figure 3). The forested, Bear Creek corridor to the Neuse River (approximately 5 miles downstream) represents the only significant regional corridor providing connectivity of the Site to contiguous natural areas. Auxiliary wetland preservation and management projects should be considered to conserve this remaining regional wildlife corridor along the lower reaches of Bear Creek near confluence with the Neuse River.

3.7.1 Protected Species

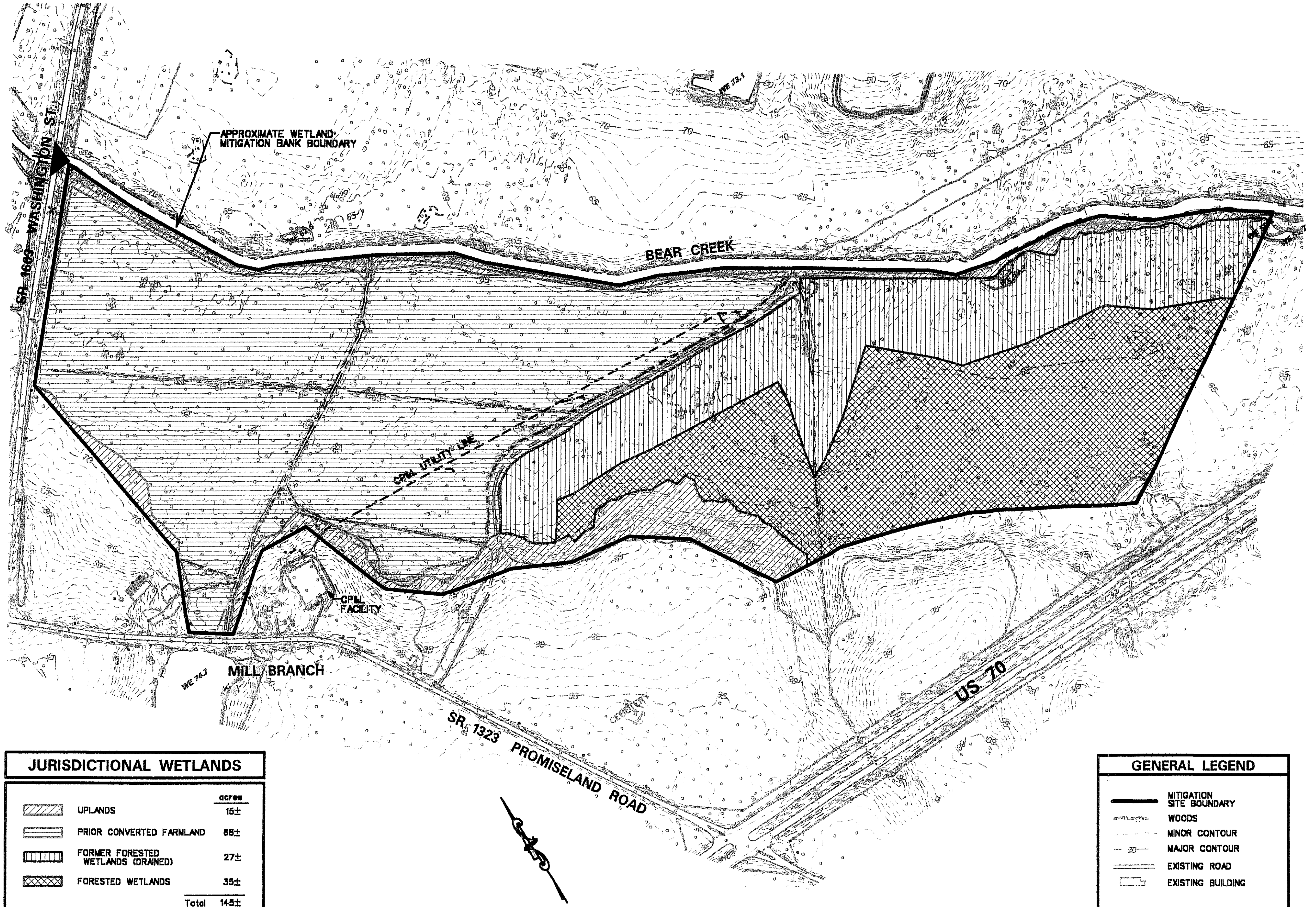
Federal listed species with Endangered (E) or Threatened (T) status receive protection under the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*). The U.S. Fish and Wildlife Service (FWS) lists the red-cockaded woodpecker (*Picoides borealis*) and sensitive jointvetch (*Aeschynomene virginica*) as the only federal protected species with ranges that extend into Lenoir County. Due to the prevalence of agriculture and lack of suitable habitat, these species are not expected within 5 miles of the Site. The N.C. Natural Heritage Program (NCNHP) maintains no documented recordings of threatened or endangered species in the area.

3.8 JURISDICTIONAL WETLANDS

Jurisdictional areas are defined using the criteria set forth in the COE Wetlands Delineation Manual (DOA 1987). The wetland determination was supplemented by the groundwater drainage model near ditches and canals in the forested area (Section 4.1). Based on the groundwater model, approximately 35 acres of jurisdictional wetlands were identified within forested sections of the Site. Figure 10 depicts the approximate location of existing jurisdictional wetlands.

NRCS records indicate that farmed portions of the Site are designated as prior-converted (PC) crop land. A PC crop land is a wetland which was both manipulated and cropped prior to 23 December 1985 to the extent that it no longer exhibits important wetland functions (Section 512.15 of the National Food Security Act Manual, August 1988). PC crop lands are not subject to regulation under the jurisdiction of Section 404 of the Clean Water Act. Approximately 68 acres of PC crop land occur within hydric soil areas of the Site (Figure 10).

The remaining 27 acres of former wetlands in forested areas were predicted by groundwater models to lack wetland hydrology due primarily to dredging activities. Groundwater well data in the early growing season of 1999 (Table 2) correlates with jurisdictional wetland boundaries generated by the groundwater model in forested areas.



JURISDICTIONAL WETLANDS

	acres
UPLANDS	15±
PRIOR CONVERTED FARMLAND	68±
FORMER FORESTED WETLANDS (DRAINED)	27±
FORESTED WETLANDS	35±
Total	145±

GENERAL LEGEND

- MITIGATION SITE BOUNDARY
- WOODS
- MINOR CONTOUR
- MAJOR CONTOUR
- EXISTING ROAD
- EXISTING BUILDING

Project: APPROXIMATE JURISDICTIONAL WETLANDS
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919 828 3433
Fax: 919 828 3518

Dwn By: MAF | Date: AUG 1999 | Ckd By: JWN | Scale: 1"= 400' | ESC Project No.: 99-016 | Figure: 10

growing season) was conducted to allow further analysis of wetland restoration potential. The growing season is defined as the period between 25 February and 29 November (277 days, USDA 1995). Wetland hydrology is achieved in the model if target hydroperiods are met for one half of the years modeled (i.e. 19 out of 38 years).

4.1.2 Model Applications and Results

DRAINMOD simulations were used to model: 1) the historic, reference wetland conditions (relatively undisturbed); 2) the hydroperiod exhibited by abandoned farmland immediately after ditches are effectively removed; and 3) the zone of wetland loss and degradation due to ditching under existing conditions. The models for reference and abandoned farmland are theoretical applications of DRAINMOD that will require field testing to substantiate predictions. The model was applied to Pamlico soils which dominate the Site. Model applications and results are summarized below.

Reference Wetland Model

For development of reference wetland standards, modeling was performed to predict historic wetland hydroperiods (as percent of the growing season) in various undrained conditions. The reference model was developed by effectively eliminating the influence of ditching and forecasting the average hydroperiod over the number of years modeled. Two iterations were performed to evaluate changes in wetland hydroperiod between: 1) old field (post farmland) stages of wetland development; and 2) forested stages of wetland development.

Old field stages of wetland development were simulated by modifying soil drainage characteristics such as rooting functions in proximity to the soil surface, A horizon (plow layer) hydraulic conductivity, and water storage capacity within the plow layer. The old field model provides a hypothetical approximation of the potential hydroperiod exhibited immediately after drainage networks are removed.

Forested stages were modeled to predict wetland hydroperiods that may occur within reference (relatively undisturbed) wetlands in the region. The reference forest model may provide a projection of wetland hydroperiods and associated functions that may be achieved over the long term (10+ years) as a result of wetland restoration activities and steady state forest conditions. The steady state model application assumes increases in rooting functions, organic matter content, and water storage capacity relative to post-farmland periods.

The reference model predicts that, in Pamlico soils, old field stages of wetland development exhibit an average wetland hydroperiod encompassing 22% of the growing season over the years modeled (Table 4). This average hydroperiod translates to free water within 1 foot of the soil surface for a 61 day period, typically occurring from 29 February to 30 April. During the 38-year modeling period, reference wetland hydroperiods exhibited a range extending from less than 5% (2 out of 38 years) to more than 36% (2 out of 38 years) of the growing season, dependent upon rainfall patterns (Table 4).

TABLE 4

Groundwater Model Results
Reference Wetland Hydroperiods For Pamlico Soil
Bear Creek-Mill Branch Mitigation Site

Percent of Growing Season	Number of Years Wetland Hydrology Acheived (38-year model period)	
	Old Field Stage (immediately after backfilling and plugging ditches; relatively low surface water storage)	**Forested Stages** (10+ years after restoration; relatively high surface water storage)
18% (50 days)	28/38	33/38
20% (55 days)	26/38	32/38
22% (61 days)	**22/38**	31/38
24% (66 days)	15/38	31/38
26% (72 days)	12/38	30/38
28% (78 days)	7/38	29/38
30% (83 days)	7/38	27/38
32% (89 days)	6/38	**21/38**
34% (94 days)	5/38	19/38
36% (100 days)	2/38	18/38

As surface topography, rooting, roughness, and storage variables increase during successional phases, the model predicts that hydroperiods will increase to steady state forest conditions averaging a 32% wetland hydroperiod over the 38 years modeled (Table 4). The average hydroperiod translates to free water within 1 foot of the soil surface for an 89 day period extending from 29 February to 28 May. Again, the hydroperiod ranges from less than 12% (4 years) to more than 36% (18 years) during the 38 year period dependent upon rainfall patterns. Therefore, the reference model suggests that groundwater fluctuations must be tracked within a reference wetland site to accurately assess a target hydroperiod for any given year.

As described above, the average wetland hydroperiod in Pamlico soil is forecast to exhibit a gradual increase from 22% of the growing season immediately after drainage structures are removed and crop production ceases to as much as 32% under steady state forest conditions. A gradual increase in hydroperiods may suggest that water storage capacity (rooting functions, organic materials/debris accumulation, microtopography, etc.) exhibits a significant effect on maintenance of wetland hydrology. In old field stages of succession, accelerated runoff may occur within the former plow layer. For purposes of this model, runoff is assumed to occur at accelerated rates which reduce the influence of evapotranspiration on wetland hydrodynamics. If so, accelerated runoff will reduce amounts of available water within the soil surface layer in interior floodplain areas. Consequently, periodic flooding or accelerated discharge would be expected to occur at the lower end of the landscape gradient, along Bear Creek. This accelerated drainage would be expected to decrease as successional vegetation colonizes the Site.

Methods may be employed to increase complexity in the soil surface (plow layer). These modifications, including woody debris deposition, limited bedding, soil scarification, and/or deep harrowing (ripping), may increase water storage capacity across the soil surface. If water storage is not adequately established during early stages of wetland development, marginal or non-wetland conditions may occur in elevated (upslope) areas of the Site. Invariably, rooting influences on water storage capacity will require an extended period of forest development to establish (assumed at greater than 10 years).

__Wetland Degradation Model__

The reference wetland model was utilized to forecast the maximum zone of ditch influence on reference wetland hydroperiods. The maximum zone of influence may be used to predict the area of wetland hydrological enhancement that may result due to effective ditch removal. In addition, the model provides an estimate of the area that may continue to be degraded in perpetuity by remaining ditches and canals used to drain adjacent properties. Ditch depths and spacing were varied in the model until wetland hydroperiods were reduced relative to the reference hydroperiods depicted in Table 4 (22% to 32% of the growing season).

In Pamlico soils, the model predicts that ditches suppress the early successional and steady state reference wetland hydroperiod below an average 22% or 32% of the growing season at distances of greater than 1000 feet from the ditch (Table 5). Specifically, the projected hydroperiod is suppressed from occurring from more than 19 out of 31 years to less than 19 out of 31 years at an over 2000-foot parallel ditch spacing in Pamlico soils. Figure 11 depicts the zone of wetland degradation induced by dredging in Bear Creek and diversion of Mill Branch, encompassing approximately 34 acres within the forested area (12.5% to 32% polygon, Figure 11).

Wetland Loss Model

The wetland loss model was applied to determine which areas may not achieve wetland hydrology criteria under existing conditions (Table 5 and Figure 11). The DRAINMOD simulations indicate that ditches effectively eliminate groundwater driven wetlands at distances ranging from 105 feet to 395 feet (Table 5, 12.5% of the growing season). The drainage contours depicted in Figure 11 suggest that 96 acres within the hydric soil area currently supports hydroperiods of less than 12.5% of the growing season.

Post-Restoration Model

The model was applied to predict site alterations required to restore wetland hydrology. Primary alterations include effectively eliminating drainage systems and re-introduction of surface microtopography (Section 5.1). However, the dredged channel along Bear Creek must remain intact in order to drain the upper watershed. Without auxiliary inputs of surface or groundwater, wetlands will continue to be drained for a zone extending approximately 390 feet adjacent to the Bear Creek canal. Restoration plans were subsequently designed to divert surface water into a perennial source of groundwater for this accelerated drainage area (Section 4.2). A backwater slough will be established on the secondary floodplain that provides: 1) an elevated groundwater gradient across the primary floodplain (in proximity to Bear Creek); and 2) an estimated 1-year return interval for surface water flooding into the primary floodplain. These auxiliary sources of groundwater recharge are predicted to reduce the relatively steep groundwater gradient induced along Bear Creek, providing for establishment of wetland hydroperiods in areas up to 50 feet from the canal (Figure 12). In southwestern reaches of the Site, the zone of post-restoration, wetland loss expands to 395 feet adjacent to Bear Creek because this area is located outside of the perennial groundwater recharge area described above.

Based on these simulations, wetland hydrology (12.5%) is forecast to occur within approximately 122 acres of the primary and secondary floodplains (Figure 12). The model suggests a net increase in wetland area of 88 acres as a result of restoration plans (34 acres pre-restoration, 122 acres post-restoration).

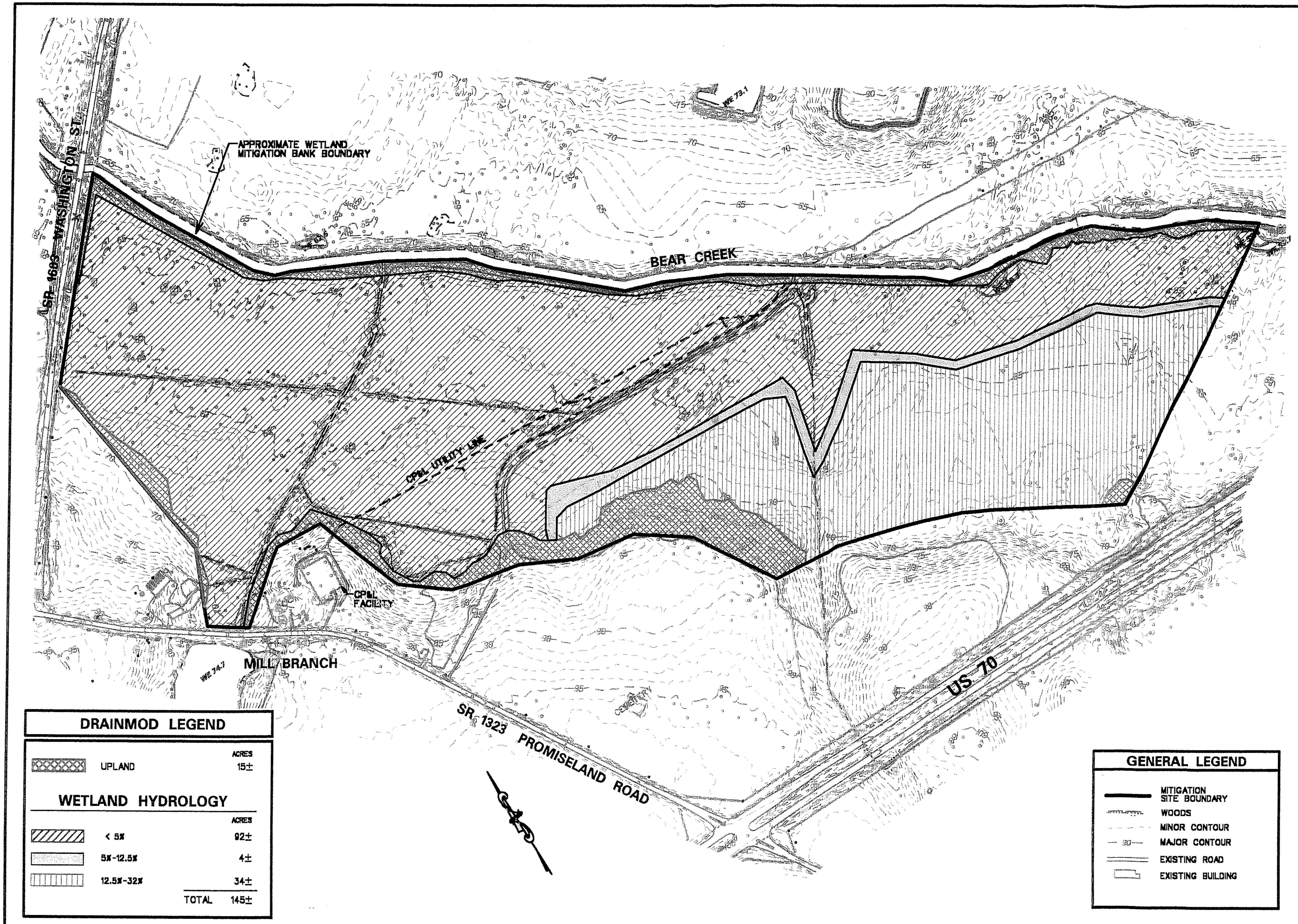
TABLE 5

Groundwater Model Results
Zone of Wetland Loss and Wetland Degradation for Pamlico Soil
Bear Creek-Mill Branch Mitigation Site

Old Field Stage (immediately after backfilling and plugging ditches) (relatively low surface storage)			
Ditch Depth (feet)	**Wetland Hydroperiod** (% of the growing season)		
	0-5% (loss)	**5-12.5%** (loss)	**12.5-21%** (degradation)
	Zone of Influence (feet)*		
1	35	105	>600
2	130	205	>800
3	180	265	>1000
4	220	305	>1000
5	260	335	>1000
6	290	365	>1000
7	315	390	>1000
8	330	410	>1000
9	340	420	>1000
10	340	425	>1000

Forested Stages (10+ years after restoration) (relatively high surface storage)			
Ditch Depth (feet)	**Wetland Hydroperiod** (% of the growing season)		
	0-5% (loss)	**5-12.5%** (loss)	**12.5-31%** (degradation)
	Zone of Influence (feet)*		
1	35	90	>600
2	130	170	>800
3	180	230	>1000
4	220	270	>1000
5	255	300	>1000
6	295	340	>1000
7	315	360	>1000
8	340	380	>1000
9	350	390	>1000
10	355	395	>1000

* Zone of influence equal to ½ of the modeled ditch spacing

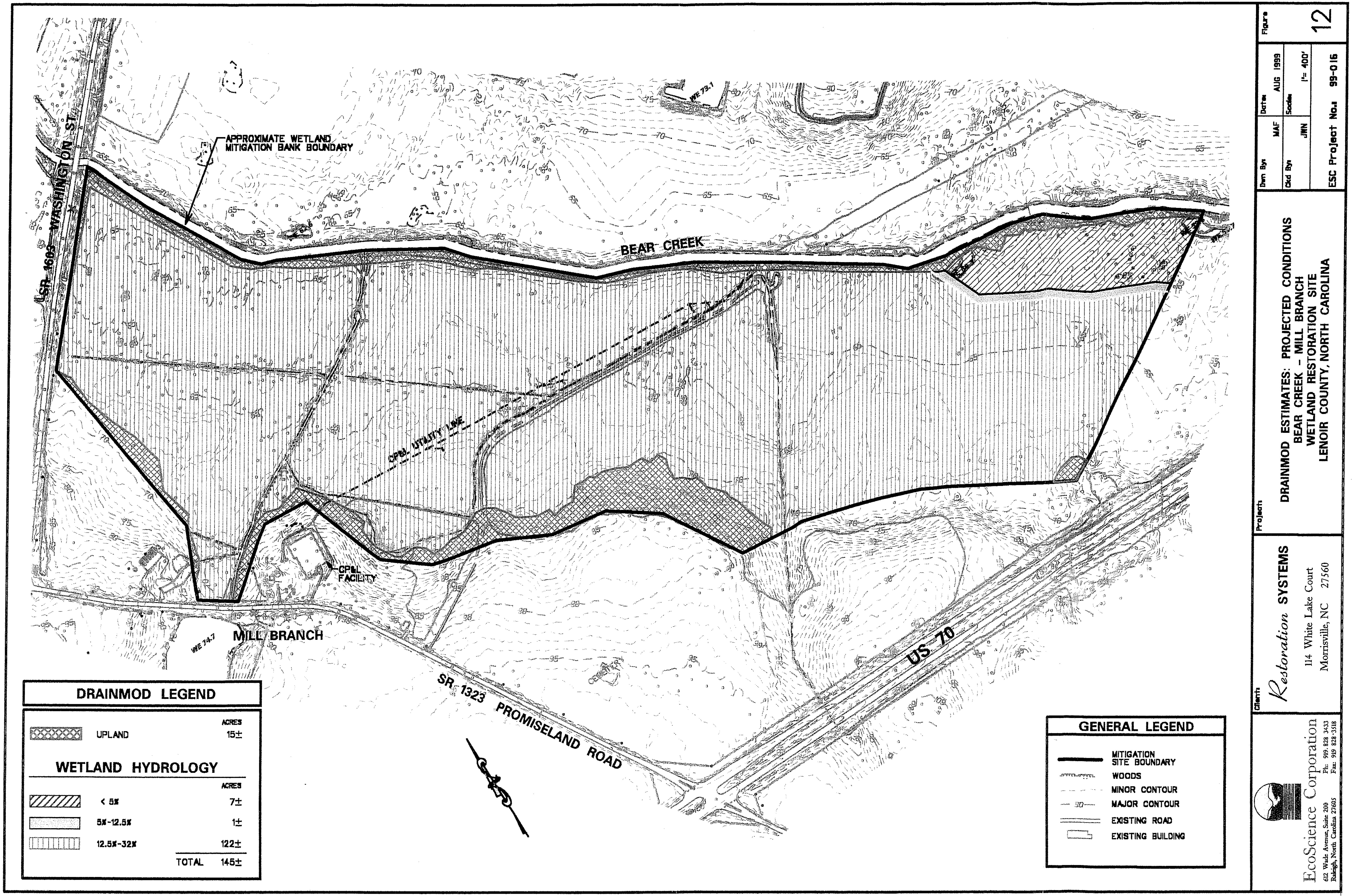


EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919 828 3433
Fax: 919 828 3518

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

Project: DRAINMOD ESTIMATES: EXISTING CONDITIONS
BEAR CREEK – MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Dwn By: MAF	Date: AUG 1999	Figure
Ckd By: JWN	Scale: 1"= 400'	11
ESC Project No.: 99-016		


APPROXIMATE WETLAND MITIGATION BANK BOUNDARY
SR 1603 WASHINGTON ST.
BEAR CREEK
CP&L UTILITY LINE
CP&L FACILITY
MILL BRANCH
WE 74.7
WE 73.1
SR 1323 PROMISELAND ROAD
US 70
DRAINMOD LEGEND
ACRES
UPLAND 15±
WETLAND HYDROLOGY
ACRES
< 5% 7±
5%-12.5% 1±
12.5%-32% 122±
TOTAL 145±
GENERAL LEGEND
MITIGATION SITE BOUNDARY
WOODS
MINOR CONTOUR
MAJOR CONTOUR
EXISTING ROAD
EXISTING BUILDING
Project:
DRAINMOD ESTIMATES: PROJECTED CONDITIONS
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA
Client:
Restoration SYSTEMS
114 White Lake Court
Morrisville, NC 27560
EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919 828 3433
Fax: 919 828-3518
Dwn By: MAF
Date: AUG 1999
Ckd By: JWN
Scale: 1"= 400'
ESC Project No.: 99-016
Figure 12

4.2 SURFACE WATER ANALYSES

Surface drainage on the Site and surrounding area was analyzed to predict feasibility of diverting existing surface drainage into the primary and secondary floodplains without adverse effects to the Site or adjacent properties. The following presents a summary of hydrologic and hydraulic analyses along with provisions designed to maximize groundwater recharge, nutrient reduction, and wetland restoration while reducing potential for impacts to adjacent properties.

Wetland and stream restoration effects caused by mitigation activities were evaluated by simulating peak flood flows for the Bear Creek and Mill Branch watersheds using: 1) existing Federal Emergency Management Agency (FEMA) studies; 2) the USACE, HEC-2 Water Surface Profiles model; 3) the Water Surface Profile (WSPRO) computational model; and 4) USGS Bear Creek gauge data at Mays Store Road (approximately 2 miles downstream from the Site).

Watersheds and land use estimations were measured from USGS quadrangles. Surveyed cross sections and water surfaces were obtained along dredged channels and behind knickpoints (weirs). Valley cross-sections were obtained from detailed topographic mapping to 1-foot contour intervals. Observations of existing hydraulic characteristics were incorporated into the model and computed water surface elevations were calibrated by utilizing engineering judgement. The flood elevations observed after Hurricane Floyd in September 1999 were used to further refine model results for the 100-year to 500-year flood boundaries.

4.2.1 Overbank Flood Model

Bear Creek

Table 1 and Figure 8 (Section 3.0) provide model results that predict Bear Creek discharge and flood elevations for the 1-, 2-, 5-, 10-, 50-, 100-, and 500- year storm. The model indicates that dredging and dike construction have effectively eliminated the influence of overbank flooding on the Site. The dike is not overtopped until the 100-year storm. Limited flooding and backwater conditions at the confluence of Mill Branch with Bear Creek and the unnamed tributaries does not occur until the 10-year storm. If the dike were lowered to the elevation of the adjacent floodplain below SR 1603 (approximately 65 feet above MSL), flooding from the river into upper reaches of the Site would be restored to less than 1 foot depth for the 5-year return interval. The flood waters would migrate as sheet flow or groundwater migration in the down-valley direction, across restored forested floodplains within the Site.

Lowering of the levee immediately below SR 1603 to 65 feet above MSL may provide a 95-year increase in return interval relative to existing conditions. River floods with a 5 to 10-year return interval are projected to maintain unrestricted access to upper reaches of the primary floodplain physiographic area. However, removal of the levee is not expected to effect the FEMA, 100-year to 500-year flood elevations because the constructed levee is overtopped during these events throughout the on-site reach of Bear Creek.

Mill Branch

Historic aerial photography (1953) indicates that Mill Branch may have once flowed to the southeast, within backwater areas along the outer edge of the Bear Creek floodplain. The area was converted for agriculture and Mill Branch was diverted into an inter-field ditch prior to 1970. Relict stream fragments have been identified in the forested area that may represent the former channel of Mill Branch. The channel areas are demarcated by discontinuous, linear depressions that appear to support meander geometry. The fragments support relatively coarse sand beds ranging from 0.5 to 2 feet in thickness. The adjacent soil surfaces and overburden burying the channel are dominated by organic material and fine sands.

After excavation of the overburden, the relict stream fragments appear to support cross-sectional areas of less than 10 square feet. The limited size of channel suggests that the stream system may have been anastomosed or braided at the confluence with the river floodplain.

The existing Mill Branch channel supports a cross-sectional area of approximately 80 square feet, which has induced effective abandonment of adjacent floodplain surfaces. Surface water models predict that Mill Branch stream flows are confined within the ditch up to the 5-year flood event (Table 1 and Figure 8). During the 5-year event, limited flooding occurs immediately prior to the confluence of Mill Branch with Bear Creek, induced primarily by backwater conditions in the area. Based on the model, flood elevations associated with the 10-year return interval along Mill Branch results in wide-spread flooding which appears to mimic historic conditions during the 1- to 2-year flows (Figure 8).

Restoration plans should be designed to restore this 1- to 2-year flood extent from Mill Branch, while providing a perennial source for groundwater recharge in the primary floodplain areas associated with Bear Creek. Target conditions may be achieved by creating a backwater slough within the secondary floodplain, similar to conditions found in regional reference wetlands. Backwater ponding will provide an auxiliary source for groundwater recharge within the primary floodplain (downslope direction). In addition, Reference cypress-tupelo swamps may be restored in the slough and flood flows directed into relict stream channels along southwestern reaches of the Site (within existing forest areas).

The flows from Mill Branch would outlet into Bear Creek approximately 3000 feet downstream from the existing outlet. The increased length of stream corridor will provide adequate flow pathways needed to restore in-stream aquatic habitat in the forested area as well as backwater swamps in crop lands. Detailed hydrological restoration methods are described in Section 5.1.

4.2.2 Off-Site Drainage

Potential for impacts to adjacent land uses was evaluated to determine the maximum elevation of water surfaces that may be restored during flood events and within the backwater slough described above. In addition, the potential for impacts to wetland restoration as a result of adjacent development was studied. The evaluation focused on SR 1323 at Mill Branch, the SR 1603 crossing of Bear Creek, and the proposed Goldsboro Bypass west of the Site.

4.2.2.1 Bear Creek

As part of this project, the FEMA, 100-year floodplain along Bear Creek should not be modified. The FEMA, 100-year flood stage (69.1 feet above MSL) was exceeded during plan development as a result of Hurricane Floyd in September 1999. Based on mapping of sediment boundaries along the outer floodplain, the flood elevation reached approximately 70.6 feet above MSL. The flood over-topped the entire length of constructed levee. Based on site visits, the peak flood duration persisted for approximately 4 hours. During the period, the primary floodplain resided under, on average, 6 feet of water. The flood recession extended for approximately 4 days with inundation ceasing over the period.

In-stream modifications along Bear Creek would be expected to increase the 100-year flood elevation on-site and within the upper watershed. Therefore, in-stream modifications are not proposed as part of this project. However, removal of levee sections are not expected to increase the FEMA floodplain, because the levee structure is over-topped by flood waters. Levee modifications may include removal or lowering at various locations to restore more frequent floods (5-year return interval) with limited potential for impacts to the FEMA floodplain or adjacent properties.

4.2.2.2 Mill Branch

Boundary conditions at Mill Branch include: 1) a fixed, impoundment weir immediately above SR 1363; 2) the sediment wedge immediately behind the weir; and 3) the road culvert; 4) the Mill Branch channel; and 5) the Mill Branch floodplain. The elevation of each structure is depicted in the following table:

Structure	Elevation (feet above MSL)	Note
Top of Weir (pond water surface)	74.7	6- to 11-foot drop over 50 feet from the weir and sediment wedge to the road culvert
Bottom of Weir	69	
Sediment Wedge	70	
Road Surface	79	
Road Culvert (Invert)	64	at downstream end
Mill Branch Channel (invert)	63	immediately below culvert
Mill Branch-Bear Creek Floodplain (average)	65	interior floodplain

The impoundment weir was blown out during Hurricane Floyd and the landowner is currently developing plans to reconstruct the weir for irrigation use. Therefore, the relationship between the weir, pond, and Site was evaluated assuming that the Mill Branch impoundment weir is repaired.

Impoundment Weir Repaired

The objective of restoration includes the development of a backwater condition within the secondary floodplain of Mill Branch (Figure 4). The backwater condition will include shallow inundation of the Mill Branch-Bear Creek floodplain which resides at an average, 65 feet above MSL. Therefore, the stream outlet from the backwater slough will reside at approximately 66 feet above MSL, providing on average, 1 foot of inundation across the secondary floodplain. The embankments that provide for backwater storage adjacent to the stream outlet will rise approximately 1 to 2 feet above the planned outlet (to 68 feet above MSL).

Based on outlet elevations, the water surface within the backwater slough will reside at approximately 66 feet above MSL during normal flow periods. This water surface elevation will induce up to 2 feet of low flow or standing water within the road culvert (invert elevation = 64 feet above MSL). However, the backwater condition will not approach the bottom of the weir which resides at 69 feet above MSL, 3 feet above the water surface during normal flows. In this scenario, the road surface also remains more than 13 feet above the water surface.

During peak storms, the water surface may rise up to a maximum of 68 feet above MSL in the backwater slough, behind the embankments. This flood situation will induce approximately 4 feet of backwater in the road culvert and approach within 1 foot of the bottom of the pond weir, but area-wide flooding in the Site will prevent further elevation of off-site water surfaces. In addition, the road surface will continue to remain 11 feet above the inundation.

4.2.2.3 Proposed Goldsboro Bypass

The proposed Goldsboro Bypass corridor crosses immediately above the impoundment, approximately 700 feet west of SR 1363 and the Site. The bypass is in the preliminary planning and design stage, with final design beginning in approximately 2 years. Road construction is scheduled to begin after 2006.

The project will include culverting or bridging of Mill Branch to allow for continued stream flows into the impoundment (pers. comm. Project Engineers, 9/99). In order to facilitate road construction and bridge/culvert placement at the crossing, it is anticipated that NCDOT may perform one of the following activities at the impoundment weir location:

1) Temporarily remove the impoundment weir and drain the pond during construction, for approximately 1 to 3 years. Subsequently, the impoundment weir would be reconstructed at the existing elevation (74.7 feet above MSL) by the property owner.

2) Permanently remove the impoundment weir.

3) Replace the impoundment weir with a low-stage, in-stream weir. The low-stage weir would be designed to remove ponded conditions in the vicinity of the road construction area. The weir would also reduce potential for down-cutting into pond sediments and subsequent downstream sedimentation.

Off-Site drainage impacts associated with: 1) temporary/permanent removal of the weir; or 2) replacement of the impoundment weir with a low-stage, in-stream weir are described below.

Impoundment Weir Removed

If the pond weir is temporarily or permanently removed, the bottom of weir (69 feet above MSL) and/or sediment wedge (70 feet above MSL) represents the design elevation for evaluating off-site impacts. However, the sediment wedge is expected to down-cut around the bottom of the weir and head-wall if the structure is not repaired. Down-cutting into the pond sediment will occur because a steep, 12% slope exists between the blown out weir, sediment wedge, and the low-lying culvert. If this occurs, extensive unconsolidated sediment will be transported from the former pond, onto the Site, and potentially into Bear Creek. Eventually, the stream will incise into the unconsolidated pond sediment to approximately 65 feet above MSL. Channel down-cutting and incision through the pond will also drain adjacent wetland surfaces within the bottom of the former pond. The down-cutting would continue to migrate in the upstream direction over time.

Water surfaces in the backwater slough will be designed to reduce potential for large-scale down-cutting in the former pond. The normal water surface (66 feet above MSL) will induce 2 feet of standing water in the culvert, reducing grade and flow velocities from the stream segment in the former pond. Sediment accumulation in the immediate vicinity of the culvert may be anticipated, potentially blocking lower portions of the culvert over time.

Impoundment Weir Replaced with Low-stage, In-stream Weir

An alternative that may avoid accelerated pond degradation and sedimentation in the road culvert entails the construction of a low-stage in-stream weir in place of the existing impoundment weir. The former pond surface would subsequently be restored into swamp forest habitat and stream flows established through the system. The top of the low-stage weir would reside at the elevation of the sediment wedge, approximately 70 feet above MSL or 4.7 feet lower than the impoundment weir. Stream flows would be allowed to develop through a notch in the weir. Subsequently, tree and shrub species adapted to survival in unconsolidated sediment would be planted on the former pond surface. Approximately 4 acres of former pond surface may be restored to forested wetland habitat as a result of these modifications. This 4-acre, potential wetland restoration area is not currently included in this mitigation plan. The area may be considered in the future, based upon agency comments.

Under all possible highway bypass alternatives, conveyance of stream flows will be facilitated by spanning structures over the Mill Branch channel. If the impoundment weir is temporarily or permanently removed, heavy sediment loads would begin to approach the wetland restoration area. However, a majority of the sediment would be expected to deposit in the immediate vicinity of SR 1363 (above the Site boundary). The deposition would occur because a backwater, cypress-tupelo swamp will be restored as a water quality buffer between the highway corridor, surrounding development, and restored bottomland hardwoods adjacent to Bear Creek.

All three impoundment scenarios: 1) impoundment weir repaired; 2) impoundment weir removed; and 3) impoundment weir replaced with low-stage structure, are not expected to exhibit an adverse impact on wetland restoration or long-term function within the Site. The primary benefit of weir reconstruction will occur up-stream of, and within the road culvert, where the open water system and wetland surfaces may be degraded or displaced if the weir is not replaced.

4.3 REFERENCE PLANT COMMUNITIES

In order to establish a forested wetland system for mitigation purposes, a reference community needs to be established. According to Mitigation Site Classification (MiST) guidelines (EPA 1990), the area of proposed restoration should attempt to emulate a Reference Forest Ecosystem (RFE) in terms of soils, hydrology, and vegetation. In this case, the target RFEs were composed of relatively undisturbed woodlands in the region which support soil, landform, and hydrological characteristics that restoration will attempt to emulate. All of the RFE sites have been impacted by selective cutting or high-grading, therefore the species composition of these plots should be considered as a guide only. Reference forest data used in restoration was modified to emulate steady state, climax community structure as described in the Classification of the Natural Communities of North Carolina (Schafale and Weakley 1990).

Circular plot sampling was utilized to establish base-line, vegetation composition and structure in reference areas. Species were recorded along with individual tree diameters, canopy class, and dominance. From collected field data, importance values (Brower *et al.* 1990) of dominant canopy and mid-story trees were calculated. The composition of shrub/sapling and herb strata were recorded and identified to species. Hydrology, surface topography, and habitat features were evaluated. Both on-site and off-site reference communities were sampled and are described below.

4.3.1 On-site Reference Plant Communities

Two relict communities were identified in southern reaches of the Site that continue to characterize steady-state forest conditions. The vegetative communities sampled include Bottomland Hardwood Forest and Mesic Oak-Hickory Forest (Schafale and Weakley 1990).

Bottomland Hardwood Forest

Three plots located in the forested floodplain in the southern portion of the Site were sampled. The overstory is dominated by swamp tupelo (*Nyssa biflora*) [Importance Value = 39.3], sweet gum [19.0], American holly (*Ilex opaca*)[13.5], and red maple [13.3] (Table 6). River birch (*Betula nigra*) , loblolly pine, cherrybark oak, water oak, and sweetbay are also represented. The shrub/sapling layer is characterized by Chinese privet (*Ligustrum chinensis*), mayberry (*Vaccinium elliotii*), southern wild raisin (*Viburnum nudum*), and the overstory species listed above. Herbaceous species include netted chain fern (*Woodwardia areolata*), Virginia chain fern (*Woodwardia virginiana*), Japanese honeysuckle (*Lonicera japonica*), blackberry (*Rubus* sp.), muscadine (*Vitis rotundifolia*), greenbriar (*Smilax rotundifolia*), sedges (*Carex* spp.), Carolina jessamine (*Gelsemium sempervirens*), cinnamon fern (*Osmunda cinnamomea*), and poison ivy (*Toxicodendron radicans*).

Mesic Oak-Hickory Forest

Two plots located in the lower upland slopes along the southern boundary of the Site were sampled. The overstory vegetation is dominated by flowering dogwood (*Cornus florida*) [IV =26.9], water oak (*Quercus nigra*) [25.2], pignut hickory (*Carya glabra*) [16.3], white oak (*Quercus alba*) [11.8], and mockernut hickory (*Carya alba)* [8.2] (Table 7). Other species include American holly, black oak (*Quercus velutina*), sassafras (*Sassafras albidum*), hackberry (*Celtis laevigata*), cherrybark oak (*Quercus pagoda*), and mulberry (*Morus rubra*). The shrub/sapling layer is fairly dense and characterized by Chinese privet (*Ligustrum chinensis*), red bay (*Persea palustris*), beauty berry (*Callicarpa americana*), blueberry (*Vaccinium* spp.), sweet pepperbush *(Clethra alnifolia*),and the overstory species listed above. Common vines and herbaceous species include Japanese honeysuckle (*Lonicera japonica*), blackberry (*Rubus* sp.), muscadine grape (*Vitis rotundifolia*), greenbriar (*Smilax rotundifolia*), sedges (*Carex* spp.), and poison ivy (*Toxicodendron radicans*).

The sites exhibit evidence of past silvicultural practices such as selective cutting, high-grading, and ditch construction which has resulted in a less diverse, intra-specific tree assemblage. Therefore, community restoration procedures have been modified to facilitate a reduction in dominance by disturbance adapted species such as red maple and sweet gum.

4.3.2 Off-site Reference Plant Communities

Two reference sites in Lenoir county were identified to assist in plant community identification and future restoration activities (Figure 1). Reference Site1, located along an unnamed tributary at confluence with the Neuse River floodplain, contains two distinct physiographic landscape areas that characterize and encompass the many, steady-state forest communities historically found on the Site. Reference Site 2 (Figure 1) provides a depiction of early successional species composition that can be expected in the first decade after wetland restoration. The two physiographic areas, designated as Primary Floodplain and Backwater Slough, are described below.

TABLE 6

On-Site Reference Forest Ecosystem
Coastal Plain Bottomland Hardwood Forest (Canopy Species)

Species	Density		Basal Area		Relative Density	Relative Basal Area	Importance Value
	trees/ha	trees/acre	sq m/ha	sq ft/acre			
Swamp Tupelo	185	77	17.8	77.5	32.4	46.3	39.3
Sweetgum	96	40	8.1	35.4	16.9	21.2	19.0
American Holly	128	53	1.8	7.6	22.5	4.5	13.5
Red Maple	72	30	5.4	23.4	12.7	14.0	13.3
River Birch	24	10	1.1	4.9	4.2	2.9	3.6
Loblolly Pine	8	3	2.0	8.8	1.4	5.3	3.3
Cherrybark Oak	16	7	1.4	6.2	3.0	3.7	3.3
Water Oak	24	10	0.5	2.4	4.2	1.4	2.8
Sweetbay	16	7	0.3	1.1	2.8	0.7	1.7
Total	570	237	38.4	167.2	100	100	100

[1] Importance value = (Relative Density + Relative Basal Area)/2*100

TABLE 7

On-Site Reference Forest Ecosystem
Mesic Oak Hickory Forest (Canopy Species)

Species	Density		Basal Area		Relative Density	Relative Basal Area	Importance Value
	trees/ha	trees/acre	sq m/ha	sq ft/acre			
Flowering Dogwood	247	100	2.7	11.8	31.3	15.7	23.5
Water Oak	173	70	4.0	17.2	21.9	23.0	22.4
Pignut Hickory	49	20	4.1	17.7	6.3	23.6	14.9
White Oak	49	20	2.6	11.3	6.3	15.1	10.7
Mockernut Hickory	49	20	1.5	6.4	6.3	8.5	7.4
Mulberry	25	20	0.8	1.3	6.3	1.7	4.0
Black Oak	25	10	0.8	3.5	3.1	4.7	3.9
American Holly	49	20	0.8	1.0	6.3	1.3	3.8
Hackberry	25	20	0.8	1.0	6.3	1.3	3.8
Cherrybark Oak	25	10	0.5	2.4	3.1	3.2	3.2
Sassafras	25	10	0.3	1.4	3.1	1.8	2.5
Total	741	320	18.8	75.0	100	100	100

[1] Importance value = (Relative Density + Relative Basal Area)/2*100

4.3.2.1 Primary Floodplain

The primary floodplain includes those plant communities located on interior flats and ridges between the river and the backwater slough. The predominant communities found include levee forest and bottomland hardwood forest.

Levee Forest

The levee forest is found on course textured, moderately well drained alluvial deposits along the existing river channel and former river meanders (oxbows). The dominant overstory trees species include sycamore (*Platanus occidentalis*) [IV =52.0], red maple [20.5], sweetgum [13.5], ash (*Fraxinus* spp.) [9.1], and ironwood (*Carpinus caroliniana*) [4.8] (Table 8). Shrubs and saplings include deciduous holly (*Ilex decidua*), slippery elm (*Ulmus rubra*), and the various overstory species. Vines are dense and include species include muscadine (*Vitis rotundifolia*), saw green-briar (*Smilax bona-nox*), trumpet creeper (*Campsis radicans*), and climbing hempweed (*Mikania scandens*). The herbaceous layer is generally sparse but may include False nettle (*Boehmeria cylindrica*), sedge (*Carex* sp.), and Virginia dayflower (*Commelina virginica*).

Bottomland Hardwood Forest

Bottomland hardwood forests are found on river point bars, old meander scars, and relatively flat portions of the interior floodplain. The dominant overstory trees include overcup oak (*Quercus lyrata*) [IV = 38.4], American elm [23.5], ash (*Fraxinus* spp.) [15.6], bald cypress (*Taxodium distichum*) [7.1] and red maple [6.0] (Table 9). Other overstory species include water hickory (*Cary aquatica*), swamp tupelo (*Nyssa biflora*), and sweetgum. Shrubs and sapling species include ironwood, slippery elm (*Ulmus rubra*), and the various overstory species. Vines are generally not as dense in the interior flats as in the levee forest, except in canopy gaps. Typical vines are similar to those found in levee forests. The herbaceous layer is generally sparse. However low areas within the interior flat forest may be fairly dense and include species such as False nettle (*Boehmeria cylindrica*), bladder sedge (*Carex intumescens*), Virginia dayflower (*Commelina virginica*), lizard tail (*Saururus cernuus*), marsh duneflower (*Aneilema keisak*), and St. John's-wort (*Hypericum walterii*). Giant cane (*Arundinaria gigantea*) is prevalent in places.

4.3.2.2 Backwater Slough

The backwater ecosystem includes those plant communities located in depressions along the outer edge of the floodplain. The predominant communities found within backwater sloughs include cypress-gum swamp, riverine swamp forest, and embankment communities.

Cypress Gum Swamp

Cypress-gum swamps are located in depressional areas where lateral flow is restricted. These sites are hydrologically influenced by upland seeps and drainages, and by occasional riverine flooding. Flooding in these areas is nearly permanent, except in times of drought.

TABLE 8

Off-Site Reference Forest Ecosystem
Levee Forest (Canopy Species)

Species	Density		Basal Area		Relative Density	Relative Basal Area	Importance Value[1]
	trees/ha	trees/acre	sq m/ha	sq ft/acre			
Sycamore	148	60	11.2	48.9	35.3	68.7	52.0
Red Maple	124	50	1.9	8.3	29.4	11.7	20.5
Sweetgum	74	30	1.5	6.7	17.6	9.3	13.5
Green Ash[2]	49	20	1.1	4.6	11.8	6.5	9.1
Ironwood	25	10	0.6	2.7	5.9	3.8	4.8
Total	570	237	38.4	167.2	100	100	100

[1] Importance value = (Relative Density + Relative Basal Area)/2*100.
[2] Green Ash (*Fraxinus pennsylvanica*) is difficult to distinguish vegetatively from Pumpkin Ash (*Fraxinus profunda*) and Water Ash (*Fraxinus caroliniana*). All three species can be expected in this forest community type.

TABLE 9

Off-Site Reference Forest Ecosystem
Bottomland Hardwood Forest (Canopy Species)

Species	Density		Basal Area		Relative Density	Relative Basal Area	Importance Value[1]
	trees/ha	trees/acre	sq m/ha	sq ft/acre			
Overcup Oak	99	40	33.5	146.0	17.4	59.4	38.4
American Elm	148	60	11.9	51.7	26.1	21.0	23.5
Green Ash[2]	124	50	2.9	12.7	26.1	5.1	15.6
Bald Cypress	49	20	3.1	13.6	8.7	5.5	7.1
Red Maple	49	20	1.8	8.0	8.7	3.3	6.0
Water Hickory	25	10	1.8	7.9	4.3	3.2	3.8
Swamp Tupelo	25	10	0.8	3.5	4.3	1.4	2.9
Sweetgum	25	10	0.6	2.7	4.3	1.1	2.7
Total	544	230	38.4	167.2	100	100	100

[1] Importance value = (Relative Density + Relative Basal Area)/2*100.

[2] Green Ash (*Fraxinus pennsylvanica*) is difficult to distinguish vegetatively from Pumpkin Ash (*Fraxinus profunda*) and Water Ash (*Fraxinus caroliniana*). All three species can be expected in this forest community type.

The canopy is dominated by water tupelo (*Nyssa aquatica*) [70.5] and bald cypress [18.5] (Table 10). Other species such as overcup oak and water ash (*Fraxinus caroliniana*), water hickory, and swamp cottonwood (*Populus heterophylla*) may occur occasionally in high areas and along the fringe where flooding is less severe. Shrubs and herbaceous species are few. Duckweed (*Lemna* spp.) may be common in gaps. Lizard tail, false nettle, marsh duneflower and sedges are commonly found in shallow areas and on logs and stumps.

Riverine Swamp Forest

Riverine swamp forests are communities located on low hummocks above the level of the adjacent swamp. These small communities have course textured, sandy soils. The canopy is dominated by red maple [25.9], sweetgum [24.5], green ash (*Fraxinus pennsylvanica*) [23.6], ironwood [14.1], cherrybark oak [7.8], swamp chestnut oak (*Quercus michauxii*) [2.3], and slippery elm [1.7] (Table 11). The shrub/sapling layer is dominated by deciduous holly and the overstory species listed above. The vine and herbaceous layer is dense. Vines species include trumpet creeper, muscadine grape, common green-briar, poison ivy, blackberry, cross vine (*Bignonia capreolata*), and climbing dogbane (*Trachelospermum difforme*). Common herbs include false nettle, three-way sedge (*Dulichium arundinaceum*), sedges, Gulf coast swallow -wort (*Cynanchum angustifolium*), lizard tail, and pokeweed (*Phytolacca americana*) Hummocks lower in stature may be completely covered by marsh duneflower and Virginia dayflower.

Embankment Communities

Vegetation assemblages have colonized low-lying embankments that sustain ponding, backwater conditions, and cypress-tupelo swamps in the area. The embankments may represent former beaver dams, abandoned logging roads, or relict impoundment structures. These embankments are located at intermittent locations within the swamp forest habitat. The embankments are generally elevated several feet above the surrounding swamp. The prominent vegetation on these backwater levees are similar to swamp forest and cypress-gum swamp (Table 12).

4.3.3 Early Successional Floodplain Communities

Reference Site 2 is located adjacent to Bear Creek approximately 3 miles south of the Site (Figure 1). The site has been logged within the past few years. The site is in the early stages of forest succession and dominated by various opportunistic herbaceous and woody species. The species inventory provides a list of diagnostic wetland species that may be used to evaluate restoration success during early successional stages of wetland development. Table 13 provides a detailed inventory of character species at Reference Site 2, along with noted presence or absence of these species within farmed portions the Site and within the steady-state forest reference areas described above.

TABLE 10

Off-Site Reference Forest Ecosystem
Cypress-Gum Swamp (Canopy Species)

Species	Density		Basal Area		Relative Density	Relative Basal Area	Importance Value[1]
	trees/ha	trees/acre	sq m/ha	sq ft/acre			
Water Tupelo	494	200	21.4	93.4	66.7	74.3	70.5
Bald Cypress	148	60	5.2	22.5	20.0	17.9	18.9
Overcup Oak	49	20	1.8	7.9	6.7	6.3	6.5
Green Ash[2]	49	20	2.0	0.5	6.7	1.6	4.1
Total	740	300	30.4	167.2	100	100	100

[1] Importance value = (Relative Density + Relative Basal Area)/2*100.
[2] Green Ash (*Fraxinus pennsylvanica*) is difficult to distinguish vegetatively from Pumpkin Ash (*Fraxinus profunda*) and

Water

Ash (*Fraxinus caroliniana*). All three species can be expected in this forest community type.

TABLE 11

Off-Site Reference Forest Ecosystem
Riverine Swamp Forest (Canopy Species)

Species	Density		Basal Area		Relative Density	Relative Basal Area	Importance Value[1]
	trees/ha	trees/acre	sq m/ha	sq ft/acre			
Red Maple	148	60	5.8	26.0	22.2	29.6	25.9
Sweetgum	173	70	4.7	20.4	25.9	23.2	24.5
Green Ash[2]	210	85	3.2	13.8	31.5	15.7	23.6
Ironwood	74	30	3.4	15.0	11.1	17.1	14.1
Cherrybark Oak	25	10	2.4	10.5	3.7	12.0	7.8
Swamp Chestnut Oak	25	10	0.2	0.9	3.7	1.0	2.3
Slippery Elm	12	5	0.3	1.3	1.9	1.5	1.7
Total	667	270	20.1	87.9	100	100	100

[1] Importance value = (Relative Density + Relative Basal Area)/2*100.
[2] Green Ash (*Fraxinus pennsylvanica*) is difficult to distinguish vegetatively from Pumpkin Ash (*Fraxinus profunda*) and

Water

Ash (*Fraxinus caroliniana*). All three species can be expected in this forest community type.

TABLE 12

Off-Site Reference Forest Ecosystem
Embankment Communities (Canopy Species)

Species	Density		Basal Area		Relative Density	Relative Basal Area	Importance Value[1]
	trees/ha	trees/acre	sq m/ha	sq ft/acre			
Sycamore	148	60	11.2	48.9	35.3	68.7	52.0
Red Maple	124	50	1.9	8.3	29.4	11.7	20.5
Sweetgum	74	30	1.5	6.7	17.6	9.3	13.5
Green Ash[2]	49	20	1.1	4.6	11.8	6.5	9.1
Ironwood	25	10	0.6	2.7	5.9	3.8	4.8
Total	570	237	38.4	167.2	100	100	100

[1] Importance value = (Relative Density + Relative Basal Area)/2*100.

[2] Green Ash (*Fraxinus pennsylvanica*) is difficult to distinguish vegetatively from Pumpkin Ash (*Fraxinus profunda*) and Water Ash (*Fraxinus caroliniana*). All three species can be expected in this forest community type.

Table 13
Off-Site Reference Ecosystem (Herbaceous Layer)
Early Successional Floodplain Communities

		REF Site 2	REF Site 1					
		Early	Ag. Field	Cypress-		Interior	Backwater	Interior
		succes-	Bear	Gum	Levee	Flat	Levee	Hummock
Scientific Name	Common Name	sional	Creek	Swamp	Forest	Forest	Forest	Forest
Acer rubrum	Red Maple	*	*	*			*	*
Aneilima keisak	Marsh Duneflower	*		*		*	*	
Arundinaria gigantea	Switch Cane	*						
Arundo donax	Giant Reed	*						
Asimina triloba	Common Pawpaw	*						
Athyrium asplenioides	Southern Lady Fern	*						
Betula nigra	River Birch	*						
Bidens frodosa	Devil's Beggar-ticks	*						
Carex spp.	Sedges	*	*	*	*		*	*
Carex crinita	Fringe Sedge	*						
Carex lupulina	Hop Sedge	*						
Carex vulpinoidea	Fox Sedge	*						
Cephalanthus occidentalis	Button Bush	*						
Chasmathium laxum	Slender Spike Grass	*						
Clethra alnifolia	Coastal Sweet-pepperbush	*						
Cuscuta sp.	Dodder	*						
Cyrilla racemiflora	Ti-ti	*						
Eleocharis obtusa	Blunt Spikerush	*						
Eupatorium capillifolium	Dog-fennel	*	*					
Fraxinus caroliniana	Water Ash	*						
Fraxinus pennsylvanica	Green Ash	*			*		*	*
Galium tinctorium	Bed-straw	*						
Hibiscus moscheutos	Crimson-eyed Hibiscus	*						
Hypericum mutilum	Slender St. Johns-wort	*						
Hypericum walterii	St. Johns-wort	*		*		*		
Ilex decidua	Possum-haw	*			*			*
Impatiens capensis	Spotted Jewel-weed	*						
Juncus biflorus	Turnflower Rush	*						
Juncus coriaceus	Leathery Rush	*						
Juncus effusus	Soft Rush	*	*					
Juncus repens	Creeping Rush	*						
Liriodendron tulipifera	Tulip Poplar	*						
Liquidambar styraciflua	Sweetgum	*						*
Ludwegia alternifolia	Bushy Seed-box	*						
Ludwegia palustris	Marsh Seed-box	*						
Ludwegia uraguayensis	Uragauy Seed-box	*	*					
Magnolia virginiana	Sweetbay	*						
Mikania scandens	Climbing Hempweed	*			*			
Osmunda cinnamomea	Cinnamon Fern	*						
Osmunda regalis	Royal Fern	*						
Pilea pumila	Clearweed	*						

Table 13 continued
Off-Site Reference Ecosystem (Herbaceous Layer)
Early Successional Floodplain Communities

Scientific Name	Common Name	Early successional	On-site Bear Creek	Cypress-Gum Swamp	Levee Forest	Interior Flat Forest	Backwater Levee Forest	Interior Hummock Forest
Pluchia foetida	Stinking Camphorweed	*						*
Polygonum cespitosum	Water-pepper	*						
Polygonum hydropiperoides	Swamp Smartweed	*						
Polygonum pensylvanicum	Smartweed	*					*	
Populus heterophylla	Swamp Cottonwood	*						
Ptilimnium capillaceum	Hair-like Mock Bishop-weed	*						
Quercus lyrata	Overcup Oak	*						
Quercus michauxii	Swamp Chestnut Oak	*						
Rhexia mariana	Maryland Meadow Beauty	*						
Rhyncospora spp.	Beakrush	*						
Rubus spp.	Blackberry	*	*					*
Sacciolepis striata	American cupscale	*						
Salix nigra	Black Willow	*						
Saururus cernuus	Lizard's Tail	*		*		*		*
Scirpus cyperinus	Wool-grass	*						
Scleria triglomerata	Whip Nutrush	*						
Scutellaria lateriflora	Skullcap	*						
Solidago spp.	Goldenrod	*	*					
Taxodium distichum	Bald Cypress	*					*	
Toxicodendron radicans	Poison Ivy	*	*			*		*
Typha latifolia	Horsetail	*						
Vernonia noveboracensis	American speedwell	*						
Viburnum nudum var. *nudum*	Southern Wild Raisin	*						
Lemna minor	Lesser Duckweed			*				
Boehmeria cylincrica	False nettle		*	*	*	*	*	*
Nyssa aqutica	Water Tupelo			*		*		
Vitis rotundifolia	Muscadine Grape				*	*		*
Smilax bona-nox	Saw Green-briar				*			*
Campsis radicans	Trumpet Creeper		*		*	*	*	*
Commelina virginica	Virginia Dayflower				*	*		*
Carya aquatica	Water Hickory				*			
Carex intumescens	Bladder Sedge					*		*
Dulichium arundinaceum	Three-way Sedge					*		*
Phytollacca decandra	American Phytolacca		*				*	*
Smilax rotundifolia	Common Greenbriar		*				*	*
Panicum sp.	Panic Grass		*				*	*
Carex dulichum	Sedge						*	
Carex grayi	Gray's Sedge						*	
Bignonia capreolata	Crossvine							*
Cynanchum angustifolium	Gulf coast Swallow-wort							*
Melothria pendula	Creeping Cucumber							*
Ulmus rubra	Slippery Elm							*
Trachelospermum difforme	Climbing Dogbane							*
Viola sp	Violet							*

4.4 REFERENCE PHYSIOGRAPHY AND SURFACE TOPOGRAPHY

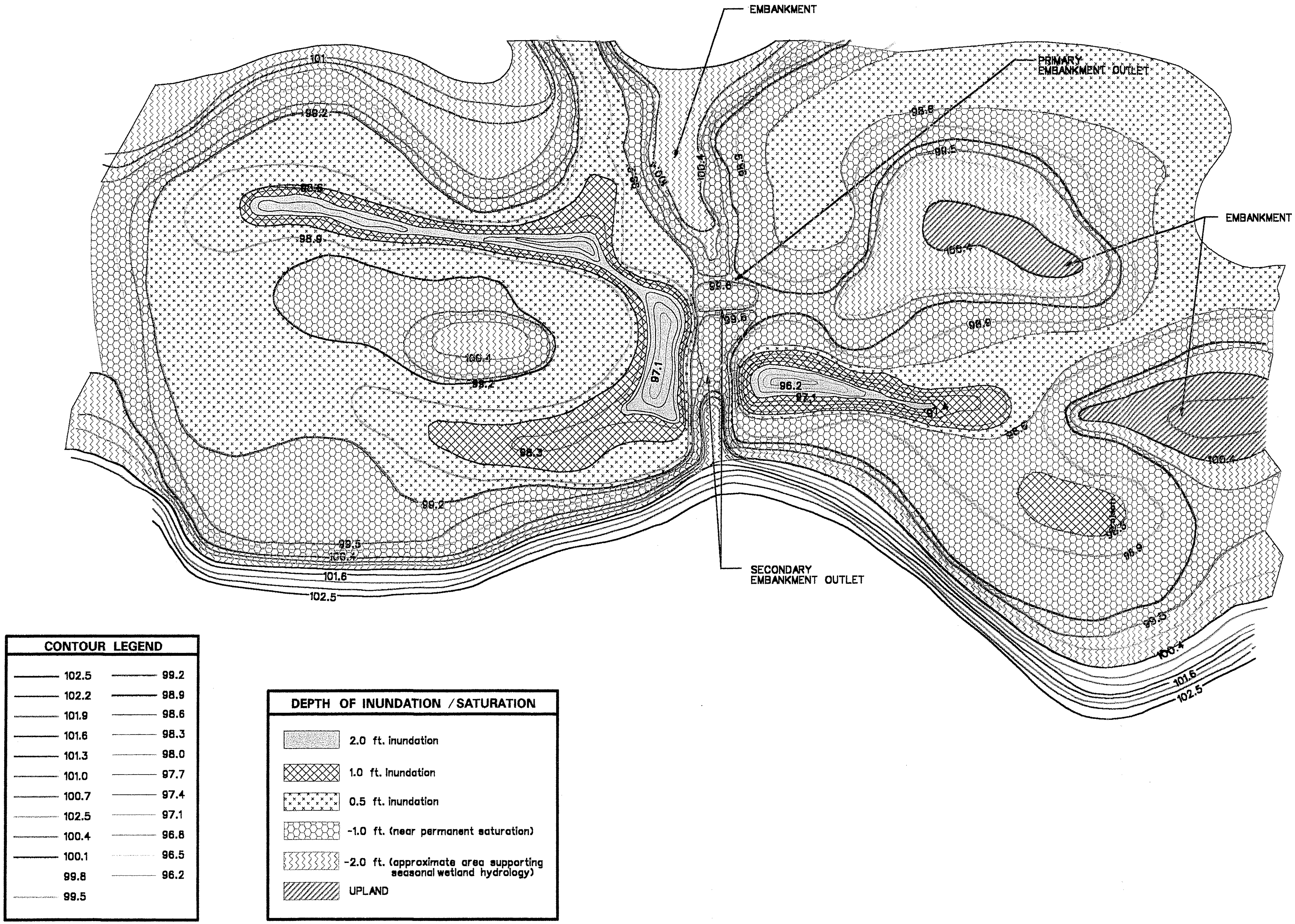
Surface features were mapped within the reference cypress-tupelo swamp in order to establish base-line topographic conditions for restoration planning use. This community lies within a near-permanently inundated area supported by swales, hummocks, and embankments within outer portions of the Neuse River floodplain. A small tributary flows into the backwater area from adjacent uplands and upper reaches of the river floodplain.

Topographic maps were prepared to 0.2-foot contour intervals by laser level and tape measure. Embankments, primary/secondary outlets, and jurisdictional wetland boundaries were measured relative to the water surface within the ponded area. Cross-sections and profiles were generated for the reference, embankments, outlets, and basin floor. The depth of inundation, slope of the basin floor, and embankment characteristics represent the primary features extrapolated to the mitigation site for restoration use.

Figure 13 provides a plan view of the cypress-tupelo swamp, including the depths of inundation present across the basin floor. Figure 14 and Figure 15 depict representative cross-sections and profiles of the basin floor and embankment.

A majority of the area resides under approximately 0.5 feet of water with depths of inundation ranging to over 2 feet immediately above and below the embankment (Figure 13). The embankment height (101 feet above MSL) averages approximately 3.5 feet above the basin floor (97.5 feet above MSL) and is elevated approximately 2 feet above the primary outlets and water surface (99.2 feet above MSL) (Figure 14). The slope of the basin floor averages 0.0084 rise/run.

Secondary outlets occur at intermittent locations along the embankment (Figure 15). These elevated, minor outlets function during peak tributary floods (Figure 15) and reduce flow velocities present at the larger, primary outlets. The area supports up to approximately 7 feet of inundation during river floods, as evidenced by Hurricane Floyd. The embankments and adjacent slopes support jurisdictional wetlands to elevations approximately 2 feet above the normal water surface. These reference basin characteristics have been utilized to orient restoration design of backwater, cypress-tupelo swamps, representing a carbon-copy method for wetland restoration on river floodplains (Section 5.0).

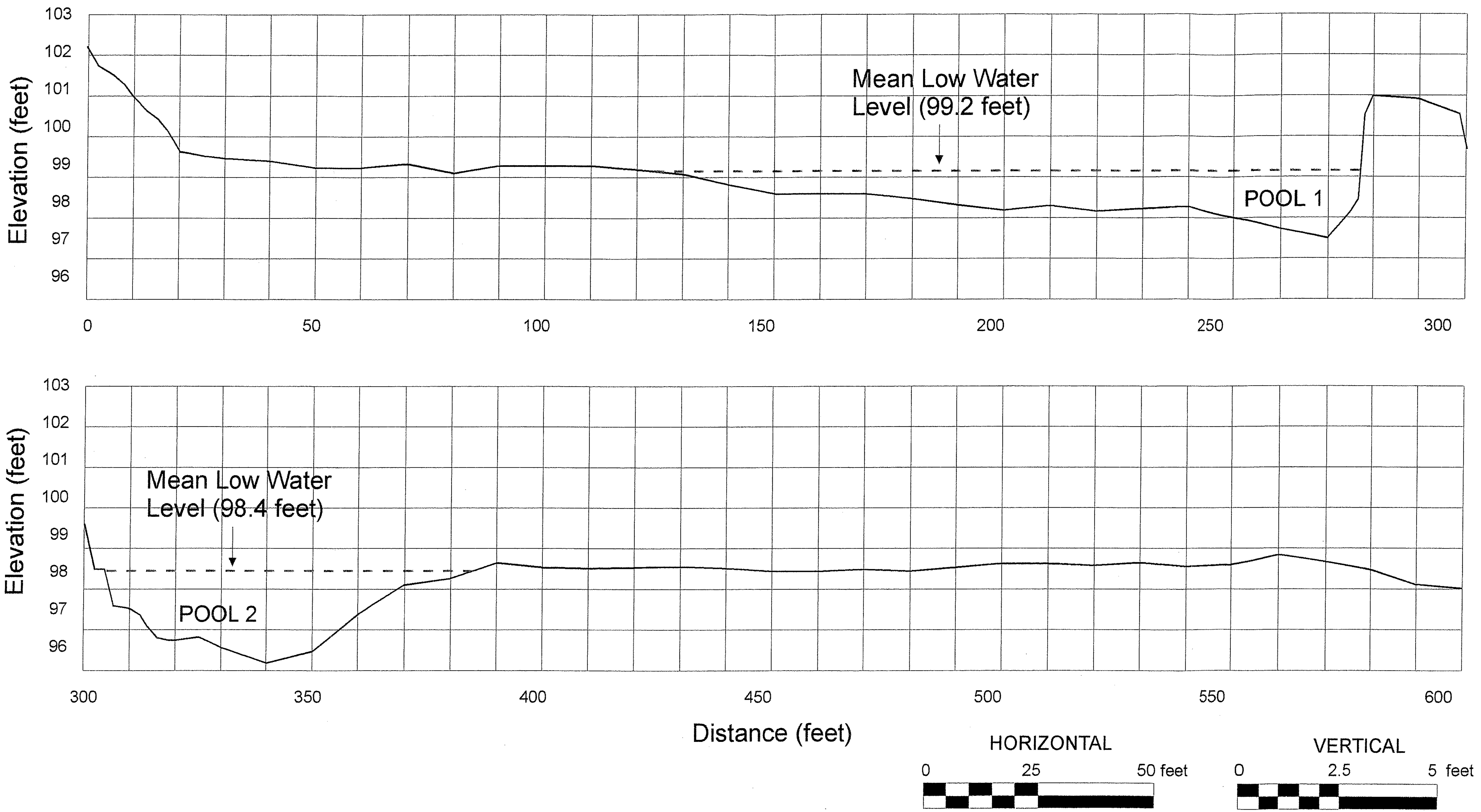


REFERENCE SITE: PLAN VIEW
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Dwn By: MAF	Date: AUG 1999
Ckd By: JWN	Scale: 1"= 50'
ESC Project No.: 99-016	
Figure	13

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

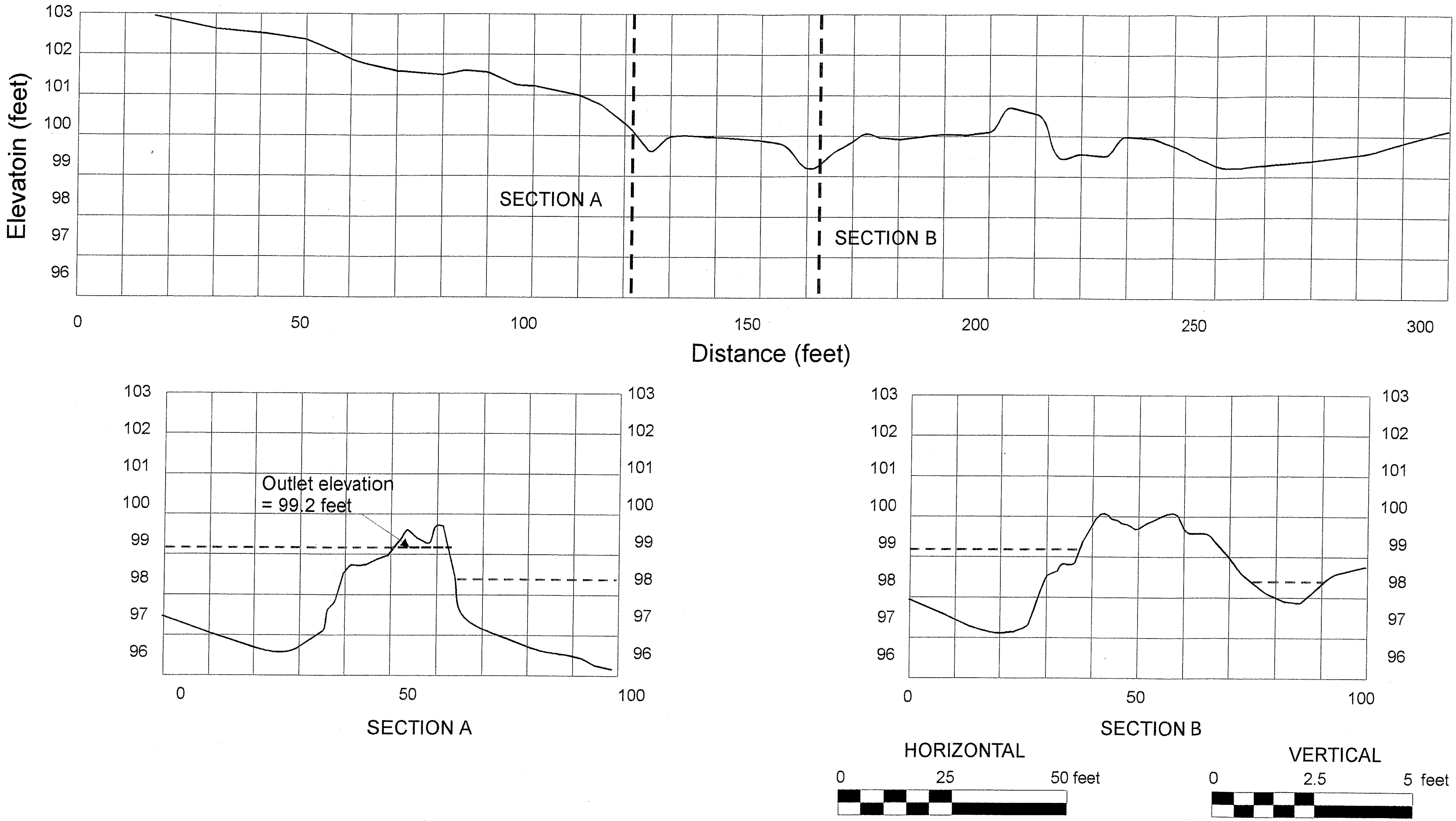
EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919.828.3433
Fax: 919.828.3518



EcoScience Corporation
612 Wade Ave., Suite 200
Raleigh, North Carolina 27605 919 828-3433

REFERENCE SITE: PROFILE OF BASIN FLOOR
BEAR CREEK - MILL BRANCH MITIGATION SITE
LENOIR COUNTY, NORTH CAROLINA

Figure:	14
Project:	99-016
Date:	August 1999



EcoScience Corporation
612 Wade Ave., Suite 200
Raleigh, North Carolina 27605
919 828-3433

Profile of Reference Embankment
BEAR CREEK MITIGATION SITE
Lenoir County, North Carolina

Figure:	15
Project:	99-016
Date:	August 1999

5.0 WETLAND RESTORATION PLAN

This restoration plan has been developed according to specifications outlined in the COE/EPA mitigation banking guidelines (60 FR 12286-12293, 1995) and N.C. Division of Water Quality's wetland mitigation policy (Administrative Code for 401 Water Quality Certification; Section: 15A NCAC 2H.0500). Specifically, this mitigation proposal will provide for the replacement of wetland acres lost due to a proposed activity at a minimum of a 1:1 ratio, through restoration, prior to utilizing enhancement or preservation to satisfy the mitigation requirements. In addition, mitigation has been designed to provide for replacement of similar riverine wetlands, including bottomland hardwood and swamp forests.

5.1 WETLAND HYDROLOGY AND SOIL RESTORATION

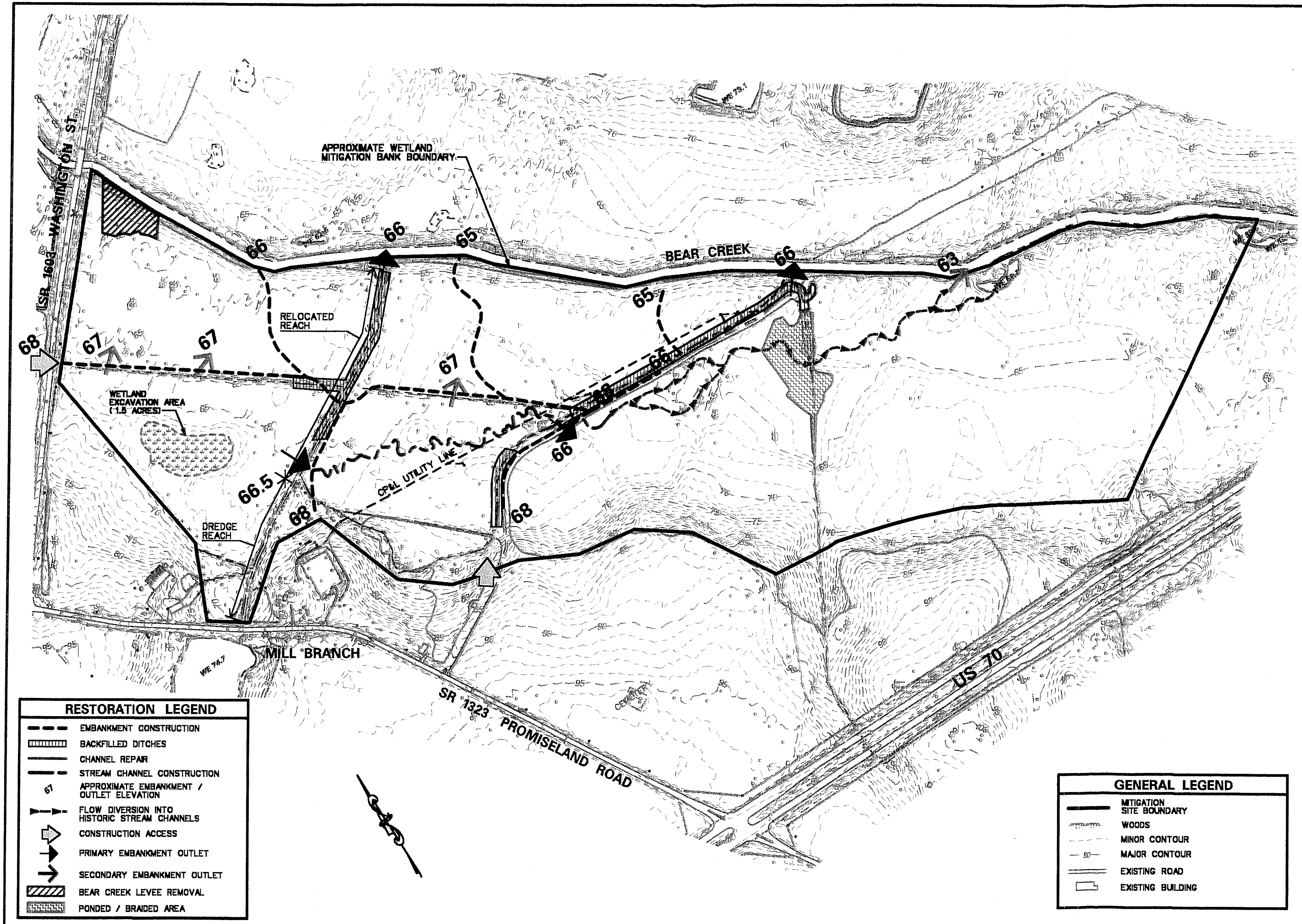
Site alterations to restore groundwater, surface flow dynamics, and wetland hydrology include: 1) ditch backfilling; 2) ditch outlet plugs; 3) river levee removal; 4) embankment construction; 5) Mill Branch channel repair; 6) wetland surface scarification; 7) seasonal pool construction; and 8) woody debris deposition (Figure 16).

5.1.1 Ditch Backfilling

Ditches will be back-filled using on-site earthen material from road fill, spoil ridges adjacent to canals, constructed depressions, and the Excavated Area depicted in Figure 16. Additional fill will be obtained from the river levee as needed. Where vegetation has colonized the spoil ridges, trees and rooting debris will be removed, to the maximum extent feasible, before re-insertion of earthen fill into the canal. The ditches/canals will be filled, compacted, and graded to the approximate elevation of the adjacent wetland surface. Certain, non-critical ditch sections may remain open to provide flood storage and energy dissipation, dependent upon the availability of on-site fill material. Open ditch sections will be isolated between effectively backfilled reaches to reduce potential for long term, preferential groundwater migration.

5.1.2 Ditch Outlet Plugs

The ditch outlets into Bear Creek will be effectively plugged to prevent migration of flows back into the former ditch, and directly into the river (Figure 16). The ditch plugs will be constructed at two locations: 1) the former ditch outlet transporting flows from Mill Branch; and 2) the ditch outfall supporting the two unnamed tributaries. The plugs will represent low density material or permanent, hardened structures designed to withstand erosive forces associated with river floods. If earthen material is used, each plug will backfilled in 2-ft lifts of vegetation free material and compacted into the bottom of the ditch. The earthen material may be obtained from adjacent levee sections and/ or through construction of shallow wetland pools within the primary floodplain. The top of the plugs will extend to a minimum 67 feet above MSL to prevent overtopping by periodic flood flows.



Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

Project: REVISED HYDROLOGY RESTORATION PLAN
BEAR CREEK – MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Dwn By: MAF	Date: JUNE 2000		Figure
Ckd By: JWN	Scale: 1"= 400'		16
ESC Project No.: 99-016			

EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919.828.3433
Fax: 919.828.3518

These terminal plugs at the ditch outfalls will represent relatively large, near permanent structures spanning the excavated canal and tying into the existing levee above and below the structure. Erosive flows will be experienced on the Bear Creek side of plugs. In addition, hydraulic head may be experienced against the interior face of the unnamed tributary plug. Therefore, structural support will be placed on the face, such as crushed rock or gabions. The stabilized outfall plugs will allow diversion of Mill Branch and the unnamed tributaries into historic stream channels and migration of stream flows through approximately 3000 linear feet of restored, forested wetlands on the Site.

5.1.3 River Levee Removal

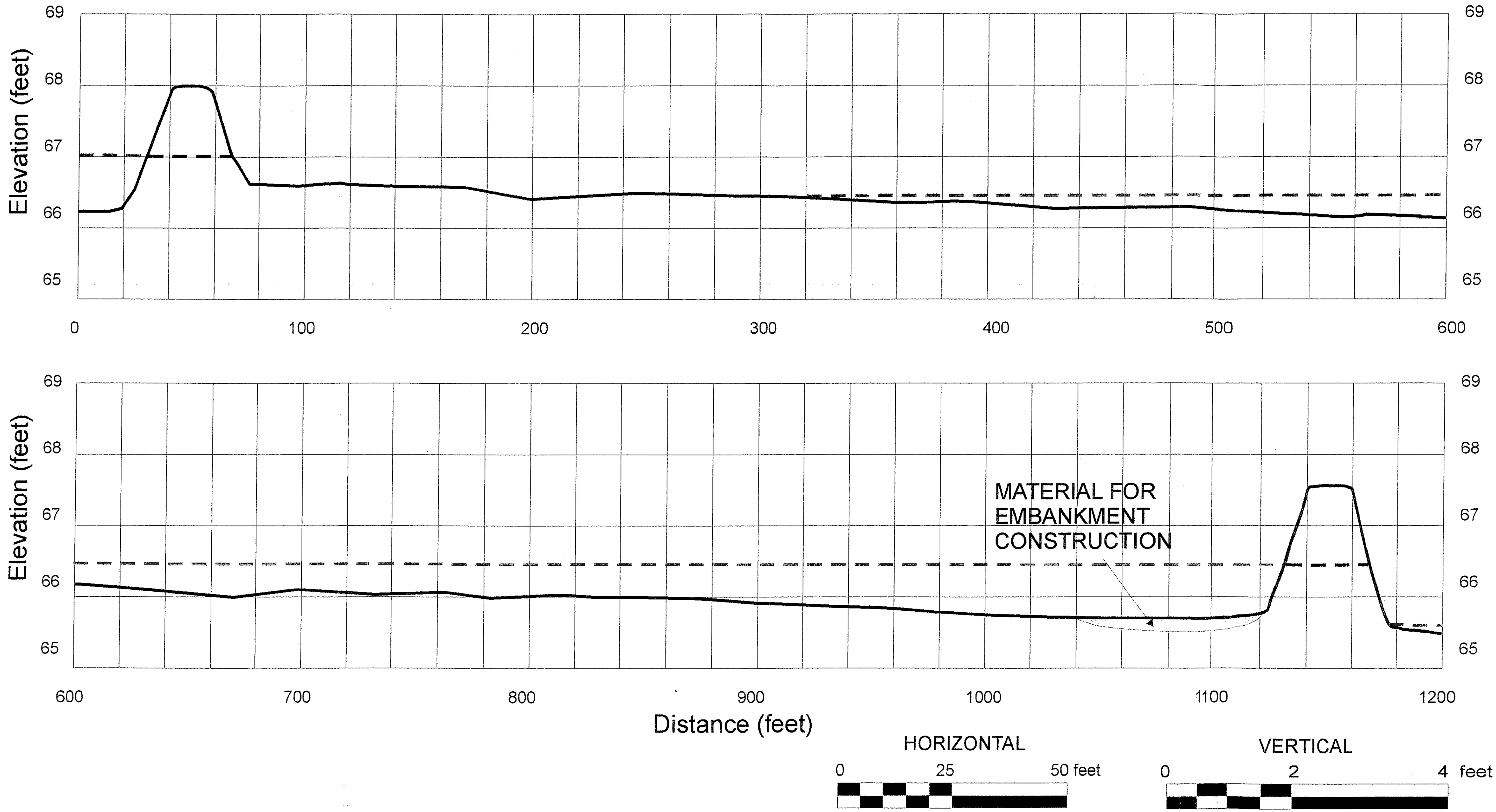
The Bear Creek levee will be lowered to approximately 65 feet above MSL along a section immediately below SR 1603 (Figure 16). The lowered section will extend for a minimum of 200 feet; additional length may be removed if on-site fill is needed. Based on flood studies, lowering of the levee to 65 feet above MSL will allow flood flows from Bear Creek to enter the Site at a 5-year return interval. However, the FEMA, 100-year flood boundaries will not be affected because the existing levee is overtopped during the 100-year storm.

5.1.4 Embankment Construction

Embankments will be constructed within agricultural lands in northeastern reaches of the Site (Figure 16). The embankments will serve to: 1) establish a backwater cypress tupelo swamp; 2) provide a perennial source for groundwater recharge; 3) allow diversion of Mill Branch back into the historic stream channel; and 4) facilitate nutrient reduction goals in the Neuse River basin (Section 3.5). The embankments will be constructed to mimic backwater embankment features measured in the reference wetlands (Section 4.4). Figure 17 and Figure 18 provide representative cross-sections and profiles of the primary basin and embankment.

The primary embankment extends from northwest to southeast, between the primary and secondary floodplain areas. The embankment will extend for approximately 2000 linear feet and average approximately 68 feet above MSL along contiguous sections. The top of the embankment will rise, on average, 2 to 3 feet above the existing soil surface and will remain saturated by adjacent inundation. A series of secondary outlets will be constructed through the embankment towards the primary floodplain. The primary outlet will be directed into the historic Mill Branch channel, with the outlet elevation (and resultant water surface) fixed at approximately 66 feet above MSL.

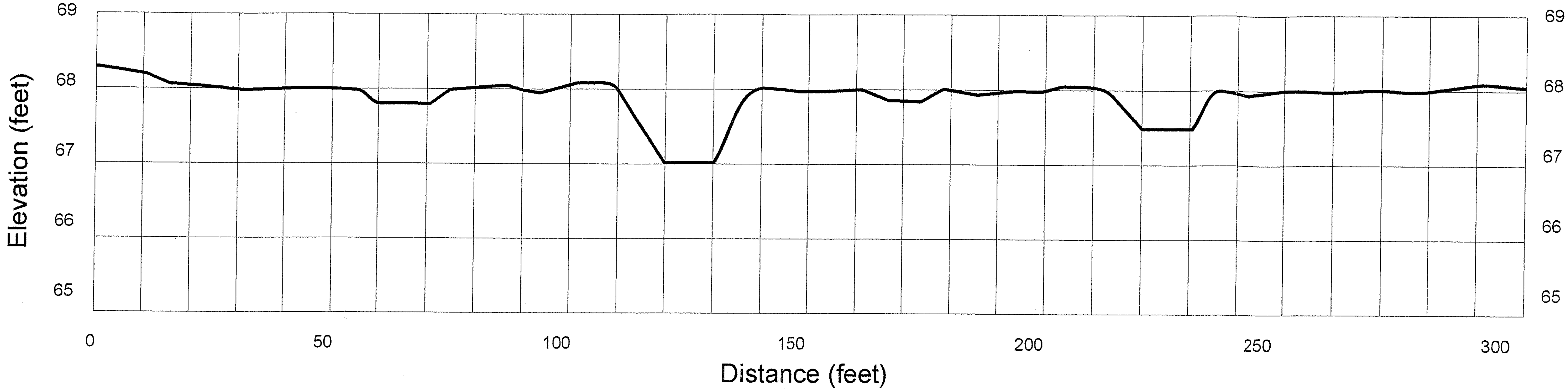
A series of three secondary embankments will be constructed across the primary floodplain to provide flood storage and energy dissipation functions. These embankments range from 1 to 2 feet above the floodplain surface and function primarily to reduce storm runoff during early stages of wetland development.

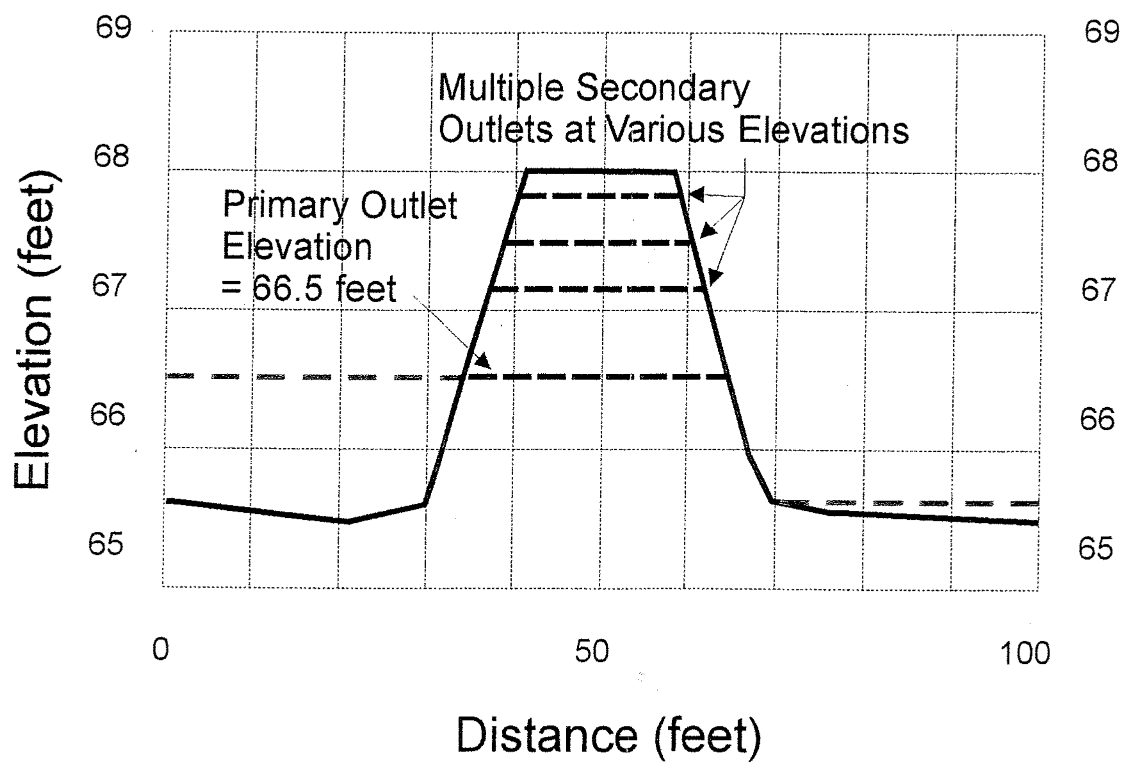


EcoScience Corporation
612 Wade Ave., Suite 200
Raleigh, North Carolina 27605
919 828-3433

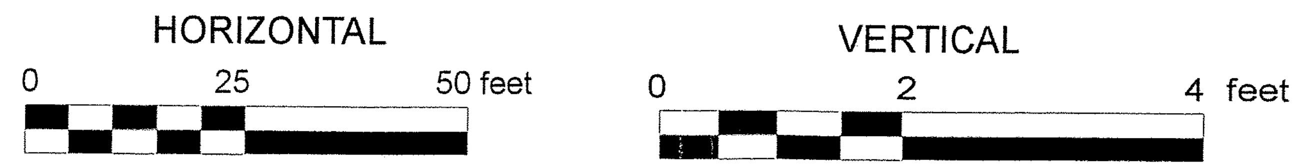
RESTORATION SITE: TYPICAL PROFILE AND CROSS-SECTION OF BASIN FLOOR
BEAR CREEK - MILL BRANCH MITIGATION SITE
LENOIR COUNTY, NORTH CAROLINA

Figure:	17
Project:	99-016
Date:	August 1999





THIS IS A SCHEMATIC REPRESENTATION OF THE CONSTRUCTED BASINS. DISTANCES AND ELEVATIONS ARE APPROXIMATE AND SHALL BE VERIFIED IN THE FIELD IN ACCORDANCE WITH DETAILED ENGINEERING PLANS.



EcoScience Corporation
612 Wade Ave., Suite 200
Raleigh, North Carolina 27605 919 828-3433

RESTORATION SITE: TYPICAL PROFILE AND CROSS-SECTION OF EMBANKMENTS
BEAR CREEK - MILL BRANCH MITIGATION SITE
LENOIR COUNTY, NORTH CAROLINA

Figure:	18
Project:	99-016
Date:	August 1999

The embankments will be constructed by pushing earthen material from backwater areas and compacting the material as a broad, 10- to 20-foot wide hummock (Figure 17). The outlets may be temporarily stabilized with woody debris or coarse rock material placed immediately above and below the structure. However, these low-lying embankments do not represent permanent structures. After successional vegetation colonizes the Site and reforestation is underway, sediment deposition patterns, debris accumulation, alternative flow pathways, and natural adjustments will be allowed to develop within the bottomland ecosystem, effectively replacing the embankment structures with natural backwater features. The embankments will be constructed to persist until forest cover and surface topography is established. The objective in early years is to reduce normal stream flow velocities near 0 feet per second in backwater areas and allowing micro- and macro-topography to develop over time in abandoned farm fields.

5.1.5 Mill Branch Channel Repair

At the Site confluence, Mill Branch will flow into the constructed backwater slough described above, similar to reference wetland conditions measured in the region. The backwater flow will be directed to the southeast, along the outer edge of the Bear Creek floodplain. Subsequently, Mill Branch flows will be discharged into the historic stream channel that remains in forested portions of the Site.

In the forested area, the channel will be allowed to re-develop primarily through passive processes. Braiding, ponding, and anastomosed conditions will occur, similar to reference streams in the region. Reference streams often exhibit braided (alluvial fan), backwater, or anastomosed features at the confluence with large river floodplains.

The relict channels have partially to completely filled in with organic debris, logging material, fallen trees, and dense shrub thickets. In addition, old road beds and logging trails cross the relict channel at several locations. After flow diversion, modifications to channel sections may include systematic hand clearing of logging debris, tree jams, and other significant impediments to stream flow. No mechanized land clearing or excavation should be performed at the current time. Re-introduced peak flows are expected to passively clean out organic debris and to re-establish in-stream aquatic habitat. However, the stream should be monitored periodically to evaluate hydraulic changes and stream improvements may be performed to enhance riffle/pool habitat over time.

Mechanized stream improvements will only occur if stream hydrodynamics are superseded by relatively deep, impounded pools of standing water that threaten to eliminate the floodplain forest canopy. If needed, future alterations to promote stream flows will include: 1) removal of incidental fill associated with former road beds; 2) grading along relict skid trails; and/or 3) removal of large debris jams or soil ridges associated with antecedent land uses. If beaver activity ensues, loss of the forest canopy will be allowed as part of natural wetland processes at the Site.

This method for stream restoration avoids substantial clearing in forested wetland areas. Passive stream restoration will provide greater nutrient reduction than active channel construction and direct connectivity to Bear Creek. However, riffle and pool (in-stream) habitat will occur within relict channel segments throughout the forested area. The outlet for Mill Branch will be established approximately 3000 feet down-valley from the existing outfall, providing much greater length for the establishment and maintenance of in-stream aquatic habitat relative to existing conditions.

5.1.6 Wetland Surface Scarification.

Before wetland community restoration is implemented, agricultural fields and graded back-fill material on the primary floodplain will be scarified. The scarification will be performed as linear bands directed perpendicular to land slope (surface water flows). After scarification, the soil surface should exhibit complex microtopography ranging to 1 feet in vertical asymmetry across local reaches of the landscape. Restored microtopographic relief is considered critical to short term hydrology restoration efforts. Therefore, multiple passes along each band is recommended to ensure adequate surface roughing and surface water storage potential across the Site. Subsequently, community restoration will be initiated on scarified wetland surfaces.

5.1.7 Seasonal Pool Construction

Seasonal pools will be constructed in the primary floodplain if additional fill material is needed for the above described tasks. The pools will be constructed by excavating shallow, irregularly shaped (oblong) depressions placed perpendicular to land slope. The depressions will range to a maximum of one foot below the existing surface elevation in the center of the depression. The depressional area will extend over a radius of 10 to 100 feet (long axis). The location and attributes of oval depressions will be constructed to mimic oxbows and other depressional features found in the reference wetlands.

5.1.8 Woody Debris Deposition

Woody debris cleared during restoration activities or located in adjacent areas should be placed on restored wetland surfaces to the maximum extent practicable. The absence of large woody debris represents a limiting factor in the establishment of habitat diversity, nutrient cycling (soil microbial) functions, and energy dissipation on abandoned farmland (Brinson et al. 1995). Woody debris jams may also be used as temporary stabilization structures located through embankment outlets.

5.2 WETLAND COMMUNITY RESTORATION

Restoration of wetland forested communities provides habitat for area wildlife and allows for development and expansion of characteristic wetland dependent species across the landscape. Ecotonal changes between community types contribute to diversity and provide secondary benefits, such as enhanced feeding and nesting opportunities for mammals, birds, amphibians, and other wildlife.

RFE data, on-site observations, and ecosystem classification has been used to develop the species associations promoted during community restoration activities. Target Community associations include: 1) levee forest; 2) bottomland hardwood forest; 3) riverine swamp forest/cypress-gum swamp; and 4) mesic hardwood forest. Figure 19 provides a conceptual depiction of potential forest communities to be restored across the landscape. Figure 20 identifies the location of each target community on the Site.

Emphasis has been focused on developing a diverse plant assemblage. This is particularly vital due to the limited distribution of mast-producing hardwood tree species presently existing in the vicinity, as evidenced during the RFE search. Planting a variety of mast-producing species will provide a food source for wildlife and will facilitate habitat diversity in a region dominated by agriculture fields.

The restoration of upland forest communities has also been proposed. Upland forest restoration plans are designed to enhance wetland functions and to restore a wetland/upland forest ecotone that is considered rare in the region. The target forest community is composed primarily of upland oaks and hickories, among intermittent stems of blackgum, American beech, and tulip poplar. For upland restoration areas, the forest restoration can be modified to allow for maintenance of food plots or other wildlife management features.

5.2.1 Planting Plan

The planting plan is designed to reestablish wetland community patterns across the landscape. The plan consists of: 1) acquisition of available wetland species; 2) implementation of proposed surface topography improvements; and 3) planting of selected species on-site. The COE bottomland hardwood forest mitigation guidelines (DOA 1993) were utilized in developing this plan.

Species selected for planting will be dependent upon availability of local seedling sources. Advanced notification to nurseries (1 year) may facilitate availability of various non-commercial species. Planted species names by community are listed below.

Levee Forest

1. Black Willow (*Salix nigra*)
2. River Birch (*Betula nigra*)
3. American Sycamore (*Platanus occidentalis*)
4. Green Ash (*Fraxinus pennsylvanica*)
5. Ironwood (*Carpinus caroliniana*)
6. Possum-haw (*Ilex deciduous*)
7. American Elm (*Ulmus americana*)
8. Willow Oak (*Quercus phellos*)
9. Tulip Poplar (*Liriodendron tulipifera*)

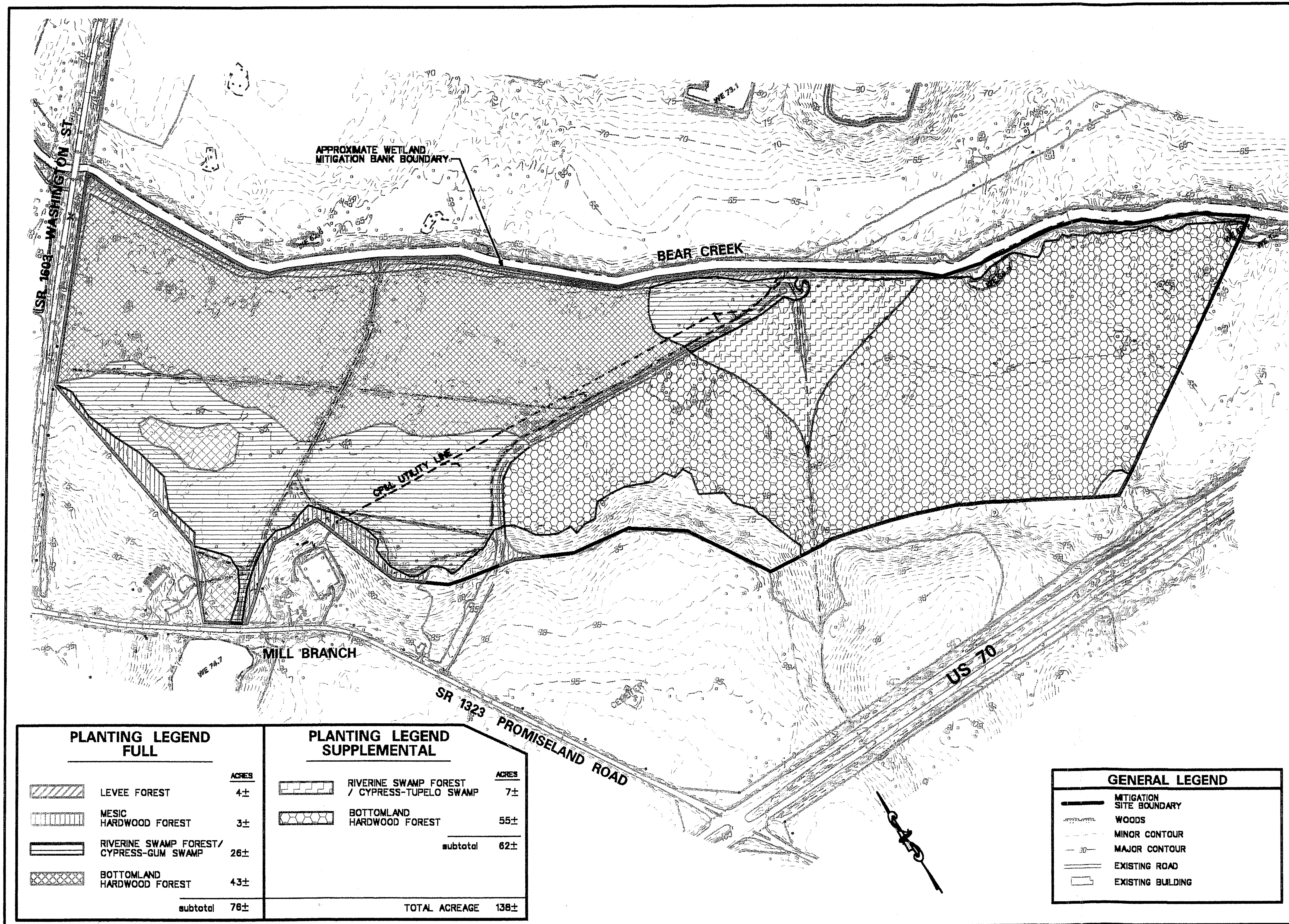
COMMUNITY ASSEMBLAGE (Schafale and Weakley 1990)	COASTAL PLAIN LEVEE FOREST	COASTAL PLAIN BOTTOMLAND HARDWOOD	RIVERINE SWAMP FOREST (Blackwater Subtype)	CYPRESS-GUM SWAMP (Backswamp Variant)	MESIC HARDWOOD FOREST (Coastal Plain Subtype)
DIAGNOSTIC VEGETATION	Red Maple River Birch American Sycamore Ironwood American Elm Green Ash Swamp Cottonwood Muscadine Grape	Cherrybark Oak Laurel Oak Overcup Oak Willow Oak Water Oak Swamp Tupelo Green Ash American Elm Sweetgum Deciduous Holly	Bald Cypress Swamp Tupelo Swamp Cottonwood Green Ash Water Hickory Tulip Poplar Overcup Oak	Water Tupelo Bald Cypress Carolina Ash Lizard Tail Three-way Sedge	Tulip Poplar American Beech Southern Red Oak White Oak Shagbark Hickory Dogwood Horse Sugar Beautyberry

LAND FORM	Natural Levee/ Blackwater Stream	Primary Floodplain	Secondary Floodplain	Backwater Slough	Mesic Upland Slope
SOILS	Chewacla/Bibb	Bibb/Johnston	Pamlico/Johnston	Pamlico/Johnston	Wagram
	Somewhat Poorly to Poorly Drained	Poorly to Very Poorly Drained	Very Poorly Drained	Very Poorly Drained	Well Drained

EcoScience Corporation
612 Wade Ave., Suite 200
Raleigh, North Carolina 27605 919 828-3433

TARGET LANDSCAPE ECOSYSTEM
BEAR CREEK MITIGATION SITE
LENOIR COUNTY, NORTH CAROLINA

Figure:	19
Project:	99-016
Date:	August 1999



PLANTING LEGEND FULL

	ACRES
LEVEE FOREST	4±
MESIC HARDWOOD FOREST	3±
RIVERINE SWAMP FOREST/ CYPRESS-GUM SWAMP	26±
BOTTOMLAND HARDWOOD FOREST	43±
subtotal	76±

PLANTING LEGEND SUPPLEMENTAL

	ACRES
RIVERINE SWAMP FOREST / CYPRESS-TUPELO SWAMP	7±
BOTTOMLAND HARDWOOD FOREST	55±
subtotal	62±
TOTAL ACREAGE	138±

Figure 20

Drn By MAF | Date AUG 1999
Ckd By JWN | Scale 1"= 400'
ESC Project No. 99-016

Project: PLANTING PLAN BEAR CREEK - MILL BRANCH WETLAND RESTORATION SITE LENOIR COUNTY, NORTH CAROLINA

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919 828 3433
Fax: 919 828 3518

Bottomland Hardwood Forest

1. Swamp Tupelo (*Nyssa biflora*)
2. Cherrybark Oak (*Quercus pagoda*)
3. Laurel Oak (*Quercus laurifolia*)
4. Overcup Oak (*Quercus lyrata*)
5. Willow Oak (*Quercus phellos*)
6. Swamp Chestnut Oak (*Quercus michauxii*)
7. Water Oak (*Quercus nigra)*
8. Water Hickory (*Carya aquatica*)
9. Green Ash (*Fraxinus pennsylvanica*)
10. American Elm (*Ulmus americana*)
11. Bald Cypress (*Taxodium distichum*)
12. Tulip Poplar (*Liriodendron tulipifera*) (Coastal Plain variant)

Riverine Swamp Forest/Cypress-Gum Swamp

1. Water Tupelo (*Nyssa aquatica*)
2. Bald Cypress (*Taxodium distichum*)
3. Atlantic White Cedar (*Chamaecyparis thyoides*)
4. Button-bush (*Cephalanthus occidentalis*)
5. Swamp Tupelo (*Nyssa biflora*)
6. Swamp Cottonwood (*Populus heterophylla*)
7. Carolina Ash (*Fraxinus caroliniana*)
8. Overcup Oak (*Quercus lyrata*)
9. Laurel Oak (*Quercus laurifolia*)
10. Water Hickory (*Carya aquatica*)

Tree establishment within swamp forest communities may be complicated by shallow inundation in low-lying areas. The stems of planted seedling must elevate the leaf area above the level of inundation, ranging from 0.5 to 2 feet above the soil surface.

Mesic Mixed Hardwood Forest

1. Tulip Poplar (*Liriodendron tulipifera*)
2. White Oak (*Quercus alba*)
3. Southern Red Oak (*Quercus falcata*)
4. American Beech (*Fagus grandifolia*)
5. Northern Red Oak (Quercus rubra)
6. Pignut Hickory (*Carya glabra*)
7. Mockernut Hickory (*Carya tomentosa*)
8. Blackgum (*Nyssa sylvatica*)
9. Cherrybark Oak (*Quercus pagoda*)
10. Ironwood (*Carpinus caroliniana*)

Two levels of planting will be used, Full and Supplemental. Full planting will occur in the abandoned farm fields, currently void of any trees. Bare-root seedlings of tree species will be planted within specified areas at a density of 435 stems per acre (10-ft centers). Supplemental planting will occur in existing forested areas to ameliorate species deficiencies. Bare-root seedlings of tree species will be planted in tree gaps at a density of 70 stems per acre. The total number of stems and species distribution within each planting association is shown in Table 14.

Planting will be performed between December 1 and March 15 to allow plants to stabilize during the dormant period and set root during the spring season. Opportunistic species, which typically dominate early- to mid-successional forests, have been excluded from initial plantings on interior floodplains. Opportunistic species such as sweet gum, red maple, loblolly pine, and black willow may become established. However, to the degree that long term species diversity is not jeopardized, these species should be considered important components of steady-state forest communities. Planted stems of black willow, ironwood, and possum haw will be placed on ditch outlet plugs for stabilization purposes.

The planting plan is the blueprint for community restoration. The anticipated results stated in the regulatory success criteria (Section 7.0) may reflect vegetative conditions achieved after steady-state forests are established over many years. However, the natural progression through early successional stages of floodplain forest development will prevail regardless of human interventions over a 5-year monitoring period.

<u>TABLE 14</u>

Planting Plan
Bear Creek-Mill Branch Mitigation Site

Vegetation Association (Planting area)	Levee Forest	Bottomland Hardwood Forest	Bottomland Hardwood Forest	Riverine/C-G Swamp Forest	Riverine/C-G Swamp Forest	Mesic Hardwood Forest	TOTAL STEMS PLANTED
Stem Target Area (acres [ac])	435/ac[2] 4 ac	435/ac 43 ac	70/ac 55 ac	435/ac 26 ac	70/ac 7 ac	435/ac 3 ac	138 ac
SPECIES	# planted (% total)	# planted (% total)	# planted (% total)	# planted (% total)	# planted (% total)	# planted (% total)	# planted (% total)
Black Willow	90 (5)						90
Ironwood	90 (5)						90
Possum-haw	90 (5)						90
River Birch	350 (20)						350
American Sycamore	350 (20)						350
American Elm	170 (10)	940 (5)					1110
Green Ash	260 (15)	940 (5)					1200
Willow Oak	170 (10)	1870 (10)	390 (10)			130 (10)	2560
Tulip Poplar	170 (10)	940 (5)				70 (5)	1180
Swamp Tupelo		1870 (10)	390 (10)	2260 (20)	50 (10)		4570
Cherrybark Oak		1870 (10)	390 (10)			130 (10)	2390
Laurel Oak		1870 (10)	580 (15)	1130 (10)	70 (15)	70 (5)	3720
Overcup Oak		1870 (10)	770 (20)	1130 (10)	70 (15)		3840
Swamp Chestnut Oak		1870 (10)	390 (10)				2260
Water Oak		1870 (10)					1870
Water Hickory		940 (5)	190 (5)	570 (5)	20 (5)		1720
Bald Cypress		1870 (10)	770 (20)	2260 (20)	100 (20)		5000
Water Tupelo				2260 (20)	100 (20)		2360
Atlantic White Cedar				1130 (10)	70 (15)		1200
Swamp Cottonwood				570 (5)			570
White Oak						200 (15)	200
Southern Red Oak						200 (15)	200
American Beech						200 (15)	200
Northern Red Oak						130 (10)	130
Pignut/Mockernut Hickory						130 (10)	130
Blackgum						70 (5)	70
TOTAL	1740	18720	3870	11310	480	1330	37450

1: Some non-commercial elements may not be locally available at the time of planting. The stem count for unavailable species should be distributed among other target elements based on the percent (%) distribution. One year of advance notice to forest nurseries will promote availability of some non-commercial elements. However, reproductive failure in the nursery may occur.

2: Scientific names for each species, required for nursery inventory, are listed in the mitigation plan.

3: Vegetation associations targeted for 70 stems/acre are supplemental planting areas. Vegetation associations targeted for 435 stems/acre are full planting areas.

6.0 MONITORING PLAN

The Monitoring Plan consists of a comparison between reference and restoration areas along with evaluation of jurisdictional wetland criteria (DOA 1987). Monitoring will entail analysis of three primary parameters: hydrology, soil, and vegetation. Monitoring of restoration efforts will be performed for 5 years or until success criteria are fulfilled.

6.1 HYDROLOGY

After hydrological modifications are being performed, surficial monitoring wells will be designed and placed in accordance with specifications in U.S. Corps of Engineers', Installing Monitoring Wells/Piezometers in Wetlands (WRP Technical Note HY-IA-3.1, August 1993). Monitoring wells will be set to a depth of approximately 24 inches below the soil surface. All screened portions of the well will be buried in a sand screen, filter fabric, and/or a bentonite cap to prevent siltation during floods. Recording devices will be placed above the projected flood elevation (approximately 67 feet above MSL) The well will be stabilized from flood shear by reinforcing steel bar (re-bar).

Ten monitoring wells will be installed in restoration areas to provide representative coverage within each of the quadrants (physiographic landscape areas) depicted in Figure 21. In addition, three monitoring wells will also be placed in reference areas in similar landscape positions.

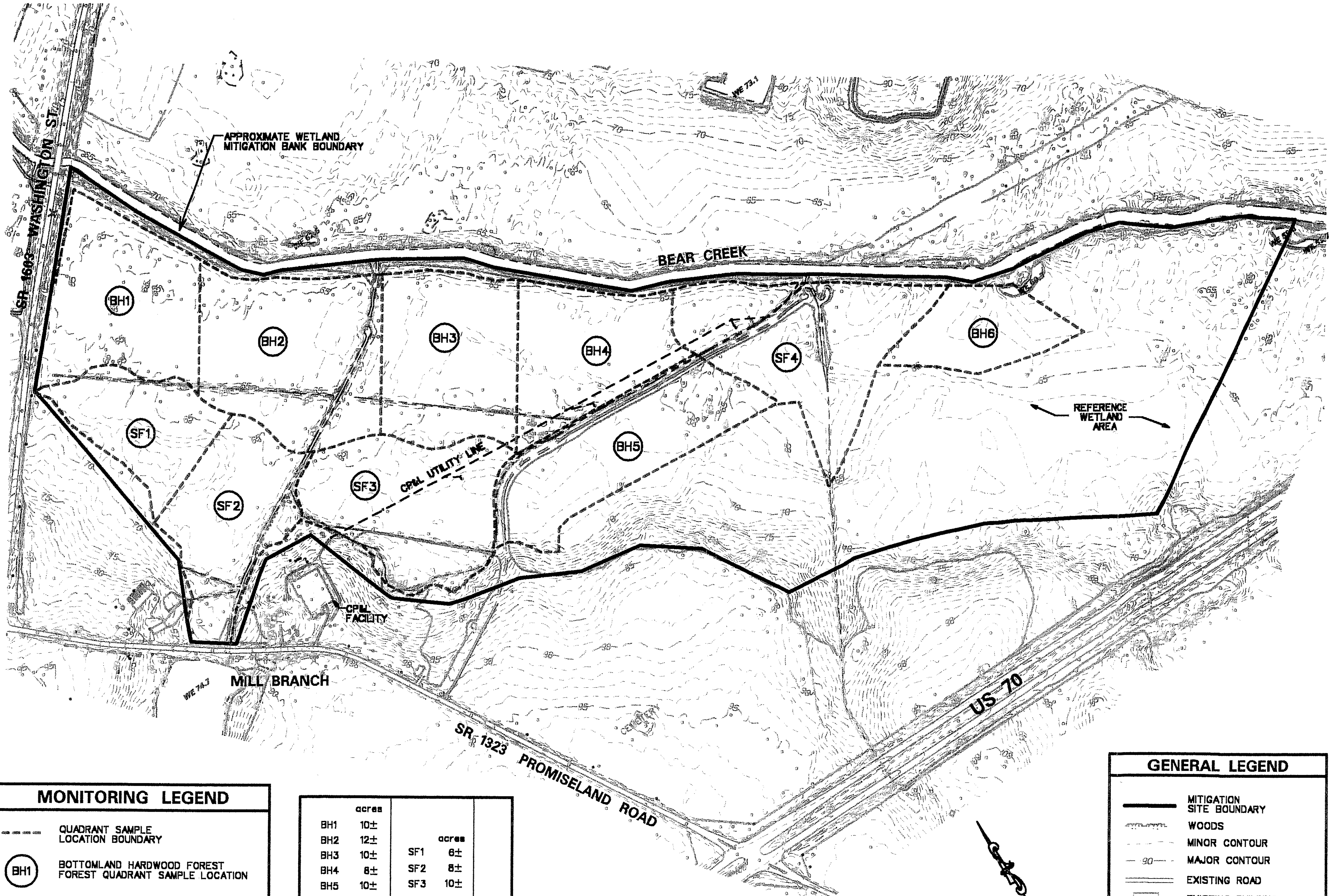
Hydrological sampling will be performed in restoration and reference areas during the growing season (25 February to 29 November) at intervals necessary to satisfy the hydrology success criteria within the designated quadrant (Figure 21). In general, the wells will be sampled weekly through the Spring and early Summer and intermittently through the remainder of the growing season, if needed to verify success.

6.2 HYDROLOGY SUCCESS CRITERIA

Target hydrological characteristics have been evaluated using a potential combination of three different methods: 1) regulatory wetland hydrology criteria; 2) reference groundwater modeling; and 3) reference wetland sites.

Regulatory Wetland Hydrology Criteria

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



MONITORING LEGEND

- QUADRANT SAMPLE LOCATION BOUNDARY
- (BH1) BOTTOMLAND HARDWOOD FOREST FOREST QUADRANT SAMPLE LOCATION
- (SF1) RIVERINE SWAMP FOREST / CYPRESS-TUPELO SWAMP QUADRANT SAMPLE LOCATION

	acres		acres	total acres
BH1	10±			
BH2	12±			
BH3	10±	SF1	6±	
BH4	8±	SF2	8±	
BH5	10±	SF3	10±	
BH6	5±	SF4	11±	
subtotals	55±		35±	90±

GENERAL LEGEND

- MITIGATION SITE BOUNDARY
- WOODS
- MINOR CONTOUR
- MAJOR CONTOUR
- EXISTING ROAD
- EXISTING BUILDING

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

Project: MONITORING PLAN
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Dwn By:	Date:	Figure
MAF	AUG 1999	21
Ckd By:	Scale:	
JWN	1" = 400'	

ESC Project No.: 99-016

EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919 828 3433
Fax: 919 828 3518

Reference Groundwater Model

The reference groundwater model forecasts that the wetland hydroperiod in interior areas of the Site will average 22% of the growing season in early successional phases. As steady state forest conditions develop, the average wetland hydroperiod is forecast to encompass 32% of the growing season. Over the 31 year modeling period, the annual hydroperiod fluctuated from less than 12.5% to over 36% dependent upon rainfall patterns and successional phase. In addition, the on-site landscape includes diverse wetland geomorphology, especially near uplands and the stream channel, which are not characterized by the model.

Due to wide fluctuations in modeled annual hydroperiod (<12-36+%), the groundwater model cannot provide a specific hydrology success criteria above the regulatory criterion (12.5%) on an annual basis. A specific success criteria such as a 22% target hydroperiod will fail in 50% of the years sampled. A success criteria of 12.5% (the regulatory criteria) will also fail in 10% of the years sampled in reference wetlands (4 out of 38 years).

Reference Wetland Sites

Three monitoring wells will be placed in the reference wetland area depicted in Figure 21. These wells will provide reference hydroperiods for the primary floodplain (bottomland hardwood) physiographic area. Wells may also be placed in backwater sloughs located in off-site wetland preservation areas described in Section 8.0.

Success Criteria

Target hydrological characteristics include a minimum regulatory criteria or a comparison to reference in drought years (years in which reference is within 2% of or below the regulatory wetland criteria (5% or 12.5% of the growing season).

Under normal climatic conditions, hydrology success criteria comprises saturation (free water) within 1 foot of the soil surface for a minimum of 5% of the growing season for the primary floodplain and bottomland hardwood (BH) quadrants depicted in Figure 21. The secondary floodplain and riverine swamp forest (SF) quadrants must support saturation (free water) within 1 foot of the soil surface for a minimum of 12.5% of the growing season. This hydroperiod translates to saturation for a minimum, 15-day (5%) to 35-day (12.5%) consecutive period during the growing season, which extends from February 25 through November 29 (USDA 1977).

In drought years, the hydroperiod must exceed 75% of the hydroperiod exhibited by the reference wells located within the same physiographic landscape area (Figure 21, BH or SF quadrants). If a well fails to meet target hydrological characteristics in a given year, the credit associated with that quadrant will be withheld until contingency measures are implemented and hydrology success criteria is achieved within that quadrant in following years.

6.3 SOIL

Mitigation activities will restore the periodic deposition and transport of river and stream sediments during overbank flood events. As a result, soils (Fluvaquents) are continuously reworked by fluvial processes. Because iron reduction rates (gleying) are not spatially or temporally uniform on recent alluvial deposits, soil color or other visual, hydric soil properties are not considered suitable for quantitative wetland soil monitoring/success criteria on active river floodplains.

Soil monitoring will entail measurement of sediment accretion/reduction (aggradation/ degradation) at the location of each monitoring well and other hydraulically active areas as identified by Site managers. Mitigation activities are designed to provide for flood and sediment storage from the watersheds. Therefore, hydraulic and energy dissipation patterns should be distributed throughout as much of the Site as possible. However, an area of particularly accelerated sediment deposition may raise land surfaces above the elevation of the primary wetland floodplain over a relatively short period of time. Conversely, deep scour holes or head-cuts may form in locations where flow velocity or sediment deficits exceed a "normal distribution". Soil monitoring is designed to provide a cursory review to predict the need for additional levee openings or drainageways if accelerated deposition or scour potentially jeopardizes wetland restoration efforts.

The re-bar used to support monitoring wells will be marked upon installation and in each monitoring year at the elevation of the existing ground surface. In addition, the height of silt lines will be recorded to predict the depth of inundation during the flood period. Additional re-bar will be placed and measured in high energy areas identified by Site managers, as needed. The change in elevation of the alluvial surface and deposition / scour patterns relative to flood elevations will be recorded and compared to previous years.

6.4 SOIL SUCCESS CRITERIA

Success criteria require that the deposition / scour rate not exceed over 1 foot change in surface elevations in any given year. Any areas affected by this excessive deposition / scour will be mapped in the field. The area will be reviewed to determine modifications to levees or drainage patterns that should be implemented, if any. Credit for the mapped area will be withheld until measures are taken to modify deposition / scour patterns or until success criteria are achieved. Changes in surface elevations of less than 1 foot per year will meet regulatory success criteria; however, modifications to deposition / scour patterns may also be considered in certain circumstances, such as scour in the vicinity of a backfilled ditch.

6.5 VEGETATION

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

Vegetation will receive cursory, visual evaluation during periodic reading of monitoring wells to ascertain the general conditions and degree of overtopping of planted elements by weeds. Subsequently, quantitative sampling of vegetation will be performed once annually during the fall (October / November) for 5 years or until vegetation success criteria are achieved. Sampling dates may be modified to accommodate river flood events and plot inundation, as needed.

During the first sample event, a visual survey will be performed in the reference wetlands to identify all canopy tree species represented within target communities. These reference tree species will be utilized to define "character tree species" as termed in the success criteria.

Permanent, 0.05-acre circular plots will be established at representative locations in the restoration area quadrants depicted in Figure 21. Each quadrant will support two randomly placed plots for a total of 20 plots. The plots will be randomly placed by obtaining bearing and distance from the well based on a random numbers table. The distribution will provide a 1% sample and a depiction of tree species available for expansion within restoration areas of the Site. In each plot, tree species and number of stems will be recorded and seedling/sapling/tree height measured. Tree data from each plot will be combined to calculate an average density, by species, represented in restoration quadrants.

In each plot, presence/absence of shrub and herbaceous species will be recorded. A wetland data form (DOA 1987) will be completed to document the classification and description of vegetation, soil, and hydrology.

6.6 VEGETATION SUCCESS CRITERIA

The vegetation success criteria has been designed to evaluate bottomland hardwood forest and riverine swamp forest separately. This division in success criteria by community type has been applied because bottomland hardwood forests typically contain relatively high tree species diversity while backwater swamp forests are characterized by relatively low diversity, sometimes dominated by one or two tree species.

Bottomland Hardwood Forest

The bottomland hardwood forest quadrants are depicted in Figure 21 as plots BH1 through BH 6. For these quadrants, a minimum mean density of 320 character trees/acre must be surviving for 3 years after initial planting. Subsequently, 290 character trees/acre must be surviving in year 4, and 260 character trees/acre in year 5. In addition, at least five character tree species must be present, and no species can comprise more than 20 percent of the 320 stem/acre total.

Riverine Swamp Forest

The riverine swamp forest quadrants are represented by plots SF1 through SF4 (Figure 21). For these partially inundated quadrants, an average density of 320 character tree species per acre must be surviving in the first three monitoring years. Subsequently, 290 character tree species per acre must be surviving in year 4, and 260 character tree species per acre in year 5. Planted species may represent up to 100% of the required stem per acre total. In a deficit situation, each naturally recruited species identified as character trees in reference may represent up to 20% of the required stem per acre total (ex: 3 naturally recruited species may represent up to 60% of the 320 stem/acre total).

If vegetation success criteria is not achieved based on average density calculations by community type, those individual plots that do not support the stem per acre requirement and the representative quadrant will be identified (Figure 21). Credit associated with that quadrant will be withheld and supplemental planting will be performed in that quadrant, as needed, until achievement of vegetation success criteria. Alternatively, that quadrant, or a portion of the quadrant, may be mapped and classified as emergent (non-forested) wetland and acre-credits by wetland type altered accordingly. In any circumstance, the credit associated with individual quadrants will be released if the plots in that quadrant achieve success criteria.

No quantitative sampling requirements are proposed for herb and shrub assemblages. Development of a forest canopy over several decades and restoration of wetland hydrology will dictate success in migration and establishment of desired wetland understory and groundcover populations.

6.7 REPORT SUBMITTAL

An Annual Wetland Monitoring Report (AWMR) will be prepared at the end of each monitoring year (growing season). The AWMR will depict the sample plot and quadrant locations and include photographs which illustrate site conditions. Data compilations and analyses will be presented as described in Sections 6.1 through 6.6 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 AWMR.

7.0 IMPLEMENTATION SCHEDULE

Project implementation will include performance of restoration work in four primary stages: 1) embankment construction, levee removal, stream repair, auxiliary ditch backfilling, and site preparation; 2) channel diversion, primary ditch backfilling, and plug construction; 3) tree and shrub planting; and 4) monitoring plan Implementation. This mitigation plan or implementation schedule may be modified based upon civil design specifications, permit conditions, or contractor limitations. The schedule assumes that restoration activities are initiated in the spring of 2000.

Stage 1: Embankment Construction, Auxiliary Ditch Backfilling, and Site Preparation

Stage 1 will be performed in the spring of 2000 after groundwater tables have dropped, on average, more than one foot from the soil surface based on monitoring wells. Embankments will be constructed and allowed to revegetate and stabilize prior to Stage 2 efforts. During the period, auxiliary ditches will be backfilled and the river levee removed at designated locations. Excavated earthen material will be stockpiled, as needed, for use during Stage 2 activities. Soil scarification, hand clearing of the stream corridor, and woody debris deposition will also be performed. The Site will not be bush-hogged after Stage 1 to provide maximum vegetation roughness and cover for the remaining implementation period.

Stage 2: Channel Diversion, Primary Ditch Backfilling, and Plug Construction

Stage 2 will be performed in the summer after constructed embankments and floodplain surfaces have revegetated and stabilized. This effort will entail diversion of stream flows into the vegetated, backwater slough and prepared, historic channel. Subsequently, primary floodplain ditches will be backfilled and ditch outlet plugs constructed adjacent to Bear Creek. Nursery contacts and reservation of seedlings will be completed prior to or during Stage 2.

Stage 3: Tree Planting

Tree and shrub planting will be performed during the winter of 2000/2001 while seedlings are dormant. All planting activities will be completed prior to February 15, 2001 to allow for stabilization of the soil environment prior to the growing season.

Stage 4: Monitoring Plan Implementation

Monitoring wells and permanent vegetation plots will be established prior to the growing season (February 25, 2001). The Site will be visited frequently to read monitoring wells and to evaluate wetland development during the spring and summer of 2001. Vegetation sampling will be performed in the fall of 2001 (Section 6.5). Hydrology monitoring would be completed on 29 November 2001, the end of the growing season (Section 6.1). The first year of monitoring would be completed upon submittal of the annual wetland monitoring report and fulfillment of success criteria in December 2001. The monitoring sequence will be repeated as described for four additional years (to December 2005) or until success criteria are achieved.

8.0 WETLAND PRESERVATION AREAS

Wetland preservation areas will be established as part of this restoration effort to provide for contiguous, protected regional corridors to the restoration Site. Preservation areas are also being evaluated to maintain existing, unique wetland refuges that remain in the project area.

Figure 22 depicts 9 wetland preservation sites that are currently being evaluated as viable alternatives for mitigation use. Two additional sites are also being evaluated, including a 2-mile reach the Neuse River floodplain immediately below Kinston and Bogue Marsh, which abuts the Neuse River approximately 4 miles southwest of the Site.

All the sites are located within the Bear Creek or Neuse River floodplains and support bottomland hardwood and/or riverine swamp forest communities, similar to those found within the Site. Approximately 300 wetland acres within these properties will be acquired and/or protected through conservation easements. The wetland acreage will be determined by aerial photographic interpretation, limited field review, and placement of NRCS hydric soil boundaries on the property tax map. These preservation sites will be protected and managed in tandem with the Bear Creek-Mill Branch Site, as part of an regional wetland and wildlife corridor.

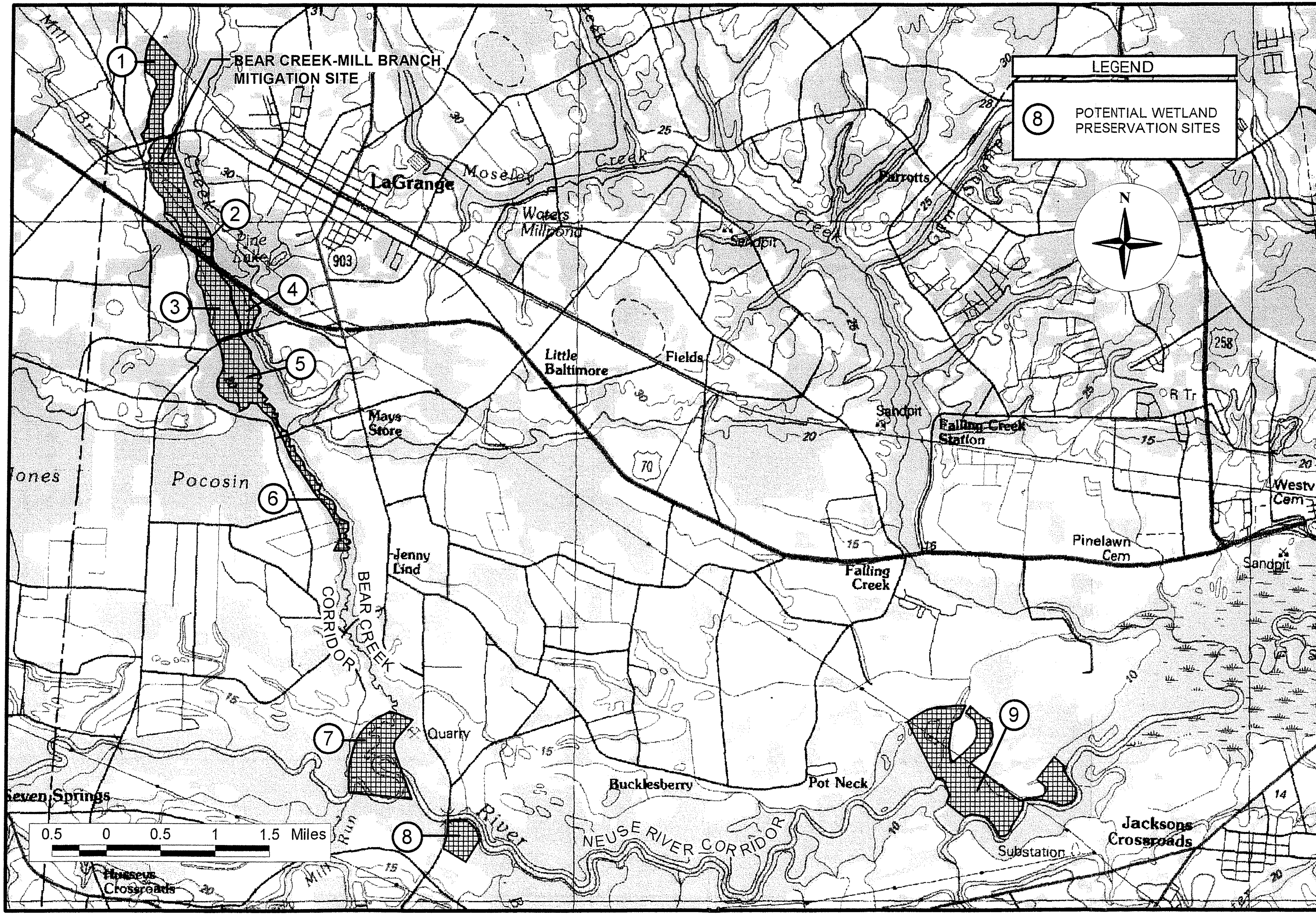


Figure 22

Date: OCT 1999

Scale: AS SHOWN

ESC Job #: 99-016

Project: **POTENTIAL WETLAND PRESERVATION SITES**

Bear Creek-Mill Branch Mitigation Site
Lenoir County, North Carolina

Client: *Restoration* SYSTEMS
114 White Lake Court
Morrisville, NC 27560

EcoScience Corporation
612 Wade Ave., Suite 200
Raleigh, North Carolina 27605
Ph: 919 828-3433 Fax: 919 828-3518

9.0 DISPENSATION OF PROPERTY

For the Bear Creek-Mill Branch Mitigation Site, Restoration Systems will remain responsible for project implementation and achievement of success criteria. However, Restoration Systems intends to immediately transfer the land deed and an attached conservation easement to the North Carolina Wildlife Habitat Foundation (Appendix B).

For the wetland preservation areas, Restoration Systems will procure conservation easements that protect the land in perpetuity. The easements will be transferred to the North Carolina Wildlife Habitat Foundation. Perpetual easements may include (but are not limited to) the following items:

1) Wildlife harvesting activities in mitigation areas will be allowed to continue under local tradition, dependent upon site constraints, and based on management plans of the North Carolina Wildlife Habitat Foundation (easement holder).

2) Garbage dumping, forest clearing, or other disturbances in mitigation areas will be regulated, monitored, and eliminated. Road access to the mitigation area, if maintained after restoration for management use, will be appropriately gated to prevent dumping activity.

3) Protective covenants on the mitigation land will specify that the land be allowed to succeed to specified tree densities, composition, and sizes before timber harvest is considered. After the successional phase, covenants will stipulate that there is to be no forest clear-cutting and no selective timbering that lowers per-acre stem counts below a target density of 6 non-pine trees per acre greater than 20 in. in diameter (within each acre of mitigation area). Managing for the presence of large trees is required to provide potential habitat for species typical of mature growth wetland forests. In addition, densities of non-pines greater than 10 inches in diameter will be maintained at or greater than 30 ft^2 of basal area per acre (for each acre of land) to provide adequate foraging potential for mast-consuming wildlife (Yoakum *et al.* 1980).

4) Dead and dying trees, snags, and logs will be left on-site to provide foraging habitat as well as to provide cavity formation potential for species such as wood duck, pileated woodpecker, and barred owl (Yoakum *et al.* 1980).

10.0 WETLAND FUNCTIONAL EVALUATIONS

Mitigation activities at the Bear Creek-Mill Branch Site and regional preservation areas should be determined based on wetland functions generated and a comparison of restored functions to potentially impacted wetland resources. Therefore, an evaluation of mitigation wetlands, by physiographic area (Figure 4), is provided to evaluate site utility for mitigation in the region.

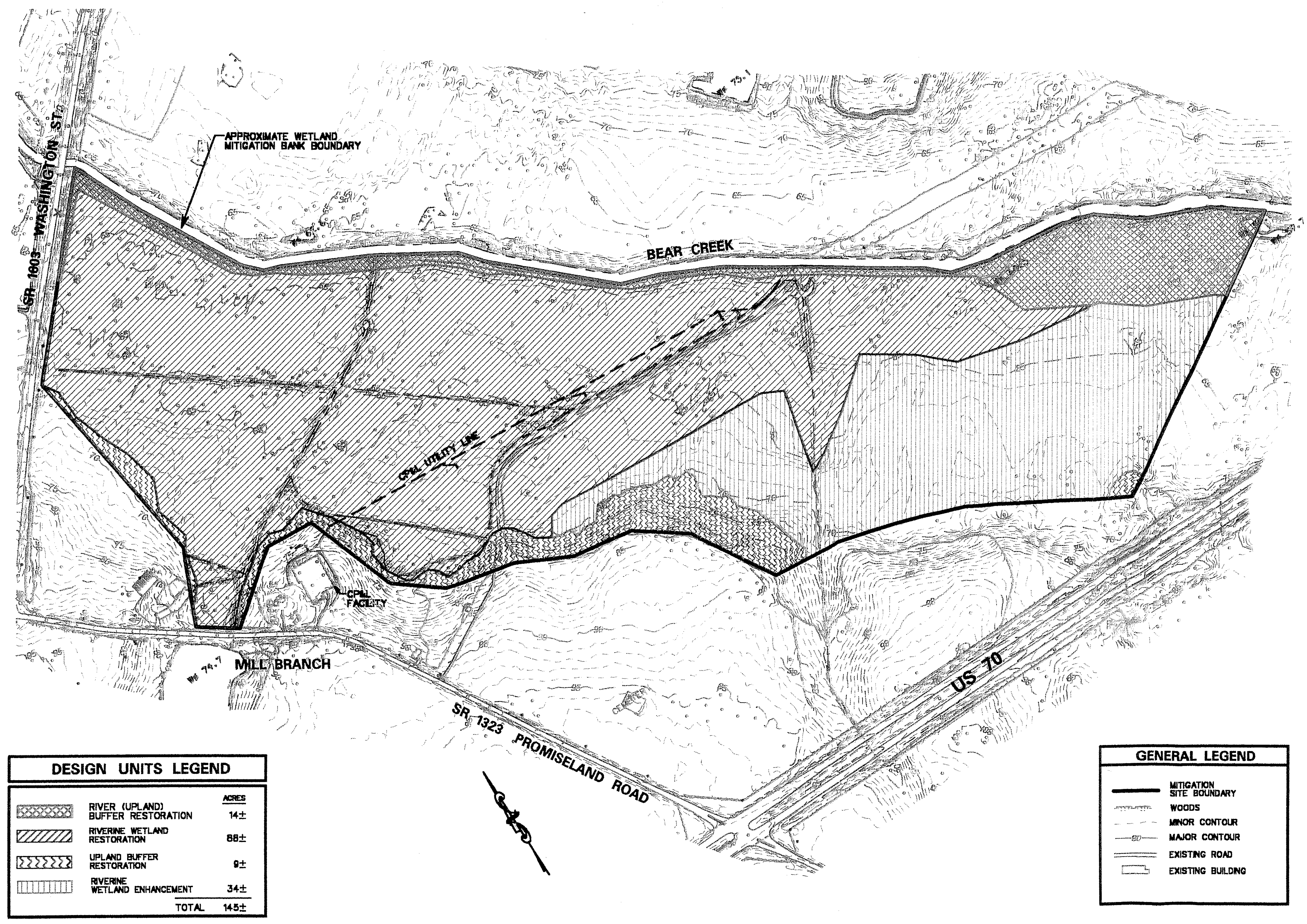
Hydrodynamic functions have been degraded or effectively eliminated due to construction of drainage networks, river and stream dredging, soil leveling/compaction, and removal of characteristic vegetation. Features which depict performance of hydrodynamic wetland functions, such as surface microtopography, seasonal ponding, stream channels, forest vegetation, and characteristic wetland soil properties have been reduced or eliminated by alternative land uses. Reduction or elimination of wetland hydrology has also negated nutrient cycling and biological functions within the complex. These former wetlands do not support natural communities adapted to wetlands or the wetland dependent wildlife characteristic in the region.

10.1 RIVERINE WETLAND RESTORATION AND ENHANCEMENT

The riverine floodplain physiographic area encompasses approximately 130 acres (Figure 4). Based on restoration analyses (Section 4.0), the area includes approximately 68 acres of wetland restoration in former crop land and 20 acres of wetland restoration in forested areas. Figure 23 and Table 15 depict the area of riverine wetland restoration, totaling 88 acres. The remaining 42 acres includes 34 acres of riverine wetland enhancement in forested areas and 8 acres of floodplains that will remained effectively drained immediately adjacent to the Bear Creek canal.

Restoration plans will re-introduce surface water flood hydrodynamics from a 54 square mile watershed. The plan includes establishment of an array of riverine communities, including levee forest, bottomland hardwood forests, riverine swamp forests, and backwater cypress-gum swamps. Therefore, riverine hydrodynamic and biogeochemical functions will be restored, including pollutant removal, organic carbon export, sediment retention, nutrient cycling, flood storage, and energy dissipation. Physical wetland functions typically associated with water quality will be replaced within the Neuse River basin.

Biological functions associated with the riverine system will also be restored including in-stream aquatic habitat, structural floodplain habitat, and interspersion and connectivity between the restored stream, floodplain, and adjacent uplands.



EcoScience Corporation
612 Wade Avenue, Suite 200
Raleigh, North Carolina 27605
Ph: 919. 828 3433
Fax: 919 828-3518

Client:
Restoration SYSTEMS
114 White Lake Court
Morrisville, NC 27560

Project:
MITIGATION DESIGN UNITS
BEAR CREEK - MILL BRANCH
WETLAND RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Dwn By: MAF	Date: AUG 1999	Figure	23
Ckd By: JWN	Scale: 1"= 400'		
ESC Project No.: 99-016			

TABLE 15
Mitigation Credit
Bear Creek-Mill Branch Mitigation Site

Mitigation Design Unit	Area (acres)	Mitigation Credit Ratio[1]	Replacement Credit (acre credits)
On-Site Riverine Wetland Restoration	88	1.8:1[2]	49
On-Site Riverine Wetland Enhancement	34	4:1	9
On-Site Upland Buffer Restoration	23	-----[2]	-----
Off-Site Riverine Wetland Preservation	300	10:1	30
TOTAL	445	5.06:1	88
Riparian Buffer Establishment	4	1770 linear feet both sides of channel (3rd order stream or less). If used, buffer credit will be allotted by reducing the wetland replacement credits by 1 credit per 885 feet of buffer (2 wetland credits total)[3].	
	4	1620 linear feet both sides of channel (fifth order river or less). If used, buffer credit will be allotted by reducing the wetland replacement credits by 1 credit per 1620 linear feet. (1 wetland credit total)[3].	
Neuse River Nitrogen Removal	-----	Projected 100,000 pounds/year (45,359 kilograms/year) (Table 3)	

1: Mitigation credit ratios denote mitigation acres : impact acres

2: Restoration of upland ecotones and wetland buffers generates reduced credit ratios for wetland restoration in the complex. Because, upland discharge buffers may provide up to a 20% increase in wetland functions (NCDOT 1994), mitigation ratios in restored wetland areas are reduced to 1.8:1 to reflect derived wetland functional benefits.

3: Buffers for third order streams or less reside within wetland restoration areas. Therefore, the buffer acreage is deducted at a ratio of 2 acres of buffer : 1 wetland replacement acre-credit.
Buffers for fifth order rivers or less reside within upland buffer restoration areas. Therefore, the riparian buffer acreage is deducted at a ratio of 5 acres of buffer : 1 wetland replacement credit.

10.1.1 Neuse River Nitrogen Reduction

Restoration plans are designed to reduce nutrient loading from the Bear Creek watershed into the Neuse River. Based on nutrient analyses (Section 3.5.2), flows bypassing the Site transport approximately 2,575,000 pounds of nitrogen into the Neuse River each year (Table 3). Of this total, the Mill Branch watershed exports approximately 144,000 pounds per year. Floodplain restoration will provide direct processing of Mill Branch flows and is projected to remove 100,000 pounds of nitrogen per year from the watershed. This 100,000 pound per year estimate represents a conservative value that does not include nitrogen removal from Bear Creek by restoration of periodic river flooding and deposition into the Site.

10.2 RIVERINE WETLAND PRESERVATION

Approximately 300 acres of wetland preservation will be incorporated into the Bear Creek-Neuse River corridor in support of wetland restoration activities at the Site. The preservation areas will promote regional connectivity to the wetland restoration area for wildlife movement and use. The preservation areas will also assist in ensuring that water quality benefits realized by wetland restoration are not negated by adjacent changes in land use on river floodplains.

10.3 RIPARIAN BUFFERS

Riparian buffers, as described in the Neuse River Nutrient Sensitive Waters Management Strategy, are lacking on streams and rivers within the Site. Effective restoration of these buffers will serve to provide water quality benefits, including nitrogen removal from the supporting watersheds.

Approximately 1770 linear feet of channel along Mill Branch and 3240 feet along the southwest side of Bear Creek do not support riparian buffers. Restoration plans will effectively restore these forested buffers within 50 feet of the streams. The Mill Branch riparian buffer encompasses approximately 4 acres within the wetland restoration area. The Bear Creek buffer resides on approximately 4 acres of the river levee (upland) physiographic area described below.

10.4 UPLAND/WETLAND ECOTONES

The groundwater slope and levee physiographic areas encompass approximately 15 acres (Figure 4). These areas, along with approximately 8 acres of the Bear Creek floodplain described above, will serve as upland/wetland ecotones and groundwater discharge slopes located immediately adjacent to riverine floodplains (23 acres total).

Integration of wetland and upland interfaces represents an important component of wetland restoration plans. Restored wetland buffers provide an ecological gradient from uplands to wetlands and establish streamside management zones (SMZs) along the riverine floodplain. Without upland restoration/enhancement and wetland buffer establishment, intrinsic functions in adjacent, restored wetlands may be diminished or lost. In addition, a number of biological and physical wetland parameters are also enhanced by the presence of wetland/upland ecotones on the mitigation site (Brinson *et al.* 1981). Mitigation credit in adjacent wetlands will be modified to depict the functional benefit derived from upland forest restoration; no direct credit is proposed for the upland buffer acreage.

Restoration and enhancement within the groundwater slope area will assist in successful restoration of the adjacent riverine floodplain. Important hydrodynamic and biogeochemical functions restored include moderation of groundwater flow and discharge towards the floodplain, dynamic surface water storage, long term surface water storage, and subsurface water storage. Characteristic pools, seeps, ephemeral and intermittent streams characteristic of reference wetlands would be expected to re-establish along the base of upland groundwater slopes due to restoration. Garbage dumping in wetlands would also be inhibited due to these upland buffers abutting the floodplain.

Biotic functions potentially restored within the wetland/upland complex include re-introduction of habitat for certain terrestrial and semi-aquatic wildlife guilds. Species populations promoted include those dependent upon interspersion and connectivity with bottomland areas along with the need for forest interior habitat. These riparian and non-riparian wetland interactions are considered degraded throughout a majority of the project region as agricultural lands dominate intermediate landscape positions (between interstream and riverine wetland habitat). Habitat value and community maintenance functions will also be improved by creation and interconnection of five plant community types, including uplands, along the restored environmental gradient.

10.5 MITIGATION CREDIT

Mitigation credit has been established based upon Environmental Protection Agency (EPA) guidelines (Page and Wilcher 1990). Table 15 depicts mitigation credit allotted within each wetland type. In summary, approximately 88 wetland replacement credits may become available for compensatory mitigation use. In addition, the Site provides for 3390 linear feet of riparian buffer credit and a projected, 100,000 pounds per year of nitrogen removal in the Neuse River Basin.

11.0 REFERENCES

Baumer, O. and J. Rice. 1988. Methods to predict soil input data for DRAINMOD ASAE Paper No. 88-2564. ASAE, St. Joseph, MI 49085.

Beets, C.P. 1992. The relation between the area of open water in bog remnants and storage capacity with resulting guidelines for bog restoration. (in) Peatland Ecosystems and Man: An Impact Assessment. (ed.) O. M. Bragg, P. D. Hulme, H. A. P. Ingram, and R.A. Robertson. International Peat Society. University of Dundee, Dundee, Scotland.

Belcher, H.W. and G.E. Merva. 1987. Results of DRAINMOD verification study for Zeigenfuss soil and Michigan climate. ASAE Paper No. 87-2554. ASAE, St. Joseph, MI 49085.

Brinson M.M., F.R. Hauer, L.C. Lee, W.L. Nutter, R.D. Smith, D. Whigham. 1995. Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. U.S. Army Corps of Engineers Waterways Experiment Station. Vicksburg, MS.

Brinson, M.M. 1993a. Changes in the functioning of wetlands along environmental gradients. Wetlands 13(2): 65-74, Special Issue, June 1993. The Society of Wetland Scientists.

Brinson M.M. 1993b. A Hydrogeomorphic Classification for Wetlands. Wetlands Research Program Technical Report WRP-DE-4. U.S. Army Corps of Engineers Waterways Experiment Station. Vicksburg, MS.

Brinson M., B. Swift, R. Plantico, J. Barclay. 1981. Riparian Ecosystems: Their ecology and status. U.S. Fish and Wildlife Service FWS/OBS 81/17

Brower, J.E., J.H. Zar, C.N. von Ende. 1990. Field and Laboratory Methods for General Ecology. William C. Brown Publishers, Debuque, IA.

Brown, Philip M., et al. 1985. Geologic Map of North Carolina, North Carolina Department of Natural Resources and Community Development, 1-.500,000 scale.

Department of the Army (DOA). 1993 (unpublished). Corps of Engineers Wilmington District. Compensatory Hardwood Mitigation Guidelines (12/8/93).

Department of the Army (DOA). 1987. Corps of Engineers Wetlands Delineation Manual. Tech. Rpt. Y-87-1. US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Division of Water Quality (DWQ). 1998. Classifications and Water Quality Standards Assigned to the Waters of the Neuse River Basin, N.C. Department of Environment and Natural Resources, Raleigh, N.C.

Division of Water Quality (DWQ). 1997. Neuse River Nutrient Sensitive Waters Management Strategy. North Carolina Department of Environment and Natural Resources.

Division of Water Quality (DWQ). 1996. Water Quality Certification Administrative Code Section: 15A NCAC 2H.0500 as amended October 1, 1996. North Carolina Department of Environment and Natural Resources.

Environmental Protection Agency (EPA). 1992. Mitigation Banking Guidance. EPA Region IV, Atlanta, GA.

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.

North Carolina Department of Transportation (NCDOT). 1994a; unpublished. Determination of applicable mitigation credit For restoration of wetland buffers and wetland/upland ecotones: US 64 wetland restoration and conservation management plan, US 64 relocation, Martin and Edgecombe Counties, North Carolina. N.C. Department of Transportation. Raleigh, N.C.

Fouss, J.L., R.L. Bengtson and C.E. Carter. 1987. Simulating subsurface drainage in the lower Mississippi Valley with DRAINMOD. Transactions of the ASAE 30 (6).(1679 - 1688).

Gayle, G., R.W. Skaggs and C.E. Carter. 1985. Evaluation of a water management model for a Louisiana sugar cane field. J. of Am. Soc. of Sugar Cane Technologists, 4: 18 - 28. Graham County Historical Society, 1992. Graham County Heritage. Robbinsville, NC.

Hvorslev, M.J. 1951. Time lag and soil permeability in groundwater observations. U.S. Army Corps of Engineers Waterways Experimental Station Bulletin 36, Vicksburg, MS.

Keller, M.E., C.S. Chandler, J.S. Hatfield. 1993. Avian Communities in Riparian Forests of Different Widths in Maryland and Delaware. Wetlands 13(2):137-144, Special Issue, June 1993. The Society of Wetland Scientists.

Page, R.W. and L.S. Wilcher. 1990. Memorandum of Agreement Between the EPA and the DOE Concerning the Determination of Mitigation Under the Clean Water Act, Section 404(b)(1) Guidelines. Washington, DC.

Rogers, J.S. 1985. Water management model evaluation for shallow sandy soils. Transactions of the ASAE 28 (3): 785-790.

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.

Schouwenaars, J.M. 1995. The selection of internal and external water management options for bog restoration. (in) Restoration of Temperate Wetlands. (ed.) B. D. Wheeler, S. C. Shaw, W. J. Fojt, and R. A. Robertson. John Wiley & Sons, Ltd. West Sussex, England.

Sharitz, R.R. and J.W. Gibbons. 1982. The Ecology of Southeastern Shrub Bogs (Pocosins) and Carolina Bays: A Community Profile. U.S. Fish and Wildlife Service. FWS/OBS-82/04.

Skaggs, R.W. 1982. Field Evaluation of a Water Management Simulation Model. Transactions of the ASAE 25 (3), pp 666-674.

Skaggs, R.W., N.R. Fausey, B.H. Nolte. 1981. Water Management Evaluation for North Central Ohio. Transactions of the ASAE 24 (4), pp 922-928.

Skaggs, R.W., J.W. Gilliam, R.0. Evans. 1991. A Computer Simulation Study of Pocosin Hydrology. Wetlands (11), pp 399-416.

Skaggs, R.W., et al. 1993. Methods for Evaluating Wetland Hydrology. ASAE Meeting Presentation Paper No. 921590. 21 p.

Smith, R.D., A. Ammann, C. Bartoldus, M.M. Brinson. 1995 (unpublished). An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices. Wetlands Research Program Technical Report WRP DE-___. US Army Engineer Waterways Experiment Station, Vicksburg, MS

Strahler, A.N. 1964. Geology. Part II. Quantitative geomorphology of drainage basins and channel networks. (in) Handbook of Applied Hydrology. (ed. V.T. Chow), pp. 4-39 to 4-76, McGraw Hill, New York.

Susanto, R.H., J. Feyen, W. Dierickx, G. Wyseure. 1987. The Use of Simulation Models to Evaluate the Performance of Subsurface Drainage Systems. Proc. of the Third International Drainage Workshop, Ohio State University, OH. pp. A67 - A76.

U.S. Department of Agriculture (USDA). 1987. Hydric Soils of the United States. In cooperation with the National Technical Committee for Hydric Soils, USDA Natural Resource Conservation Service.

U.S. Department of Agriculture (USDA). 1977. Soil Survey of Lenoir County, North Carolina. Natural Resource Conservation Service.

U.S. Geological Survey. 1974. Hydrologic Cataloging Unit Map for the State of North Carolina.

Wetland Restoration Program (WRP). 1998. Basinwide Wetlands and Riparian Restoration Plan for the Neuse River Basin. N.C. Division of Water Quality, Department of Environment and Natural Resources.

Yoakum, J., W.P. Dasmann, H.R. Sanderson, C.M. Nixon, and H.S. Crawford. 1980. Habitat Improvement Techniques. Pp 329-403 in S.D. Schemnitz (Editor). Wildlife Management Techniques Manual, 4th ed., rev. The Wildlife Society, Washington, DC 686 pp.

12.0 APPENDICES

Appendix A: Nutrient Loading Coefficients by Land Use provided by the N.C. Division of Water Quality

Appendix B: Correspondence from the North Carolina Wildlife Habitat Foundation

Appendix A

Nutrient Loading Coefficients by Land Use provided by the N.C. Division of Water Quality

Total Nitrogen and Phosphorus Load Estimation Worksheet

Post-it® Fax Note 7671
Date 3/14 | # of pages ▶ 1
To Jerry Mullins | From Barry Rehills
Co./Dept. ESS | Co. DWQ
Phone # | Phone # 733-5083 x 558
Fax # 833-0078 | Fax #

Introduction

This spreadsheet program is designed to allow the land manager to conduct quick calculations of the impacts of landcover changes on nutrient loads. The purpose of this model is to allow the user to run a variety of "what-if" scenarios.

Table 1. Landuse and Export Coefficients lbs/acre/yr

	Total N (kg/ha/yr)		Total P (kg/ha/yr)	
Landuse	Range	Median	Range	Median
Forest	0.67 - 2.6	1.9	0.01 - 0.50	0.13
Pas/Undev/Mgd. Herb.	2.91 - 6.12	4.9	0.14 - 4.9	0.8
Crops	9.65 - 21.30	15.2	0.26 - 18.6	2.41
Industrial/Commercial	12.55 - 14.79	14.6	1.46 - 1.79	1.57
Low Dens. Urban	4.0 - 7.74	6.39	0.28 - 1.01	0.62
Med/High Dens. Urb/Inst	6.95 - 9.86	9.63	1.01 - 1.91	1.12
Residential(general)	5.0 - 9.64	8.3	0.28 - 1.01	0.62
Atmospheric(open H2O)		9.8		

Table 2. Estimating Total Nutrient Loads

Project Title: ____________________

	Nitrogen Loads				Phosphorus Loads		
Landuse	Area (ha)	Coef. (kg/ha/yr)	Tot. N Load	% of N	Coef. (kg/ha/yr)	Tot. P Load	% of P
Forest	[redacted]	[redacted]	34.5	1.67	[redacted]	18	12.95
Pas/Undev/Mgd. Herb.	[redacted]	[redacted]	196	9.47	[redacted]	16	11.51
Crops	[redacted]	[redacted]	375	18.11	[redacted]	5	3.60
Industrial/Commercial	[redacted]	[redacted]	144.45	6.98	[redacted]	15	10.79
Low Dens. Urban	[redacted]	[redacted]	257.6	12.44	[redacted]	32.2	23.17
Med/High Dens. Urb/Inst	[redacted]	[redacted]	146.97	7.10	[redacted]	11.5	8.27
Residential(general)	[redacted]	[redacted]	72.8	3.52	[redacted]	2.6	1.87
Atmospheric(open H2O)	[redacted]	[redacted]	842.8	40.71	[redacted]	38.7	27.84
	263		2070.12	100		139	100

Procedures:
Notes: All non-shaded cells are locked
Pie Charts of results are on Page 2

To quickly determine an estimate of potential nitrogen loading to surface waters follow these steps:
1. Determine landcover classification for the study area.
2. Determine area of each landcover and enter in Table 2, First highlighted Column
3. Use Table 1 and determine appropriate export coefficients for the landcovers you determined. In most cases the median value is usually best. For special circumstances, however, a range is provided that allows you to pick a more appropriate export coefficient.
4. Enter coefficients into Table 2, Second highlighted Column for Nitrogen and Third Highlighted Column for Phosphorus.
5. Calculations are automatically performed and pie charts of results are presented on Page 2.

lbs/ac/yr

Appendix B

Correspondence from the North Carolina Wildlife Habitat Foundation

NORTH CAROLINA WILDLIFE HABITAT FOUNDATION

October 1, 1999

Mr. John Preyer
Restoration Systems
307-B Middle St.
New Bern, NC 28560

Dear John:

This letter will serve as a follow-up to our previous conversations concerning your wetland restoration site along Bear Creek in Lenoir County. The North Carolina Wildlife Habitat Foundation would like to be considered as the recipient of this property when you place it under a conservation easement.

As you know, the North Carolina Wildlife Habitat Foundation is a non-profit 501 (c) (3) (#58-2011100) organization devoted to land and habitat conservation. Our mission statement is to assist in the aquisition, management and protection of wildlife habitat within the state of North Carolina for the benefit of future generations.

As a former board member of the North Carolina Wildlife Resources Commission for twelve years, I have substantial experience with the management of different types of land and wildlife habitat, including bottom land hardwood forest. Our organization would be glad to coordinate our management strategy with Restoration Systems and the appropriate regulatory agencies, to insure the highest level of care be given to the long term maintenance of the property.

The location of this site and its close proximity to both the Neuse River and to Highway 70 make it an area of great educational potential for people with an interest in conservation and the environment. I would like to incorporate some type of trail or "greenway" along Bear Creek that would make the property accessible for young people whether it be school groups or scouts, if that is possible. There is much that we could do to make the property a shining example of how a wetland ecosystem functions and its impact on habitat.

I look forward to hearing from you soon.

Sincerely,

Eddie C. Bridges, Exec. Dir.

P. O. Box 29187
Greensboro, NC 27429-9187
336/375-4994